Dissertation

Competencies for midwifery ultrasound education and practice in South Africa

Submitted by

Charné Eloise Human

1999228818

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Supervisor: Dr C. Spies

Declaration

"I, **Charné Eloise Human,** declare that the Master's Degree research dissertation or interrelated, publishable manuscripts/published articles, or coursework Master's Degree mini-dissertation that I herewith submit for the Master's Degree qualification **NVRT 8900** at the University of the Free State is my independent work, and that I have not previously submitted it for a qualification at another institution of higher education."

2 February 2021

Signature **Date**

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List of Acronyms

Acronyms	Description
4IR	Fourth Industrial Revolution
HPCSA	Health Practitioners Council in South Africa
ICM	International Confederation of Midwives
IP U/S	Intrapartum ultrasound
ISUOG	International Society in Ultrasound in Obstetrics and Gynaecology
SA	South Africa
SA DoH	South Africa, Department of Health
SANC	South African Nursing Council
SASUOG	South African Society of Ultrasound in Obstetrics and Gynaecology
SAQA	South African Qualification Framework
SB	Stillbirth/s
SBR	Stillbirth rate
SDG	Sustainable developmental goals
SGA	Small for gestational birth
SOMSA	Society of Midwives of South Africa
SORSA	Society of Radiographers of South Africa
U/S	Ultrasound
WHO	World Health Organization

Concept clarification

The following concepts are relevant to this research study, and are listed in alphabetical order. The concept clarification and operationalisation ensures a clear interpretation of each concept listed. The chosen concepts are based on the research topic and components found within the field of midwifery to reduce ambiguity.

Advanced Midwife/ Midwife Specialist: An Advanced Midwife refers to a Registered Midwife who has completed a Postgraduate Diploma in Advanced Midwifery and Neonatology and is registered with the South African Nursing Council (SANC) (Regulation 368, SANC, 2014(a):1) or a Clinical Master's Degree.

On the 15 March 2014, the then Health Minister Aaron Motsoaledi announced that the Advanced Midwife would onwards be referred to as "Midwife Specialist" (SANC, 2014[a]:1). A midwife specialist is a specialist clinician with a broad autonomous practice managing a specific caseload. The midwife specialist may function as first entry-point and needs the knowledge and expertise to be able to accurately assess, diagnose and manage the patient population in the speciality area. The midwife specialist makes medical diagnoses and prescribes treatment, which requires capacity in diagnostic testing and treatment beyond the normal practice of the nurse/midwife. In South Africa, the midwife specialist may practice as an independent midwife practitioner, although not being exclusive to this category (Duma, Dippenaar, Bhengu, Oosthuizen, Middleton, Phillips, Naude & Uys, 2012:np).

Midwifery Ultrasound (U/S) Competence: According to the International Confederation of Midwives (ICM) (2013:19) the act of being competent refers to a multilayered concept that includes the combination of knowledge, psychomotor, communication, and decision-making skills that enable an individual to perform a specific task (Fullerton, Butler, Aman & Reid, 2011:e416; ICM, 2013:19;). Competence is assessed, demonstrated or observed according to a defined level of proficiency (ICM, 2013:19). In this study, midwifery U/S competence refers to the combination of knowledge, psychomotor, communication and decision-making skills that enable a midwife to perform specific midwifery U/S tasks to a defined level of proficiency.

Midwifery U/S Competency: Competency is defined as the specific minimum set of characteristics/concepts related to the combination of knowledge, skill and professional behaviour that underpins the performance of tasks associated with competence (Fullerton *et al*., 2011:6; ICM, 2013:19). The ICM competencies are presented in a framework consisting of four categories (ICM, 2018:2). In this study, midwifery U/S competencies refer to six categories, called domains, which include the specific minimum set of characteristics/concepts that underpin the performance of midwifery U/S competence. The set of characteristics/concepts for each of the six midwifery U/S domains are founded on the combination of knowledge, specific skills and professional behaviour required for competence.

Consensus: Consensus is achieved when at least two-thirds of the respondents agree on the issue at hand (Audige, Schwyzer, & Durchloz *et al.*, 2019:2063). A consensus level is set (e.g. 70%) and once the pre-determined percentage of the expert panel has come to an agreement on the importance or position of the statement, it is said to have reached consensus (Keeney, Hasson & McKenna, 2011:5). In this study and in the context of using the Delphi technique, consensus refers to the decision reached by the majority agreement of expert opinion in the field of midwifery U/S education and practice.

Midwife: The ICM defines a midwife as "a person who has completed a midwifery education programme that is based on ICM Essential Competencies for Basic Midwifery Practice and the framework of the ICM Global Standards for Midwifery Education and is recognised in the country where it is located; who has acquired the requisite qualifications to be registered and/or legally licensed to practise midwifery and use the title 'midwife'; and who demonstrates competency in the practice of midwifery " (ICM, 2017:online). In the South African context, the midwife is a person who has completed a four-year Diploma or Baccalaureus Degree (SANC Regulation 425, 1985:online) in General Nursing, Community, Psychiatry and Midwifery. A diploma in midwifery (Regulation 425) as a one-year post-basic qualification in midwifery is needed for a general nurse (SANC Regulation 368, 2014[b]) to be qualified as a midwife.

Perinatal: The World Health Organization (WHO) states that the perinatal period begins at 22 completed weeks (154 days) of gestation and ends after seven completed days after birth (WHO, 2019[a]:online). In this study, the perinatal period commences at 28 weeks of gestation (viability as defined by the Department of Health (SA DoH) in South Africa (2016:92) and ends at seven completed days after birth.

Stillbirth: A stillbirth refers to the death of a fetus ≥28 weeks of gestation and/or ≥1000 g birth weight (Lawn, Blencowe, Pattinson, Cousens, Kumar, Ibiebele, Gardosi, Day & Stanton, 2011:1451).

Stillbirth rate: The number of stillbirths per every 1 000 live births (WHO, 2016 [6]:online).

Task shifting: The WHO defines task shifting as the process of delegation, through which tasks are moved to less specialised health professionals. Task shifting is a viable and valuable solution to improve healthcare coverage by using human resources more efficiently. In turn, the accessibility of healthcare is enhanced (WHO, 2008:online). In this study, the definition as given will be used in the context of U/S screening of a person seeking reproductive health care.

Ultrasound: In this study, ultrasound (U/S) refers to the diagnostic use of U/S for female reproductive health to form a two-dimensional image used for evaluating normality. Diagnostic U/S is a sophisticated electronic technology, which utilises pulses of high-frequency sound to produce an image. The diagnostic U/S examination can be used in a variety of specific circumstances during pregnancy, such as after clinical complications, or where there are concerns about fetal growth (Whitworth, Bricker, Neilson & Dowswell, 2015:1). The childbearer may also use U/S (two-, three- or four-dimensional image) for picturing and bonding.

Abstract

Background: The benefits of U/S for the childbearing family has been widely documented, and lately, the childbearers' preference of intrapartum U/S above vaginal examination for progression of labour has emerged. Accessibility of U/S during the childbearing period in low-to-middle income countries such as South Africa is inadequate. Midwives, as the most appropriate skilled birth attendant are best positioned to perform U/S during pregnancy, intrapartum and the postpartum period. The use of midwifery U/S is recognised internationally by the ICM and nationally by SOMSA. However, in South Africa, midwifery U/S education and training is unaccredited and unregulated by SANC and the South African Qualification Authority (SAQA).

Aim: The study aimed to describe the consensus reached by expert opinion on the competencies for midwifery U/S education and practice for South Africa.

Design: A quantitative descriptive research design with a modified e-Delphi technique was implemented. A heterogeneous group of U/S experts representing midwives, sonographers, and obstetricians and gynaecologists in South Africa contributed to consensus on 118 elements of six competency domains of midwifery U/S education and practice.

Results: Expert consensus was reached on midwifery U/S competencies for education and practice in South Africa to include 52 elements pertaining to pregnancy, intrapartum and postpartum midwifery U/S.

Conclusion: With the exclusion of gynaecological U/S competence, the South African midwifery U/S competency elements are comparable to the ISUOG’s basic U/S training. It was clear that the experts were in agreement on the essential elements needed for midwifery U/S. The experts indicated that the basic midwife at the primary healthcare level would be best suited to implement midwifery U/S during pregnancy, labour and the postpartum period. Intrapartum U/S in the hands of midwives will change intrapartum care to be congruent with what mothers want. The ICM’s Philosophy and Model of Midwifery Care guides midwifery U/S within the Fourth Industrial Revolution (4IR) to stay true to the core principles of the profession.

Chapter 1 Overview of the study

> **"Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skilful execution. It represents the wise choice of many alternative."**
> **- William A. Foster**

1.1 Introduction

The International Confederation of Midwives (ICM) defines a midwife as a person who has successfully completed a midwifery education programme that is duly recognised in the country where it is located. The education programme is based on the ICM's Essential Competencies for Basic Midwifery Practice, and the framework of the ICM Global Standards for Midwifery Education. The midwife, who has acquired the requisite qualifications and demonstrates competency in the practice of midwifery, who is registered and legally licensed to practise midwifery, may use the title 'midwife' (ICM, 2017:1).

The practice of the midwifery profession is guided by the ICM's philosophy and model of midwifery care (ICM, 2014:1), which states that a midwife works in partnership with women while advocating and protecting the normal physiological process of positive pregnancy and childbirth experience (WHO, 2018:2). Midwifery care should exemplify respect for human dignity, compassion and promotion of human rights for all persons. The midwifery care rendered is holistic and continuous in nature, emancipatory, and allows the partnership of care to be culturally sensitive and diverse (ICM, 2014:1-2).

A midwifery-led continuity model of care benefits mothers and newborns, amongst others, by improving the pregnancy and birth experience (ICM, 2014:1; Sandall, Soltani, Gates, Sheena & Devane, 2016:2). According to the WHO (2018[b]:2) and the ICM (2014:1), a midwife can provide nearly all the essential care needed for women and newborns, and is therefore regarded as a skilled birth attendant (SBA) to achieve the Sustainable Developmental Goal (SDG) target 3.1. According to SDG target 3.1.1, the aim is to reduce the global maternal mortality ratio to less than 70 per 100 000 live births by 2030 (WHO, 2018[b]:online). Unfortunately, South Africa's current rate of 134 per 100 000 live births is still a far cry away from achieving this important milestone, according to the Saving Mothers report (SA. DoH, 2017[b]:ii).

Globally, the stillbirth rate (SBR) is an essential indicator of the quality of healthcare rendered to childbearing women (WHO, 2016[c]:2). Despite South Africa reporting a slight decline in the SBR from 2002 – 2016, the SBR remains alarmingly high at 21/1000. These high numbers do not reflect the WHO target of 12/1000 births (WHO, 2020:9). In the South African context, the Saving Babies 2014-2016 Triennial Report on perinatal mortality (SA. DoH, 2017) states that unexplained intrauterine death for babies >1000g was the major cause for loss of life (24.4%) during that period. This statistic was a significant concern because 43% of unexplained stillbirths weighed above 2500g and occurred in women with uncomplicated pregnancies (Allanson, Muller & Pattinson, 2015:1; SA. DoH, 2017:24). Loss of life is always traumatic, but losing a child during an uncomplicated pregnancy without any explanation contributes to a lifetime of psychological grief.

Amongst many other strategies in preventing the tragic loss of life and related emotional distress is using U/S as a valuable diagnostic tool to identify the possible causes of the prevention of stillbirths and pregnancy complications (Ahman, Edvardsson, Kidantoc, *et al.,* 2018:241). Nkosi, Makin, Hlongwane and Pattinson (2019:350) strengthened this notion by indicating that monitoring low-risk pregnancies between 28 – 32 weeks by means Doppler flow, which is a component of the U/S, showed an increase in the identification of small for gestational age (SGA) babies who are at risk for perinatal complications.

An early U/S is beneficial for several reasons. Not only could the procedure be used to determine gestational age, but also to detect multiple pregnancies and fetal anomalies. Furthermore, early U/S for gestational dating can reduce the induction of labour for post-term pregnancy, and improve women's overall pregnancy experience (WHO, 2018[a]:online). A new pathway for intrapartum U/S emerged during the last few years that showed the positive maternal experience of trans-perineal U/S versus vaginal examination (Waife, Whitehead, Venables & Dassah, 2019:4).

Currently in South Africa midwives contribute to 68% of the total births as SBAs (Statistics South Africa, 2020:15). Therefore midwives are therefore ideally positioned to implement a technologically appropriate, non-invasive approach of surveillance during the continuum of childbirth (ICM, 2014:2). Congruent with the ICM philosophy and model of care, appropriate use of technology in a partnership with childbearing families increases a positive pregnancy and birth experience. According to the ICM, it is therefore, essential for midwives to be competent in performing a safe and effective U/S.

Likewise, the midwife specialist is regarded as a specialist clinician that should be competent in diagnostic testing beyond the standard practice in the nurse/midwife in South Africa (Duma et al, 2012:15). As the governing body of the midwifery profession in this country, the SANC regulates the midwife and midwife specialist education and practice. Despite the SANC not outlining U/S competency in its regulations, the ICM includes U/S in 'The Essential Competencies of the Basic Midwife' (ICM, 2013:8; ICM, 2018:online). The competency describes that the midwife should "evaluate fetal growth, placental location, and amniotic fluid volume, using U/S visualisation and measurement" (ICM, 2013:8). The latest update of the ICM Essential Competencies for Midwifery Practice (ICM, 2019:13) which also recognises the consideration of a country's contextual needs, yet again states the importance of midwifery U/S screening (Fullerton *et al*., 2019:415-416).

On an international level, various low- to middle-income countries have shown an effective implementation of midwifery U/S education and training programmes (Nathan, Swanson & Goldenberg, 2014:210). In South Africa, there exists variations of the teaching and learning programmes in different provinces create disparities in education standards, and to date there is no regulation or control of the quality of the training output. This absence of regulation is a key concern not only for the medico-legal risks involved in a non-regulated programme, but also for the lack of quality assurance of midwifery U/S education (SOMSA, 2017).

Midwives who were educated as part of non-regulated midwifery U/S programmes in South Africa are deemed qualified to continue practicing U/S within the public setting. However, the absence of regulation and accreditation as a confirmation of the quality of U/S education that meets set standards raises concerns for education and practice. In addition, midwives working independently or in the private healthcare setting are not deemed appropriately qualified to continue the practice of U/S, as in the public setting. The fact that different options of unaccredited midwifery U/S training programmes for South Africa are still operational validates the need for education programmes that should comply with the competencies set by the ICM.

Concerns regarding the education and practice of midwifery U/S were further highlighted during an annual congress of the Society of Midwives of South Africa (SOMSA) in August 2017. During the congress, a working group collectively decided that accredited U/S education for the midwife specialist should be established and regulated (SOMSA, 2017). Due to the level of experience and scope of practice, the midwife specialist (Duma, *et al*., 2012:np) was identified as the appropriate category of the profession to be the ideal practitioners of midwifery U/S (SOMSA, 2017).

Regardless of current midwifery U/S programmes that are operational in various provinces and close the gap of the much needed U/S by childbearers in South Africa, neither SANC nor the SAQA have approved the inclusion of U/S in a formal curriculum of midwifery education and practise. The role-players in the field of U/S, in the current climate determined by the high burden of disease in South Africa, should consider the following:

1) The impact of midwifery U/S competencies on a positive pregnancy and childbirth experience, including the maternal and perinatal mortality rate;
2) Consensus on midwifery competencies could guide the regulation and accreditation of U/S education and practice for the benefit of quality and equity in midwifery U/S education; and
3) Task shifting to enhance the accessibility of quality midwifery care, including midwifery U/S.

The midwife is ideally positioned as a vital SBA to contribute to the SDG of decreasing perinatal mortality and morbidity. Implementing a diagnostic tool such as midwifery U/S can be useful to not only decrease the perinatal mortality and morbidity, but also to contribute to a positive pregnancy and birth experience for the childbearing family (WHO, 2016[b]:online).

1.2 Problem statement

The midwife, as an SBA, is recognised by the ICM as the professional of choice for childbearing women in all parts of the world (WHO, 2016[d]:5; ICM, 2017:1). Despite the WHO, ICM and SOMSA recognising midwifery U/S as an essential competency, midwifery U/S education and practice is not regulated by SANC nor accredited by SAQA in South Africa.

Furthermore, the impact of the high SBR as part of the perinatal statistics in South Africa is an indicator of poor quality of healthcare. Midwifery U/S can increase the opportunity for targeted intervention to decrease the perinatal mortality and morbidity rate. However, the WHO emphasises that looking at perinatal survival alone has become unacceptable and that the new focus is on a positive pregnancy and childbirth experience (WHO, 2016[b]:1).

The midwife is ideally positioned to contribute to reducing the SBR while enhancing a positive pregnancy and childbirth experience by implementing a diagnostic tool such as midwifery U/S. Despite the absence of regulation and accreditation of midwifery U/S education, various unaccredited midwifery U/S programmes exist in South Africa. Consequently, the unregulated education and practice of midwifery U/S contributes to midwives not being able to practice to the full capacity of their profession as autonomous midwives. In addition, the situation creates ambiguity around midwifery U/S practice.

There is no approved set of midwifery U/S competencies in South Africa to guide education and practice. Reaching consensus could guide the regulation and accreditation of midwifery education programmes. Competencies for midwifery U/S can be instrumental in the quality assurance of midwifery U/S education and practice. Hence, consensus on competencies for midwifery U/S education and practice is crucial.

1.3 Research question

What is the consensus on competencies for midwifery U/S education and practice in South Africa?

1.4 The aim of the study

This study aimed to determine the consensus on competencies for midwifery U/S education and practice in South Africa.

1.5 Objectives

1.1.1. Identify from literature competencies for midwifery U/S education and practice.
1.1.2. Compile a list of competencies for midwifery U/S education and practice in the continuum of female reproductive health.

1.1.3. Describe the competencies for midwifery U/S education and practice as validated by expert opinion.

1.6 Demarcation

Midwifery U/S is positioned within the domain of midwifery education and practice. The competencies of midwifery U/S inform both regulation and accreditation of education and practice. The study did not aim to justify the use of midwifery U/S, but described midwifery U/S competencies through expert consensus within the Midwifery Philosophy and Model of Care (ICM, 2014:1-2).

1.7 Conceptual framework

Polit and Beck (2012:129) describe a conceptual framework as the overarching conceptual foundation of a study. The implication is that the first thought patterns of a study are conceived from a specific model or framework. A depiction of the conceptual framework for this research is given in Figure 1.1.

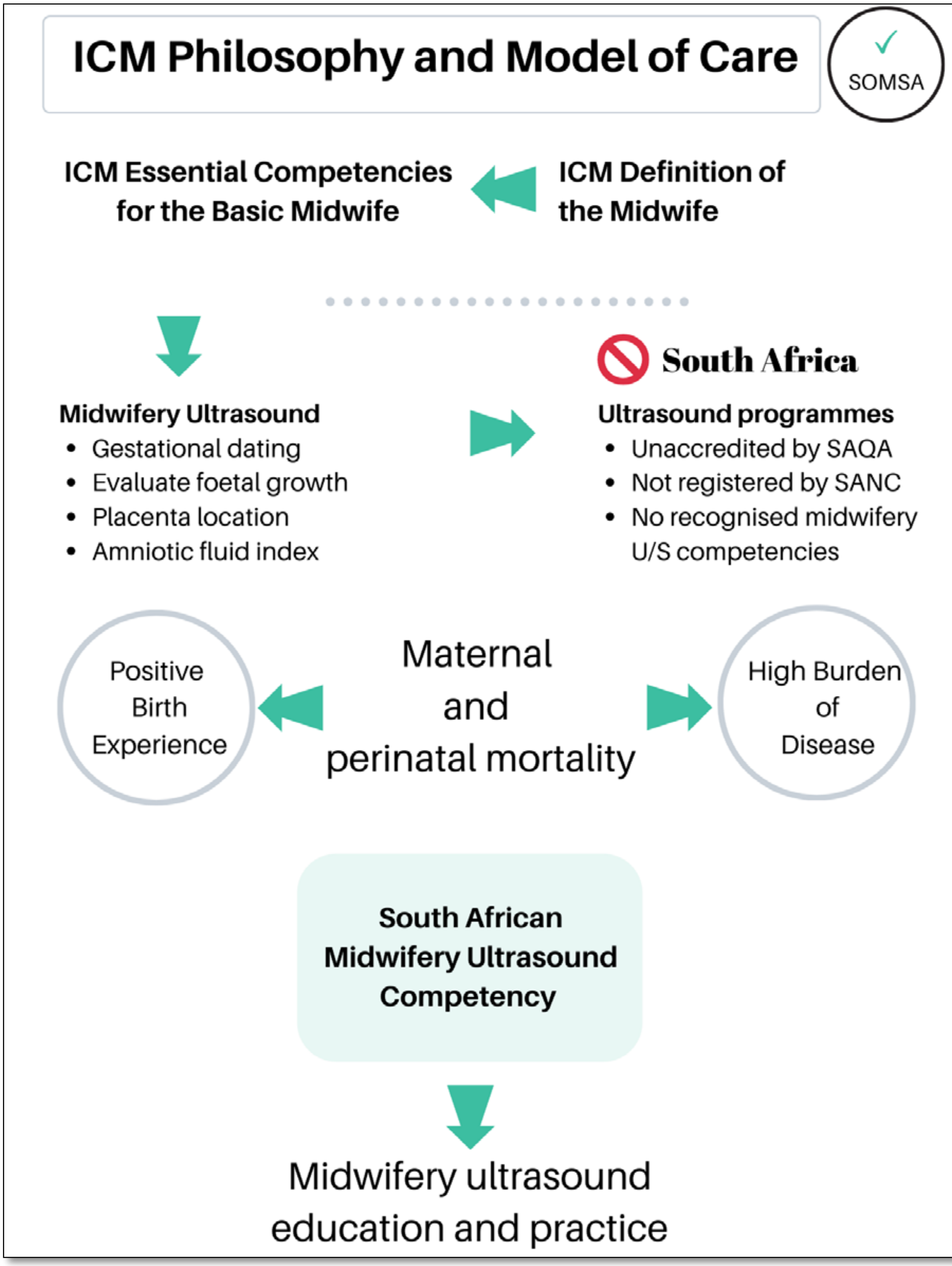


Figure 1.1 Conceptual framework for the aim of the study (designed by the researcher).

The foundation of all midwifery interventions is guided by the ICM's midwifery philosophy and model of care. As stated in Section 1.1, the midwifery philosophy states that midwifery care is a partnership between a midwife and the childbearing family. It promotes non-intervention while protecting the normal physiological process of childbirth (ICM, 2017:2). The ICM's definition of the midwife stems from its midwifery philosophy and model of care. The definition states that the title of a midwife is given to someone that completed their midwifery education, based on the essential competencies for a basic midwife, demonstrated competency, and is able to practice autonomously (ICM, 2017:1). SOMSA (2016:1), as one of the ICM affiliates, acknowledges and adopted both the midwifery philosophy and the definition of a midwife. The association subscribes to the notion that a midwife should ideally comply with the definition of a midwife, not only within the country in which he/she practices the profession, but also with international confines. The ICM Essential Competencies for basic midwifery should form the basis of midwifery education and training.

Midwifery U/S, as recognised by the ICM (ICM, 2018:13), can increase the quality of antenatal care and is directly measurable against the SBR. South Africa has a very high SBR of >21/1000 births that continues to place a high burden of disease on the community. Through task shifting in South Africa, midwifery U/S could decrease the SBR. Expansion of the midwifery functions could contribute to the partnership between the mother and midwife. Incorporating U/S in midwifery practice through task shifting and expansion of midwifery care will increase the quality of care and a positive birth experience.

As various unaccredited, unregulated midwifery U/S training programmes existed at the time in South Africa, the regulation and quality of education were highlighted by the SOMSA working group as a concern (SOMSA, 2017:1-13). To ensure that midwives can develop and maintain U/S competence and be able to practice independently as an autonomous practitioner, consensus on midwifery U/S competencies is vital for the process of further education and ultimately SAQA accreditation. By using the Delphi technique, expert opinion led to consensus of the recommended competencies for midwifery U/S education and practice in South Africa.

1.8 Paradigmatic perspective

The researcher was guided by a postpositivist worldview that recognises knowledge as truth (Taylor & Francis, 2013:18). The researcher who holds a postpositivist paradigmatic approach stands objective toward the outcome of the aim of the research (Mertens, 2015:59). The postpositivist researcher accepts knowledge that is created by using traditional research methods as truth (Creswell & Creswell, 2018:37). Observational deductions are made from data gathered during the course of the research (Creswell & Creswell, 2018:37). Multi-dimensional factors, also referred to as variables, interact with the outcomes and may influence the data (Taylor & Francis, 2013:18). Therefore the postpositivist researcher applies measures to control the possible influence of variables on the outcome (Henning, Van Rensburg & Smit, 2005:3).

1.9 Research design

A research design is defined as the structure of the study that should ensure that the reliability and validity of the findings are not affected by uncontrolled factors (Grove & Gray, 2019:41, 218, 696). For this study, a quantitative, descriptive research design was implemented. Quantitative research is a formal and systematic process in which numerical data is used to obtain information to describe variables, as well as the relationships and interactions between the variables (Burns & Grove, 2009:22). However, the aim of this study was not experimental in nature (Grove & Gray, 2019:258), and did not attempt to describe relationships or interactions between variables. As the research aimed to describe the consensus of expert opinion on competencies for midwifery U/S education and practice in South Africa, a quantitative descriptive research design was applied as further discussed in detail in Section 3.2.

In contrast with quantitative research, qualitative research aims to make meaning out of participants' lives, or their lived experiences (Maree, 2020:50). As this study focused on consensus of the competencies for midwifery U/S screening and not on the experts' experiences, a qualitative research design would not have been able to serve the aim of the study.

1.10 Research technique

The research technique refers to the method applied to support the aim of the study within the research design (Polit & Beck, 2012:257). Where there is little knowledge about the subject, or a lack of evidence-based practice in health sciences, a consensus method is invaluable (Hohmann, Cote & Brand, 2018:3272). Two of the techniques that are useful in reaching consensus are the the nominal group technique and the Delphi technique (Hohmann, Cote *et al*, 2018:3278). Due to the vast geographical distribution of experts on the study topic in South Africa, a face-to-face nominal group technique would not have sufficed. Therefore the Delphi technique was applied to reach consensus on expert opinion within a quantitative descriptive design, where little prior knowledge in the area of study exists (Avella, 2016:2).

Various types of Delphi techniques have evolved over the years, such as the classic or modified e-Delphi. In this study, the modified e-Delphi, which uses an online questionnaire was beneficial because of the ease and low cost implication of online data distribution and collection of a geographically dispersed group of experts. To purposefully establish an expert group for consensus could have been interpreted as a disadvantage of the Delphi technique due to possible selection bias (Millar, Thorstensen, Tomkins, Mepham & Kaiser, 2017:61). However, the researcher used inclusion criteria for the selection of an expert and therefore preserved the reliability, as elaborated on in Section 3.3.

To determine consensus for this study, the Biostatistics Department of the University of the Free State set the level of aggregate at 70%. The consensus level of 70% was supported by literature stating that a minimum of two-thirds of the responses for any particular statement should be set for the two highest levels of the Likert scale of the survey instrument (Du Plessis & Human, 2007:22). The development of the questionnaire was meticulously referenced to ensure transparency and inclusivity in the development process, and was further discussed in Section 3.3.1.

1.11 Population and Sampling

The population is defined as a group of individuals or elements which form the focus of the research (Grove & Gray, 2019:293). The total population of this study included obstetricians and gynaecologists, sonographers, general practitioners and midwives as healthcare workers with U/S experience during the child birthing period. From the total population, a target population is defined as the entire set of individuals or elements who meet the inclusion criteria (Grove & Gray, 2019:293; Polit & Beck, 2012:274). However, at this stage, it is important to clarify that the population of a Delphi technique does not pursue representation of the population, but rather expert opinion (Avella, 2016:306). Therefore, the inclusion criteria defined experts of this study, as discussed in detail in Section 3.4. Inclusivity of U/S experts in South Africa require the target population to be divided into two groups, as illustrated in Table 1.1.The accessible population is referred to as the target population to which the researcher had reasonable access (Asiamah, Mensah & Oteng-Abayie, 2017:1612; Grove & Gray, 2019:294),

Table 1.1 Overview of the population as related to the research aim

Research aim	To determine the consensus on competencies for midwifery U/S education and practice in South Africa.	
Total population	Health care professionals with U/S experience	
Target population	Experts in both of the following categories of expertise ➢ Subjective knowledge ➢ Mandated knowledge	
• **Inclusion criteria**	**Group A: Midwives** • Accredited by a regulatory body • Member of the executive committee of professional association or professional body • Peer identification	**Group B: Traditional U/S healthcare professionals** • Accredited by a regulatory body • Member of the executive committee of professional association or professional body • Peer identification
Accessible population	**Group A: Midwives** • Clinical experts • SOMSA executive members • Independent midwives registered on Sensitive Midwifery Independent Midwifery Practitioners registry	**Group B: Traditional U/S healthcare professionals** • Clinical experts • SASOUG executive members • SORSA executive members • NCCEMD members

Group A included experts in midwifery U/S. The midwives were identified based on clinical experience in midwifery U/S or their involvement as executive committee members representing midwifery. The aim was to have 50% of the accessible population representing midwives with clinical experience in U/S. Group B represented traditional U/S healthcare professionals such as obstetricians and gynaecologists, and sonographers within the related field of U/S, inclusive of education or the policy environment. The accessible population in Group B included executive members of the management committees of the various professional bodies who had experience in U/S, or field-specific education. The researcher aimed to have equal representation of both groups of the accessible population in the sample group.

The classification of the two main classes of sampling methods is probability and non-probability/purposive sampling (Grove & Gray, 2019:303). Probability sampling is the random selection from the population to ensure that all individuals have the same opportunity to be selected (Maree, 2020:214). As this study focused on expert consensus, which did not allow for a random selection sampling method, probability sampling was not applicable. Therefore, the researcher used, purposive sampling in selecting the experts.

A purposive sampling method is useful where the population has specific characteristics that relate to the purpose of the research, or where there is a small number of potential participants available to answer the research question (Grove & Gray, 2019:310). Since the purpose of this study was to glean the opinions of selected experts within the professional healthcare groups, stratified purposive sampling was used (Polit & Beck. 2012, 279). The combination of sampling strategies to form stratified purposive sampling allowed the researcher to identify the sample based on specified criteria for each subgroup and strata from which to identify the sample (Mertens, 2015:399).

Although Maree (2020:219) cautions against using non-probability sampling, mainly because of the difficulty to generalise findings to a larger population, generalisation was not the purpose of the study, while expert opinion was. The researcher implemented stratified purposive sampling to identify a sample of information-rich individuals (Mertens, 2015:397). A sample of a heterogeneous group of experts allowed for contextualisation of the global issue of midwifery U/S with minimal bias (Polit & Beck, 2012:276).

1.12 Recruitment of participants

The researcher contacted the potential participants via email. Experts were selected because of their active involvement and expertise in the field of U/S. An internet search of the identified experts of the various committees (refer to Table 1.1) assisted in providing the researcher with their email addresses, as this information is in the public domain. In cases where committee members or clinical midwives were not accessible via the public domain, they were contacted by first requesting the secretary or the president of the different committees to forward the applicable information about the study to the selected experts. Where certain strata were under-represented, the researcher asked the expert members and committee members to suggest experts that would be interested in participating. An email containing the aim of the study, inclusion criteria and stratum which the participant would represent were sent to the sample population. The estimated timeframe of the study and the expected time occupancy per questionnaire was described in the email. The participants who replied and indicated their willingness to participate in the study received an automated individual password with the Evasys® link that included the information letter, informed consent and the first-round questionnaire (Addendum B). Evasys® is an online automation software programme used by the University of the Free State for surveys and research projects, course and training evaluations, exams and assessments.

1.13 Pilot survey

To ensure a well-structured questionnaire, with questions that were clear and unbiased, the first-round questionnaire was sent to three individuals who met the same criteria as the prospective survey population. The three individuals that agreed to participate in the pilot survey received an automated individual password with the Evasys® link that included informed consent and the first-round questionnaire (Addendum B). The pilot participants completed the questionnaire and gave feedback on three questions that were posed to them, as described in Section 3.5.2.

This process indicated the time required for completion of the questionnaire, identified possible technical issues with the questionnaire, as well as certain content-specific concepts that needed clarity. As changes had to be made to the first-round questionnaire after the pilot survey, the data of the three individuals were not included in the final analysis (Louw, 2009:20).

1.14 Data collection

Three iterative rounds, each using a questionnaire, were used to seek consensus on the competencies of midwifery U/S education and practice (Du Plessis & Human, 2007:15). The development of the structured first-round questionnaire was guided by a literature search of the research topic and is described in Chapter 2 (Hasson & Keeney, 2011:1697). Subsequent questionnaires were adjusted based on data from preceding rounds. The data collection process is depicted in Figure 1.2.

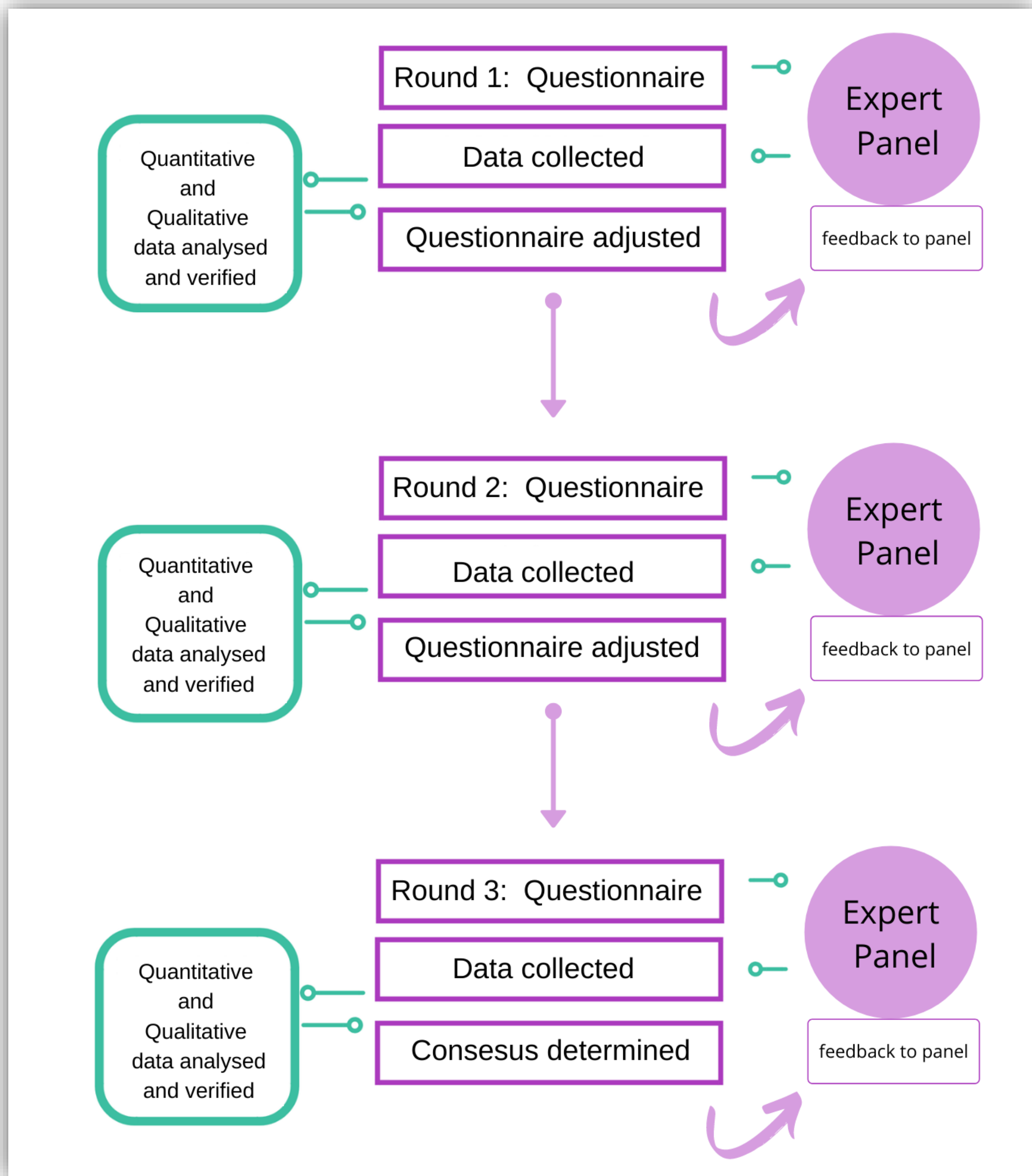


Figure 1.2 Data collection process

The modified e-Delphi consists of three rounds. Round 1 started with an email to the experts that contained a web-link to Evasys® with an individual auto-generated password. The Evasys® password enabled the experts to access the information letter, informed consent and the first-round questionnaire. After the first round, the researcher retrieved the data for statistical analyses. The consensus statement was removed and reported on in Chapter 4. However, the qualitative data were combined to form new questions. The non-consensus statements and the new questions collectively formed the second-round questionnaire. The researcher gave controlled feedback to the experts. The steps were repeated for Rounds 2 and 3. However, in Round 3, the researcher reported on consensus and the qualitative data without forming a new questionnaire.

1.15 Data analysis

Data analysis is defined as coming to a meaningful conclusion by using different techniques of statistical analysis to manage numerical data (Grove & Gray, 2019:378; Sharif, 2015:4). The quantitative data analysis included descriptive statistics and reported on the experts' collective opinion (Sharif, 2015:4). Both the quantitative and qualitative data collected by Evasys® was retrieved in a RAW CSV Excel® file. The raw data from Evasys® is received in an already-coded format, and therefore the researcher could not identify responses linked to specific experts. An independent academic researcher from the University of the Free State with extensive statistical expertise assisted the researcher in organising the data from each round. Inferences were made based on the biostatistician's recommendation of using 70% as the set level for consensus.

According to Giannarou and Zervas, (2014:67), data analysis for consensus with a Delphi technique should report on the frequency distribution, the mean and the coefficient of variation, as discussed in Chapter 4. Consensus was determined for each of the elements and each of the four levels on the Likert scale. The elements that reached consensus at 70% were removed from the questionnaire for further analysis in Chapter 4. However, non-consensus statements were reiterated in the subsequent rounds until consensus was reached, or until the end of round 3.
The qualitative data was thematically analysed by the researcher for relationships and patterns, similarities and differences (Sharif, 2015:4). The data was converted to closed-ended questions, verified with the study leaders and added to the subsequent round's questionnaire (Sharif, 2015:4). The process of data analysis is further described in Section 3.7.

Although it was not the aim of the study to report on the differences of consensus between groups A and B, the researcher reported any meaningful statistical relationships of the analysed data in Chapter 4.

1.16 Methodological rigour

Methodological rigour is defined as the soundness or precision of a study in terms of planning, data collection, analysis and reporting (Marquard, 2017:online). The traditional indicators for methodological rigour in quantitative studies are reliability and validity.

The perceived lack of methodological rigour of the Delphi technique permeates most literature on the subject. However, Avella (2016:318) pointed out that the criticism of earlier researchers such as Sackman (in Avella, 2016:318) has been repeatedly contextualised. The researcher discussed in detail measures applied to demonstrate the reliability and validity of the research n Section 3.7.

1.17 Ethical considerations

The Health Sciences Research Ethics Committee of the University of the Free State approved the study: UFS-HSD2020/0022/2104 (see Addendum A). In addition, approval was obtained by the Head of the School of Nursing, where this study was conducted.

The researcher selected the Belmont Report (The National Commission for the Protection of Human Services of Biomedical and Behavioural Research, 1979:online) as a basic point of departure in ensuring ethical conduct throughout the research process. The Belmont Report identifies three broad ethical principles which are often used in health sciences studies. These principles are a) Respect of persons, b) Beneficence, and c) Justice. A detailed description of the principles and how these were applied in this study is provided in Chapter 3.

1.18 Limitations of the study

Using a descriptive study design could be considered as a low level of research by critics. However, use of the research design was the most applicable to reach the aim of the study, as discussed in Section 5.4.

Another limitation was a gap in the knowledge that was identified by the researcher. The competence of gynaecological U/S and the integration with midwifery U/S was underrepresented in the first round questionnaire.

Lastly, the researcher reflected in Chapter 5 on the descriptors of the Likert scale used in the questionnaires. The third level descriptor could have a stronger inclination towards a positive sentiment. However, as the data analysis indicated in Chapter 4, no correlation was found between the responses and a stronger interpretation of the level descriptor.

1.19 Value of the study

The value of this research is in the establishment of expert-recommended competencies for midwifery U/S in South Africa. This list of midwifery competencies is the first of its kind in South Africa and could be used in future to inform midwifery education and practice. The knowledge gained from the research may lead to curricular development, which in turn can allow measurable and regulated competencies for midwifery U/S. National implementation will ensure equal competence by all midwifery U/S training programmes. Although the generalisation of the consensus is specific to the South African midwifery context, consensus reached during this study could potentially be utilised in comparative studies in other countries.

1.20 The layout of the dissertation

Table 1.2 Layout of the dissertation

CHAPTER 1	Overview of the study
CHAPTER 2	Literature review
CHAPTER 3	Research methodology
CHAPTER 4	Research findings
CHAPTER 5	Conclusions

An overview of the study was provided in Chapter 1, as indicated in Table 1.2. The second chapter described the literature reviewed for the proposed competencies for midwifery U/S education and practice in South Africa, and for which consensus was pursued. A description of the methodology, including the research design, research technique, the questionnaire development, data collection, data analysis, ethical considerations, methodological rigour, and limitations follow in

Chapter 3. The research findings are described in Chapter 4. In the last chapter, Chapter 5, a conclusion with recommendations are given.

1.21 Concluding remarks

The researcher aimed to address the problem of unaccredited and unregulated education and practice of midwifery U/S in South Africa by implementing a modified e-Delphi research method. The consensus reached on the competencies for midwifery U/S in South Africa has never before described. Six midwifery U/S competencies were developed based on national and international literature about the skill, knowledge and professional behaviour needed for midwifery U/S. The researcher set out to gather experts from all groups of applicable U/S healthcare professionals to contribute to consensus on midwifery competencies for education and practice in South Africa.

Chapter 2 Literature review

> **"Any new technique becomes more attractive if its clinical usefulness can be demonstrated without harm, indignity or discomfort to the patient. Anyone satisfied with his diagnostic ability and with his surgical results is unlikely to contribute much to the launching of new medical science. He should first be consumed with the given discontent with things as they are. It greatly helps, of course, to have the right idea at the right time, and quite good ideas may come, Archimedes fashion, in one's bath." - Ian Donald**

2.1 Introduction

This quotation from Ian Donald identifies the important aspect that the safe, effective and respectful use of any technological diagnostic tool, such as the ultrasound should be considered before implementation. In Chapter 2 the researcher considers the interest of the childbearing family in the context of the history of ultrasound, maternal and child health in South Africa, and the crucial fundamental components related to midwifery U/S education and practice as illustrated in Figure 2.1.

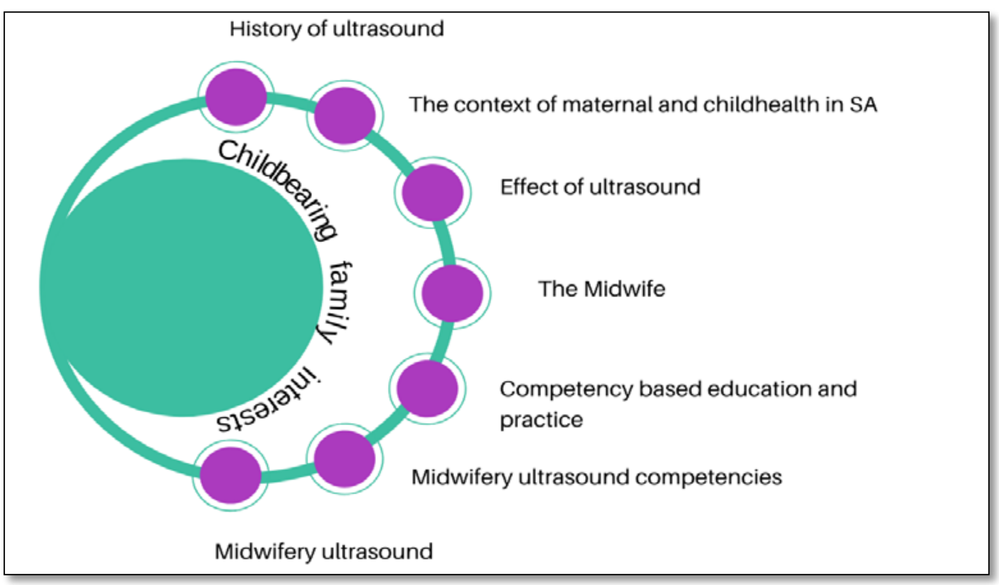


Figure 2.1 Outline of fundamentals related to midwifery U/S

The historical footprint of the U/S sheds some light on the progress of U/S during the last eight decades, and how it has developed to benefit the childbearing family. With the application of any technological technique such as the U/S, the balance between clinical usefulness and the cost related to the burden of disease lies somewhere between over-medicalisation and poor quality of care (Miller, Abalos, Chamillard *et al.,* 2016:2176). Therefore, the context of ultrasound in South Africa needs to be balanced against the benefit of U/S for the childbearing family. As the midwife is the professional of choice to render care during the profound period of childbirth (ICM, 2014:2), recognition should be given to the midwife's contribution to quality care during pregnancy and childbirth. As midwifery care is influenced by a competency approach, the competencies for midwifery ultrasound should be examined concerning how midwifery ultrasound has been positioned globally.

A formal literature search was conducted by an experienced librarian at the University of the Free State, using the Boolean search string depicted in Figure 2.2.

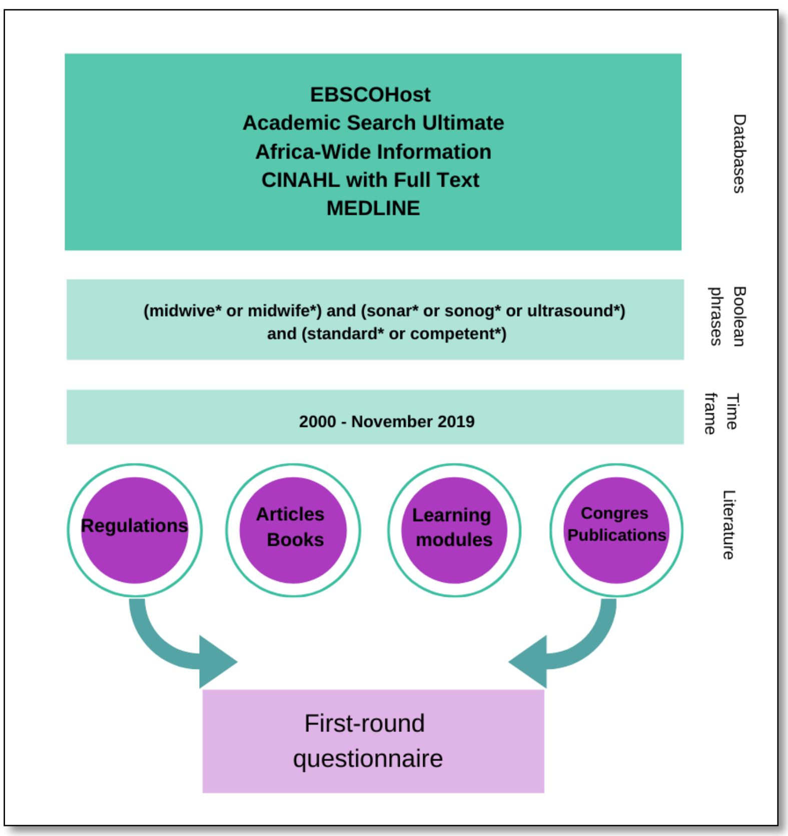


Figure 2.2 The literature search process

The literature search was supplemented with a continuous exploration of literature on midwifery U/S, U/S related topics, U/S education, and U/S competencies using Science Direct, Cochrane Library, Pubmed and Google Scholar.

U/S contributes to new terminology which does not form part of the midwifery field. For ease of reference, the researcher included certain terms that the reader may find useful (Table 2.1).

Table 2.1 U/S terminology descriptions applicable to the study.

U/S terminology	Description
Knobology	Includes the basic U/S characteristics with reference to: • Ultrasound transducers: principles of sound generation; compare transducer characteristics and applications. • Sound penetration and bio-effect with consideration related to acoustic power output. • Effect of frequency on resolution and penetration. • Effect of depth settings on field of view and image size. • Gain settings for optimal image brightness with minimum power output. • Focal zone depths to achieve best resolution of structures of interest. • Image persistence settings to reduce background noise. • Inputting patient information into ultrasound system before starting
Level 1 U/S	Complete ultrasound examination that includes early and first trimester U/S, second and third trimester U/S, gynaecological U/S.
Level 2 U/S	Specialised examinations (also called survey or targeted examinations) with detailed anatomy screening when anomalies are suspected. Includes biophysical profile
Fetal morphology	Refers to the U/S screening of anatomical structures to identify congenital anomalies
Biophysical profile	A specialised component of U/S that includes the evaluation of fetal breathing, movement, and tone. It also includes an evaluation of the amniotic fluid volume.
AOP	The AOP is the angle between the axis of the symphysis and the line drawn from the under border of the symphysis tangential to the fetal skull
SHD	The SHD is the distance between the under border of the symphysis to the fetal skull measured perpendicular to the axis of the symphysis
Biometry	Sonographic biometry (linear, circumference, area and volume)

Fetometry (measurement during first -trimester)	Includes standard measures of bi-parietal diameter [BPD], head circumference [HC], abdominal circumference [AC], and- femur length [FL]).

Adapted from Abuhamad, Minton, Benson, Chudleigh, Crites, Doubilet, Driggers, Lee, Mann, Perez, Rose, Simpson, Tabor and Benacerraf (2018:31, 41), Van Adrichem, Faes, Kinget and Jacquemyn, (2018:252), Callen and Norton (2017:5,18), ISUOG (2014:114), Ukweh, Ugbem, Okeke and Ekpo (2019:109).

2.2 History of Ultrasound

The diagnostic application of U/S in obstetrics and gynaecology has been in use for the last 80 years. Although U/S was initially developed in the early 1800s, it was the discovery of the piezo-electric effect, described by the Pierre and Jacques Curie, which led to the generation and the reception of U/S in megahertz that could be employed in echo sounding devices (Woo, 2008:1). The piezo-electric effect refers to the ability of certain materials to create an electrical charge when under mechanical pressure. The application of the piezo-electric effect is still applicable today in the single plate crystal U/S transducers/probe (Murugandoss, Coyle & Datta, 2018:42). As electrical current passes through the crystal, it produces a U/S wave at frequencies higher than 20kHz. However, for the obstetrical U/S, a bandwidth of 1-15 kHz is considered safe for diagnostic use (Murugandoss *et al.*, 2018:42), as prolonged or higher use can lead to tissue heating and cavitation (Goodchild & Chescheir, 2014:139) on which the author will elaborate elaborated on in Section 2.3.2.

During World War I, the development of the underwater sonar detection system led to underwater navigation by submarines. Alexander Belm described the underwater echo-sounding device in 1912, the same year that the Titanic sank. In 1914, Reginald Fessenden became the first person to design and build a working sonar machine for the detection of underwater icebergs (Woo, 2008:1). It is the same underwater echo principle that was instrumental in creating the U/S image. In medical ultrasound terms, the B-mode or the brightness mode refers to the cross-sectional image that is created due to the pulse-echo effect. The pulse-echo impact refers to the electrical current that is created when the sound wave bounces back in the form of an echo and reaches the piezo-crystal. The electrical current produced in the piezo-crystal by the echo is stored in the U/S machine as a single line of information (Murugandoss *et al.*, 2018:42).

During the following decades, the use of U/S technology for its diagnostic ability exploded, and a deep-seated scientific bed of knowledge was created in the field of obstetrics and gynaecology. Dr Ian Donald is heralded as the father of obstetric and gynaecological U/S. In 1958, the iconic paper 'Investigation of abdominal masses by pulsed U/S', was published. This pioneered the measurement of fetal images and set the scene for future U/S developments. During 1959, Dr Donald described the use of U/S to measure the fetal head (Campbell, 2015:215; Woo, 2008:10), developed the full bladder technique for visualisation and was the first to describe the hydatiform mole. Dr H. Robinson further developed a detailed biometry chart in 1973, as we still know it today.

Other development such as placentography, described as the visualisation of the placenta with a radiopaque medium, was instrumental in identifying the placental location for the diagnosis of antepartum haemorrhage in placenta praevia. The collaboration between Dr B. Sunden and Dr I. Donald gave way to Dr Sunden's published thesis that was the earliest and most comprehensive publication in obstetrics and gynaecology at the time. One of the critical scientific findings in Dr Sunden's thesis was that he detected no harmful effects of the U/S on pregnant rats (Woo, 2008:2-12).

Dr Kratochwil used the transvaginal probe for the early identification of a fetal heartbeat and dating of pregnancy, which led to a major change in pregnancy and childbirth management (Woo, 2008:2-12). The development of U/S changed the way we view the child birthing family, including the partner as a crucial member. It is now recommended and accepted that every pregnancy should have a minimum of one U/S (SA DoH, 2015:155; WHO, 2018(b):1). Although Lars Grennert and Per Persson demonstrated the value of routine screening in 1978 (Campbell, 2013:218), the question remains how often during pregnancy the U/S should be utilised for diagnostic purposes.

Little is however known about the general frequency of antenatal U/S exposure in low-risk women. According to Ranji and Dykes (2012:26), a mean of 6.9 U/S examinations were found to be the norm in Iran. Various recommendations for a possible second or third U/S exist (SA DoH, 2015:155; Souka *et al*., 2012; Lynn *et al.,* 2013), with benefits noted as an increased diagnosis of fetal growth restriction, polyhydramnios and suspected LGA (Al-Hafez, Chauhan, Riegel, Balogun, Hammad & Berghella*,* 2020:2). However, the consensus on the effect of U/S on the decrease of the perinatal rate has not been researched and still needs further investigation

(Holmlund, Ntaganire, Edvardsson, Lan, Sengoma, Kidanto, Ngarina, Small and Mogren, 2018:2). Despite the conflicting opinions about the frequency of U/S, the overwhelming majority of healthcare professionals agree that U/S is decisive in pregnancy management (Holmlund *et al*., 2018:7).

Recently, the face of U/S has changed yet again, which has had a major impact on IP midwifery care (ISUOG, 2018:128-139). In 2018 the International Society of Ultrasound in Obstetrics and Gynaecology (ISUOG) published a set of guidelines for the use of IP U/S, which states the practical implications and recommendations that may affect labour management. This will be discussed in detail in Section 2.7.4.

A shortage of sonographers, inadequate infrastructure, and variable power supply is only a few of the barriers to universal access of U/S during the childbearing period (Luntsi, Ugwu, Nkubli*, et al.*, 2020:1). As discussed in Section 2.7, midwives are able to utilise U/S to the benefit of the childbearer and the midwifery profession.

As seen in this brief history of the U/S, the ever-changing field of U/S has a variety of diagnostic abilities. The value of U/S as a diagnostic tool for midwives lies in the unequivocal philosophy of midwifery care that its clinical usefulness can be demonstrated, as quoted by Ian Donald, without harm, indignity or discomfort to the mother (ICM, 2014:2). Despite the industrial transformation that is evident since the first industrial revolution in the 1800s, the impact on midwifery has only gained momentum within the 4IR (Dino and Ong, 2019:4). The medicalisation of midwifery care contributed to the technocratic midwifery environment, which has seen the birth of the bio-medical model of care (Najafi, Roudsari and Ebrahimipour, 2017:5446). The inclusion of U/S to the array of medical interventions needs to be balanced between the midwifery philosophical foundation (ICM,2014:1) and the benefit it brings to birth in the current time of the fourth industrial revolution.

As the midwife is the professional of choice to care for a mother during childbirth (ICM, 2014:1), midwifery U/S as a diagnostic tool can benefit the mother by contributing to a positive childbearing experience (WHO, 2016[b]:online).

2.3 The context of ultrasound in maternal and child health in South Africa

The WHO published evidence-based recommendations as discussed in Section 1.2. The document emphasises that the focus should be a positive pregnancy and childbirth experience. As an experienced independent midwife specialist, the researcher agrees with the WHO that a positive pregnancy and childbirth experience is grounded in the quality of care rendered during the critical childbearing period (WHO, 2016[e]:ix). With target 3.1 of the SDGs being to reduce the maternal mortality ratio to less than 70 per 100 000 live births (WHO, 2020:online), the SBR can be used for global comparison of quality of maternal healthcare as it is calculated as one of the sensitive indicators for IP care (Lawn, Blencowe, Waiswa, *et al*., 2016:594; Madaj Smith, H., Mathai, *et al.,* 2017:1-2).

As an indicator of the quality of maternal healthcare, the reduction of the SBR to <12/1000 was reiterated in the 'Ending Preventable Newborn Deaths and Stillbirths by 2030' report. Stillbirths and neonatal deaths account for the most perinatal deaths. However, maternal and child health receives the lowest healthcare investment allocation (WHO & UNICEF, 2020:1-3). Developing countries such as South Africa contribute to 98% of the global SB per year (WHO, 2016[d]:online; Lawn *et al*., 2016). Ineffective strategies to decrease the SBR, which can be linked to substandard quality of care in many health facilities, remains a significant obstacle on the road to ending preventable perinatal mortality and morbidity (Tuncalp, Pena-Rosas, Lawrie, *et al.,* 2017:860; WHO & UNICEF, 2020:2). Therefore it is no surprise that in the context of healthcare in a developing country like South Africa, the reality is often that many women do not have a positive pregnancy and childbirth experience. Furthermore, the high SBR articulates the problems in maternal and child healthcare.

Evaluating the SB in South Africa from 2002-2016, as indicated in Figure 2.3, shows an underwhelming decrease of only 3,5% in the overall SBR. The current SBR of 21/1000 live births indicates that South Africa needs to change the existing action plan and accelerate the reduction of SB to meet the SBR deadline in 2030.

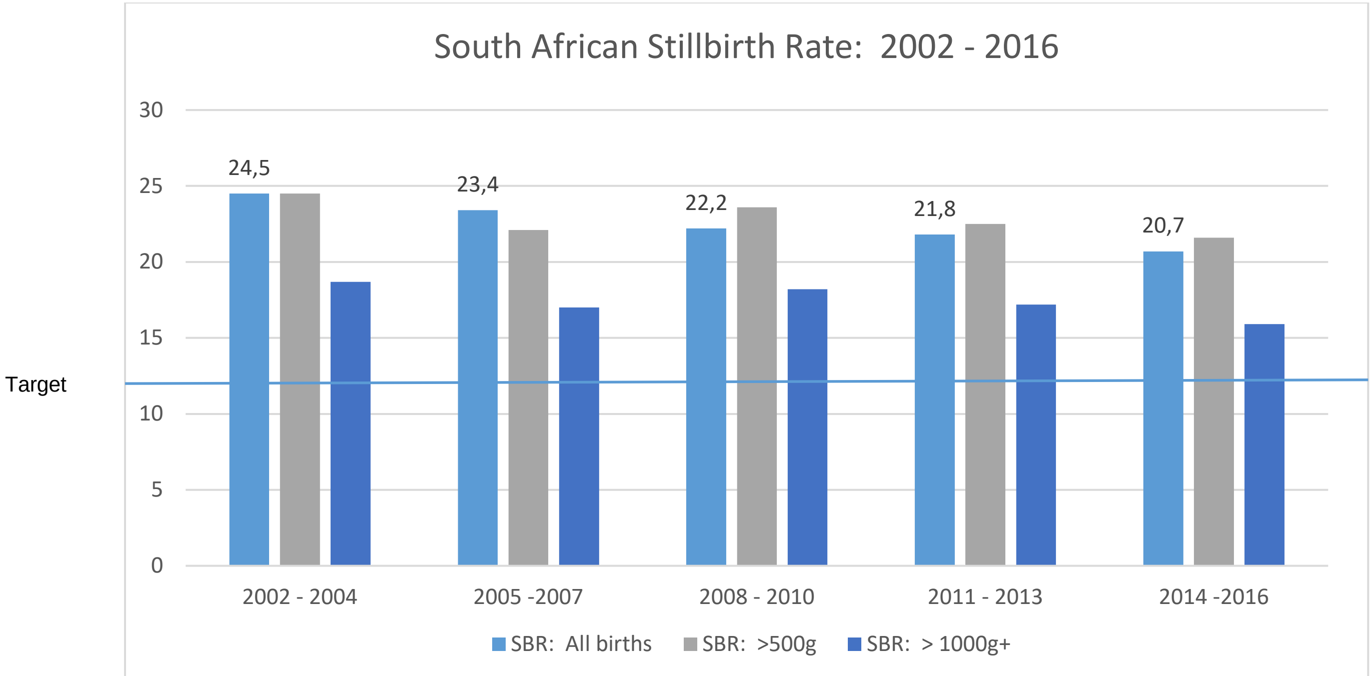


Figure 2.3 Graphic overview of SBR in SA from 2002-2016 (Saving Mothers Triennial Reports 2002 – 2016).

The decline in the SBR for neonates below 1000g was the least impressive. The slow decline in South Africa may be attributed to the country's lack of infrastructure and human resources to support neonates <1000g or 28 weeks of gestation. However, contributors to the SBR, such as fetal growth restriction, maternal infections and IP asphyxia, are considered as preventable causes (SA DoH, 2017:24). In Table 2.2, a comparison between the WHO listed causes of SB and South Africa's statistical contribution to SBR-related to viable fetuses (>1000g) is presented.

Table 2.2 Comparative causes of stillbirths: WHO vs South Africa (Adaptation from WHO, 2016a: online, and the Saving Babies 2014-2016 Triennial report on Perinatal Mortality, 2017:24).

WHO main causes of stillbirths – antepartum	**South Africa primary causes of death: fetus> 1000g**	
Fetal growth restriction	Fetal growth restriction	2.4 %
Congenital abnormalities	Congenital abnormalities	5.7 %
Maternal infections in pregnancy (malaria, syphilis and HIV)	Maternal infections	3.3 %

Maternal disorders (especially hypertension, obesity and diabetes)	Hypertension Antepartum Haemorrhage	26.2 %
NA	Unexplained stillbirths	25.3%
Childbirth complications	Intra-partum asphyxia	18.6%

Fetal growth restriction (2.4%) and congenital abnormalities (5.7%) are both conditions that can be diagnosed per U/S. They collectively contribute to 8.1% of SB in South Africa. It is noteworthy that maternal hypertension and antepartum haemorrhage, which are both related to abnormal placentation, add 26.2 % to the SBR. Both these conditions contribute to the major causes of maternal mortality in South Africa (SA DoH, 2017:iv). Combined, small for gestational age babies, congenital abnormalities, hypertension, antepartum haemorrhage and unexplained stillbirths collectively contribute to almost two thirds (71.4%) of the SBR in South Africa (SA DoH, 2017[a]:24). Intrapartum asphyxia contributes 18.6 % to the SBR, and was flagged as a significant contributor to the South African SBR. IP U/S could contribute to the reduction of IP asphyxia, as discussed in Section 2.6.4

The Provincial Assessors Report of Confidential Enquiries into Maternal Deaths in South Africa (SA, DoH, 2017:5), states that reducing the SBR can be achieved by focusing on the management of hypertension, antepartum haemorrhage and small for gestational age babies as a subgroup of unexplained stillbirths. The U/S is a valuable and essential diagnostic tool used in antenatal care as a baseline investigation which could identify causes of SB and pregnancy complications (Ahman *et al.* 2018:241: Luntsi *et al.*, 2020:1).

The use of U/S has been globally accepted to have a positive impact on the reduction of the SBR. Nkosi *et al.* (2019:350) strengthened this notion by indicating that monitoring low-risk pregnancies between 28 – 32 weeks by means Umbiflow (continuous-wave-Doppler), which is a component of the U/S, showed an increase in the identification of small for gestational age babies. The Doppler U/S is used for assessment of the blood flow of the fetal umbilical vessels. It indicates the placental function to identify abnormal flow that correlates with IUGR and adverse fetal and newborn outcomes (Hofmeyr, Haws, Bergström *et al.*, 2009:S40; Nkosi *et al.*, 2019:347). The Doppler flow is a non-invasive intervention that could directly influence a reduction of unexplained SB (Nkosi *et al.*, 2019:351). In the study by Nkosi *et al*., 10% of the mothers with low-risk pregnancies had an abnormal resistance index that contributed to a 60% reduction of macerated

SB in the study. In comparison, the control group that did not receive Doppler flow resistance in the same low-risk category had the highest SBR (Nkosi *et al.*, 2019:351). Despite the proven benefit of U/S during the antenatal period, access and equality of care is a scarce commodity in Southern Africa (Tegnander & Eik-Nes, 2008:5). According to Carrera (2011:290), 68% of women receive one U/S during pregnancy in urban areas, in contrast to only 18% in rural areas in Southern Africa. The State of the World Midwifery Report (UNFPA, 2017:10-11) elaborates on how countries could ensure effective coverage of SBA for the childbearer by ensuring high quality of care that is accessible, available and is an acceptable method of care.

Besides the issue of the lack of access to U/S , is the importance of the acceptance of an effective non-invasive intervention to the healthcare user. Intrapartum U/S is more acceptable to childbearing women than vaginal examination, and superior in terms of identifying the correct fetal head position (Van Adrichem *et al.,* 2018:251). Although the IP U/S was first described as early as 1977 (Usman *et al.,* 2015:53), the guidelines published by the ISOUG (2018:137) have strengthened the use of IP U/S. Half of all stillborn babies begin labour alive but die before birth. The investment in assisting tools during pregnancy and childbirth, such as IP U/S, comes with a quadruple return, as it affects the health of mothers and newborns, stillbirths, and asphyxia-related disabilities. One important place for investment to improve quality of care, accessibility and the availability of care, is the training and deployment of SBA (WHO and UNICEF, 2020:2,9), especially midwives, in the use of IP U/S. As midwives are the professional choice of SBA during childbirth (ICM, 2014:1), the availability of an acceptable diagnostic tool such as the IP U/S in South Africa could dramatically increase accessibility and quality of healthcare.

Despite the ease of reaching competence in IP U/S (Van Adrichem *et al*., 2018:251), it is still under-utilised in South Africa. According to the State of the World Midwifery Report (2017:iv), South Africa is the only country in the Eastern and Southern African region that has the appropriate skill mix to apply the essential interventions to reduce the perinatal mortality rate. The skill mix is comparable to most developing countries in Sub-Saharan Africa. However, due to manner that the skill mix was determined, it does not reflect actual midwifery competence. In South Africa, most registered nurses also hold a midwifery qualification, but does not have the competence required for the midwifery practice (SOMSA, 2017). Therefore, the quantification of midwives by the SANC is an unrealistic portrayal of the available competent midwifery workforce in South Africa. Despite the previous notion that midwives are not warranted to utilise U/S, the majority of women in the public health sector in South Africa birth with midwives. South African midwives are therefore ideally positioned to implement IP U/S if allowed to acquire the necessary competency. With the technical advances in ultrasound equipment, where Android devices can be connected to a U/S probe, the cost of U/S has drastically decreased, making it more available for each birth facility (Leung, Amundson, Phan, Kimura & Mercy, 2018:1; Phillips, 2020:online; Fullerton *et al*., 2019:416).

The midwife, as custodian of normal pregnancy and birth (ICM, 2014:1), is in an optimal position to render midwifery ultrasound to the childbearing woman. Midwifery U/S could contribute not only to a positive pregnancy and birth experience (Fullerton, Gherissi, Johnson & Thompson, 2014:413) but can affect the direct and indirect costs related to perinatal indicators in South Africa, as discussed in Section 2.3.3.

2.3.1 Role-players in U/S in South Africa

A wide range of healthcare practitioners in South Africa performs an obstetrical and gynaecological U/S. Despite the 4IR, U/S education and practice have been withheld from the greater spectrum of midwives in South Africa. Traditional U/S healthcare professionals such as obstetricians and gynaecologist, general practitioners, and sonographers/ radiologists have been using U/S for several decades. Notwithstanding some South African midwives being educated in various post-qualification U/S programmes, and midwives contributing to 68% of the total births as SBA (Statistics, SA, 2020:15), midwives are not perceived as appropriate healthcare professionals to utilise U/S for clinical practice (Steinberg, 2019:personal communication).

According to Callen and Norton (2017:5), an unfortunate turf war exists between healthcare practitioners as to who has the right to perform U/S. The "magic of ultrasound" (Stewart, 2011:54) has been withheld from midwives, as U/S is wrongfully assumed as the scope of practice of the medical practitioner and radiologists (Steinberg, 2019:personal communication). The disempowerment of professional groups that serve women, such as midwives, is a described barrier to quality maternal healthcare (Renfrew, Atevia, Dennis-Antwi *et al.*, 2019:396). There is growing evidence to support the systemic disempowerment of midwives. As a female-focused profession, mostly practised by women, patriarchal systems reduce midwifery to a low priority by decision-makers (Renfrew *et al.*, 2019:397). This internationally recognised disempowerment is also a reality in South Arica. In scientific publications regarding South African maternal healthcare, and in personal communication, esteemed decision-makers refer to midwives as low-level healthcare workers with a low status (Hofmeyr *et al.,* 2009:S37; Pattinson, 2020:personal communication). Midwifery is reduced to merely the "monitoring and managing of labour" (Pattinson, 2020:personal communication).

Apart from the disempowerment of midwives, a shortage of traditional U/S healthcare professionals has led to U/S not being available nor accessible in especially primary healthcare settings in South Africa. As midwives are the most accessible SBA in South Africa, they are included in midwifery U/S programmes in South Africa. These programmes aim at qualifying midwives for U/S within the public health setting. The implementation of a midwifery U/S programme in Kwa-Zulu Natal during 2004-2014 was seen as a task-shifting approach (Tegnander & Eik-nes, 2008:3). Midwives were to utilise U/S for the diagnosis of multiple pregnancies, location of the placenta and to give an overview of fetal anatomy to detect severe abnormalities with the aim of timeous upwards referral (Tegnander & Eik-nes, 2008:3). The Kwa-Zulu Natal midwifery U/S programme was supported by the National Department of Health and ISUOG. The U/S programme was implemented for more than a decade in South Africa. Despite the national and international support and funding of midwifery U/S, SANC considers U/S as the domain of traditional U/S healthcare professionals and has not published any communication about the inclusion of U/S as a midwifery competency (Tegnander & Eik-Nes, 2008:6-7; SOMSA, 2017:3).

2.3.2 Past and existing midwifery ultrasound programmes in South Africa

Ultrasound education and training programmes for midwives in South Africa have seen a variety of learning programmes within the last two decades. In Kwa-Zulu Natal, a 12 month internationally led programme by a Norwegian U/S specialist team was implemented (Tegnander & Eik-Nes, 2014). Subsequently, in Gauteng (Mashamba, 2017) and the Free State (FS DoH, 2016, SOMSA, 2017:2), other programmes for midwifery U/S education and training were implemented. The Norwegian team, after more than a decade of involvement, withdrew the programme because midwifery U/S were not being utilised within the vacuum of regulation and human resource deployment (Tegnander, 2016:personal communication).

During 2016-2017, a 16-week midwifery U/S programmes was implemented in Gauteng. The midwifery U/S programme was commissioned within the province, and supported by a manufacturer of U/S equipment (Mashamba, 2017:2). The variation of the learning programmes over different provinces saw disparities in education standards, and currently there is no regulation or control of the quality of the training output. The lack of regulation is a major concern not only for the medico-legal risks involved in a non-regulated programme, but also for the indication of the quality of the competency acquisition and practice. The programmes existing in the Free State, Kwa-Zulu Natal and Gauteng might not be the only U/S programmes available to midwives in South Africa.

The concern with the existing midwifery U/S programmes is the lack of a certification process, as midwifery U/S competency is not accredited with either SAQA nor regulated by SAQA. This lack of accreditation jeopardises the quality of current U/S education. In addition, the practice of midwifery U/S outside of the public healthcare setting has not been sanctioned.

The fact that different unaccredited midwifery U/S programmes are still available in South Africa validates the need that midwifery U/S education programmes should comply with the competency as set out by the ICM (2013:8; 2018:13; SOMSA, 2017:3). Competency-based midwifery U/S education programmes could expedite the regulation and accreditation of midwifery U/S.

2.3.3 Too little too late, (TLTL) and too much too Soon (TMTS)

As the 2030 deadline for the SDG's is fast approaching, low-income and middle-income countries are re-engineering strategies to address pregnancy-related deaths (Miller *et al.,* 2016, 2176). However, Miller *et al.* (2016:2176) state that without the emphasis on quality maternal care, the advances made to reduce mortality and morbidity will be lost. Poor quality of care is often due to inadequate resources and compliance with evidence-based standards. Furthermore, health system failures to provide timeous healthcare interventions were phrased as TLTL (Miller *et al*., 2016:2176). Conversely, TMTS refers to the over-medicalisation of childbirth (Miller *et al*., 2016:2176). In respect to U/S during the child birthing period, the inequality between public and private healthcare speaks directly to the issue of TLTL and TMTS in South Africa.

One example of TLTL is that 50% of pregnant women in public healthcare in metropolitan South Africa (Stewart, 2011:54) have access to U/S to receive the WHO recommended one U/S before 24 weeks of gestation (WHO, 2018[b]:1). According to Miller *et al.* (2016:2176), TLTL leads to an increase in the perinatal mortality and morbidity rate.

The perception exists that U/S is the most expensive component of care during childbirth (Odent, 2011:91). The low number of first trimester U/S has often reinforced this cost-benefit perception (Fullerton *et al*., 2019:416). Not only is the initial cost of U/S equipment perceived as expensive, but the first point of care with U/S is usually at secondary-level healthcare, which increases the cost of access to healthcare for the healthcare user (Daily Maverick, 2020:online). In Table 2.3, a cost comparison of fetal surveillance with three different U/S technologies is given.

Table 2.3 Cost comparison of fetal surveillance with different U/S devices

Description of function	**U/S product**	**Initial cost**	**First year cost**
• Traditional U/S colour and spectral Doppler	Vivid S6N	R290 000	R290 000
• Colour and spectral Doppler • Tele-medical support	Umbiflow® Doppler tools and computer,	R37 014,09	R108791,91
	Administrative costs	R71 777.82	
• Traditional ultrasound	Lumify® Probe	R110 000,00	R117 506,08
• Colour Doppler	Teleradiography	R 1 148,98	
• Teleradiographic support	Tablet	R6 000	

(Adapted from Bisset, 2020:personal communication; Rossouw, Nkosi & Pattinson, 2017:5; Businesstech, 2019:online.)

The cost of a traditional U/S device such as the Vivid S6N could be regarded as expensive compared to the Umbiflow® and new generation handheld smartphone devices such as the Lumify®. At approximately three times the cost it is the most expensive option (Table 2.3). However, you get what you pay for, with the full range of U/S including colour and pulse Doppler function (Philips, 2017:6). The traditional U/S devices at this price range do not include telecommunication support and is somewhat bulky, in a clinical sense, to move around. A U/S device such as the Vivid S6N is an expensive option to have in every healthcare facility in LMIC. The Umbiflow®, in comparison, is more affordable. However, with the limited utility of only Doppler functions, it does not offer the benefit of measurement or visual identification of normal and abnormal anatomy and physiology during the reproductive age. The Lumify® is in the same price range as the Umbiflow® (Table 2.3). However, the Lumify® as a handheld device, offers a range of bedside U/S measurements, colour Doppler and teleradiographic support, if needed. The disadvantage currently is the lack of pulse Doppler as an option with the Lumify® (Bisset, 2020:personal communication). However, the Lumify® is the ideal solution for midwifery IP U/S in South Africa, where pulse-Doppler is not a necessity, but rather the visualisation and measurement option of a transportable handheld device with teleradiographic support.

Another contributory factor to the cost of U/S is the reality of litigation in South Africa that translates into the high cost of obstetrics and midwifery. The then Gauteng MEC of Health, Gwen Ramokgopa, stated that more than 70% of the R13.8 billion claims against the department in 2016 was related to maternal and neonatal health (Masweneng, 2017:online). According to Snyman (2019:4), cerebral palsy accounts for 30% of claims within obstetrics, with the main reason stated to be IP asphyxia. The high cost of litigation drains excessive amounts of the financial resources intended for the improvement of healthcare services in South Africa (Mokane, 2019:8). In addition, the cost of indemnity insurance for obstetricians, gynaecologists and midwives increased during the last five years with exuberant amounts, to the disadvantage of the healthcare end-user who has to absorb the additional costs. Accessibility to U/S outside of the one examination captured within the public healthcare becomes almost non-viable, with only 16.4% (Stats SA, 2020) of individuals in South Africa with medical aid coverage.

No life should ever be quantified in terms of monetary value, and the cost of SB is the same. However, the effect of U/S on SB could decrease the ever-draining burden of disease on the South African healthcare system. The direct financial cost, that includes additional investigations of a stillbirth, contributes to between 10-70% of a live birth (Heazell, Siassakos, Blencow, et al., 2016:2). The non-direct financial cost of SB is reported as the burial costs, loss of income and additional medical expenses (Heazell *et al*., 2016:2), which are often not quantified for SB. In addition, the psychological and social aspects of SB are often neglected.

In contrast with the reality of only one U/S during pregnancy in the public healthcare system in South Africa, private healthcare professionals perform numerous U/S examinations on low-risk pregnant women. The total of U/S during one pregnancy in the private sector in South Africa can easily tally to more than eight. The logistical arrangement in private healthcare allows for an increase in the accessibility of the equipment, and in the opportunity and subsequent usage of U/S examinations.

Evidence shows that over-medicalised birth practices (with special reference to fetal surveillance), such as U/S examination for determination of fetal size in the third trimester, lead to unnecessary intervention (Moldeus, Cheng, Wikstrom & Setphansson*,* 2017:7). In addition, routine continuous cardiotocography may lead to an increase in caesarean sections without improvement in either the mortality or morbidity rate (Miller *et a*l., 2016:2178: Robinson, 2020:84). According to Miller *et al*. (2016:2178), mothers are not being informed about the associated risks of over-medicalised care, nor have they given informed consent for the excessive interventions that do not necessarily improve birth outcomes. Not only does TMTS lead to an increase in the cost of healthcare and a negative impact on health system resources (Solanki, Fawcus & Daviaud, 2019:7), but it could also lead to serious violations of the rights of the mother (ICM, 2014:1-3).

The dilemma that accompanies over-medicalised care contributes to what Odent (2011:91) describes as the nocebo effect, that influences both the healthcare professional and the childbearing family. The nocebo effect can be related to the increase in caesarean sections due to fetal surveillance and early induction of large for gestational weight fetuses (Moldéus, Cheng, Wikström and Stephansson, 2017:7). Midwifery U/S however, should comply with the sentiments expressed in the ICM philosophy and model of care. The first departure is respect for the normality of the pregnancy and childbirth, and advocates for the appropriate use of technology while promoting and protecting women's and newborns' health and rights (ICM, 2014:1-3). Therefore, great care should be taken in avoiding over-medicalisation of midwifery U/S. Midwifery U/S within the confounds of the ICM philosophy and model of care provides an opportunity for a juxtaposed consideration between the increased demand of modern technology, limited resources, and maternal and health interests (Holmlund *et al.,* 2017:4).

2.4 Effect of ultrasound

The debate regarding the safety of the U/S has been ongoing since the development in the early 1940s. The consideration of advantages versus potential harm of the childbearing mother and the developing baby should be carefully evaluated before implementing any diagnostic tool. As Donald states, before being considered, any diagnostic tool should first prove its clinical use without any harm, indignity or discomfort to the person (Woo, 2008:9)

2.4.1 Advantages of ultrasound during pregnancy and childbirth

Ultrasound is perceived as safe to use irrespective of the number of examinations (Holmlund *et al.*, 2018:2). A point-of-care U/S referred to bedside diagnosis with the use of easily accessible devices, has increased the access of U/S to include LMIC (Bentley, Hexom & Nelson, 2015:1563-1564). This increase of access has prompted a number of studies that have proven the advantages of U/S as a diagnostic tool during pregnancy, as illustrated in Table 2.4. Today, U/S is regarded as a standard component of quality antenatal care (McClure, Nathan, Saleem, *et al*. 2014:1).

Table 2.4 Advantages of ultrasound screening during the childbearing period.

	1st trimester	2nd trimester	3rd trimester	IP and postpartum
Benefits of Ultrasound	- Identify gestational dating using the U/S - Diagnosis of ectopic pregnancy	- Establish amniotic fluid volume	- Evaluation of fetal heart rate and fetal position - Assisting with visualisation with external cephalic version	- Determine malpresentation and malposition
	- Diagnosis of congenital anomalies	- Screening of anatomy includes, (not limited to): o Placental position and function o Amniotic fluid index o Abnormal fetal development	- Determine Doppler flow to evaluate the placental function	- Confirmation of cervical progress position, attitude, amniotic fluid index, placental maturation, cord around the neck of the fetus
	- Confirmation of single or multiple intra-uterine pregnancy	- Confirmation of gender.	- Diagnosis of placenta location (placenta abruption/praevia)	- Determine progress and the ability to labour using various measurements
	- Excluding abnormal development such as blighted ovum hydatiform mole)	- Evaluate fetal growth or clinical complications due to growth	- Evaluate fetal growth or clinical complications due to growth	- Diagnosis of retained placental products to ascertain normal/abnormal involution

(Adapted from Hofmeyr *et al*., 2019:S24-S25; Whitworth *et al.,* 2010:2; Nathan, Swanson, Swanson, *et al*., 2017:210; Tegnander & Eik-Nes, 2008:5; Mashaba, 2017:13; Molander, Alehagen & Berterö, 2010:19; Holmlund *et al.,* 2017:2)

Antenatal U/S aids in the increase of attendance of antenatal care (Greenwold, Wallace, Prost & Jauniaux, 2014:276; Holmlund *et al*., 2018:2), and motivates for birth with an SBA in hospital (Luntsi *et al*., 2020:2). The benefit of antenatal attendance leads to the identification of obstetrical risks, and can prevent life-threatening conditions. During the antenatal period, the use of early/first trimester U/S to identify the location of the pregnancy is the first significant benefit of U/S as a diagnostic tool. The benefit of U/S to diagnose an ectopic pregnancy (Abramowicz, 2009:296), a product of conception implanted extra-uterine, is directly measurable against the maternal mortality rate (Flores, Kassamali, Won, Stein & Reynolds*,* 2019:33). Utilising an early U/S examination during the routine management of mothers in Sub-Saharan Africa indicated a significant increase in the diagnosis of ectopic pregnancy from 12.6% to 80% (Flores *et al*., 2019:33). However, Nzaumvila *et al*. (2018:6) describe a delay in the diagnosis of ectopic pregnancy (47%) in a district hospital in South Africa, showing the significance of competent healthcare professionals and the availability of resources. The importance of access to competent and available quality U/S during pregnancy was strengthened by Nkyerkyer (2006:1), stating that each polyclinic, district, and regional hospital should have access to U/S with qualified personnel who can also interpret serum β-HCG measurement.

Dating of the gestational age is one of the most acknowledged antenatal diagnostic usages of the U/S (Hofmeyr *et al*., 2009:S25; Holmlund *et al*., 2018:7 Whitworth *et al*., 2010:2; McClure *et al.,* 2014:1). More so in South Africa, where the last normal menstrual period (LMP) is unknown in 70 – 80% of pregnancies (Tegnander & Eik-Nes, 2014:6). Although a known LMP is still the method of choice for gestational dating (SA DoH, 2016:36), the use of U/S for women presenting >20-24 weeks gestation is more accurate than an unsure LMP (Geerts, Poggenpoel & Theron, 2013:8). Accurate gestation dating with an early/first-trimester U/S (Tegnander & Eik-Nes, 2008:5; McClure *et al.*, 2014:1) decreases the induction of post-dated pregnancies up to 40% (Abramowicz, 2009:296; Hofmeyr *et al.*, 2009:S29; Whitworth *et al.*, 2010:2). Furthermore, optimisation of genetic screening tests due to accurate gestational dating in high-risk mothers could increase the detection of congenital abnormalities (Tegnander & Eik-Nes, 2008:5).

The benefits of U/S during the second and third trimesters, as described in Table 2.3, improves the diagnosis of placental location, congenital anomalies, multiple pregnancies, malpositions and malpresentation of the fetus (Hofmeyr *et al.*, 2009:S24; Tegnander & Eik-Nes, 2008:5-6; Abramowicz, 2009:296; Whitworth *et al.*, 2010:2; Nathan *et al.*, 2017:211). The early identification of obstetrical risks such as placenta praevia, malpresentation and multiple pregnancies relates to a decrease in maternal and neonatal morbidity and mortality rate (Greenworld *et al*., 2014:274, 276).

Although the WHO recommends only one ultrasound in pregnancy, the monitoring of fetal growth during the third trimester is indicated as a benefit of U/S (WHO, 2018[b]:1). Nevertheless, the benefits of routine U/S during antenatal care do not seem to result in a reduction of perinatal mortality rates (Whitworth *et al.*, 2010:2).

Despite the detection of small for gestational age fetuses, the perinatal mortality rate seems to be unchanged in low-risk pregnancies with the routine use of U/S (Henrichs, Verfaille, Jellema, *et al*., 2019:1; Mashaba, 2017:13). McClure *et al*. (2014:8) aimed to determine if the use of U/S in rural and low-income settings could positively affect the high maternal and perinatal mortality rate, but obtained the same findings as Henrichs *et al*. (2019:1) and Mashaba (2017:13). Furthermore, Goldenberg, Nathan, Swanson, et al. (2018:1593) state that early referral after routine U/S in low-risk pregnancies do not change the statistical influence on the perinatal mortality rate. However, it is important to mention that Goldenberg *et al.* (2018:1593) did not intend to measure the impact of an early U/S that could indicate benefit in the identification of complications related to miscarriages, abortions or ectopic pregnancy, as indicated by Flores *et al*. (2019:33) and Nkyerkyer (2006:1). So too has the quality of care at the referral hospitals not been evaluated in terms of management of high-risk pregnancies during the study, which could be a significant game-changer in the referral quality control cycle (Goldenberg *et al*., 2018:1597).

In a follow-up article on Goldenberg *et al.* (2018:1597), Swanson, Franklin, Swanson, *et al.* (2019:273), reconsidered the fact that U/S screening during antenatal care does not increase the birth of high-risk pregnancies in hospitals. During a supplemental descriptive study, Swanson *et al*. (2019:273) found that there were communication concerns within the continuum of care between the field sonographer and the referral hospital. The referral sonographers were not available to assist the field sonographers, which led to the birth of mothers before they could be assisted (Swanson *et al.*, 2019:276). Other concerns raised from the referral sonographers related to insufficient structural support of hospitalisation of high-risk patients. None of the issues raised by Swanson *et al*. (2019, 273-276) is new in the South African context. Hence, Mueller, Pattinson, Hlongwane, *et al.,* (2019:3) allude to the significant impact of routine U/S in LMIC on the use of antenatal care, and its improvement of patient management, and confirmation of clinically suspected obstetric complications.

The Umbiflow®, as a continuous wave Doppler, is a component of U/S. The Umbiflow measures the resistance index of the umbilical artery with a Doppler device (Nkosi *et al.*, 2019:347). In South Africa, research has indicated that the use of Doppler resistance index could reduce macerated stillbirths with a remarkable 60% (Nkosi *et al.*, 2019:347; Pattinson, 2019:18). As an inexpensive option, Pattinson (2019, 15) state that any healthcare workers can use the device for effective screening at the primary healthcare level to identify fetuses at risk for stillbirth. Rightfully, Pattinson, Hlongwane and Vannevel (2019:18) recommend the Umbiflow® to be integrated as part of the basic antenatal care package in South Africa. However, the researchers of Umbiflow® does not equate for the concern about the impact on the referral system in South Africa, as previously discussed by Swanson *et al.* (2019, 273-276). The Doppler resistance index used by the Umbiflow® with the remarkable shift in the reduction of macerated stillbirths is already a component of U/S. The researcher acknowledges the cost-benefit of a cheaper U/S device in an LMIC. However, as the midwifery philosophy and model of care is holistic in nature (ICM, 2014:1), fragmentation of a component of U/S that is easy to train to any level of the healthcare worker (Hofmeyr *et al.*, 2009:S30; Pattinson *et al.*, 2019:19), is not congruent to the philosophical foundation of midwifery.

Bellussi, Ghi, Youssef, *et al*. (2017:633) acknowledge that the U/S during labour and birth is an objective and accurate diagnostic tool. Contributing to the benefit of perineal IP U/S was the recommendation of Wiafe, Whitehead, Venables and Dassah (2019:online) that women find the U/S in labour to be more tolerable than digital vaginal examinations. Intrapartum U/S has many benefits, of which some relate to the maternal experience and others to the management of IP care. A detailed discussion is given in Section 2.7.4.

Apart from the healthcare benefits, the childbearing family progressively views U/S as a social event (Molander *et al*., 2010:20; Ahman, Edvardsson, Fagerli, Darj, Holmlund, Small & Mogren, 2019:2). Seemingly, the increased number of U/S carries benefit for the process of paternal bonding by adding a dimension of reality to the pregnancy (Abramowicz, 2009:296, Molander *et al*., 2010:19; Tegnander & Eik-Nes, 2008:6). Paternal bonding is found to be increasingly important, and U/S visualisation had a direct impact on a secure relationship and higher cognitive outcomes of the child (Atluru, Appleton & Plavsic, 2012:408). Commercial 3D/4D U/S businesses are becoming more common due to the benefit of enhanced parental bonding (Tegnander & Eik-Nes, 2008:6; Abramowicz, 2009:29; Goodchild & Chescheir, 2014:138). However, the benefit of parental bonding is not the only reason why the childbearing family would opt for a U/S (Molander *et al*., 2010:19). Other motivators include reassurance of the important aspect of fetal wellbeing and normality that it gives the parents (Molander *et al.,* 2010:19; Ahman *et al*., 2019:4). Ultrasound enables the discernment of the fetus as a child. When the fetus is personified as a child, and medical care is required, the personified child is treated as a patient by the interdisciplinary team (Ahman *et al*., 2019:6).

Midwifery U/S could increase the accessibility, availability and the acceptability of U/S to the benefit of the childbearing family. For midwifery U/S to be effective in addressing perinatal mortality rates, the referral structure will need to be assessed in further research outputs. The fact that certain studies do not relate to significant changes in the perinatal mortality rate in the routine use of U/S, does not deter from the benefit of U/S in pregnancy management during the first trimester, labour and birth (Mueller *et al.* 2019: 3: Goldenberg *et al.,* 2018:1598).

2.4.2 Disadvantages of ultrasound

Misconceptions of U/S emanated from the period after World War II, when research and development spilled over to the medical field with U/S used as heat therapy. According to Woo (2008:2-3), U/S was used for its therapeutic benefit of heat generation. Treatment modalities implemented ablation of the frontal lobe in the treatment of patients with rheumatic arthritis and Meniere's disease. As the use of U/S became more widely known, exaggerated claims led to a negative cycle of cynicism and concern. This concern about the risk of U/S is still present today and leads to unjustified avoidance of a valuable diagnostic test (Flanagan & Bell, 2019:1).

In the early 1960s, Sunden published the earliest and most comprehensive research on the effect of U/S (Woo, 2008:12). One of the key findings was that no harmful effect of U/S on pregnant rats could be determined. More recently, Torloni, Vedmedovska, Merialki, *et al.* (2009: 604; Whitworth *et al*., 2010:22) found no evidence of physical harm to the pregnant woman or the fetus due to U/S. According to Harbarger, Weinberger, Borders and Hughes. (2013:4), U/S during the perinatal period does not have any effect on hearing loss of the fetus. Additionally, their study showed a positive correlation between improved hearing amongst several infants that passed hearing screening in both ears and who had an increased number of U/S examinations during pregnancy.

Furthermore, Torloni *et al.* (2009:599) indicated no association with adverse maternal or perinatal outcome, impaired physical or neurological development, increased risk for malignancy in childhood, subnormal intellectual performance or mental diseases (Fullerton *et al.,* 2019:415). Interestingly, left-handedness in mostly male fetuses is stated as a possible effect of U/S exposure during pregnancy (Abramowicz, 2009:297; Whitworth *et al*., 2010:22).

It is important to mention that the safety of U/S and the refuting of physical harm is based on the "as low as reasonably achievable" (ALARA) principle that lessens exposure time at lower intensity settings for the safety of the mother and fetus. Disregarding the ALARA principles may lead to tissue heating, or cavitation, defined as pockets of gas in bodily fluid or tissue (Goodchild & Chescheir, 2014:138-139; Fullerton *et al*., 2019:415). Non-medical U/S, requested by parents for picturing or bonding, is associated with longer exposure time and therefore holds a risk for tissue heating or cavitation.

Ensuring that exposure time in pulsed (spectral) Doppler during the early and first trimester U/S is limited, is strongly recommended (Abramowicz, 2009:297). The American Institute of Ultrasound in Medicine (AIUM) supports the discouragement of the routine use of pulsed Doppler in the first trimester U/S examination (AIUM, 2018:E14). According to Mei, Afshar and Platt, 2019:832) the pulsed Doppler uses high frequency of sound waves with a greater energy output and therefore has a greater potential effect of the developing fetus. However, the prevalence of fatal and severe malformations with color Doppler for cardiac use in the first trimester is less significant as 1.39% (Mei *et al*., 2019:843). Most of the research findings on the potential risk of U/S are not current, and with the advancement of technology have not been updated, which leaves a gap in the inquiry which should inform the safe use of U/S (Fullerton *et al.,* 2019:416).

The disadvantages of U/S do not necessarily only relate to the physical harm of the instrument, but may rather influence the management of the childbearing mother. One such example is the use of U/S to determine fetal weight estimations during a late pregnancy U/S. According to Moldeus *et al*. (2017:2), induction due to large for gestation weight due to fetal surveillance in late pregnancy increases early inductions with no benefit to the neonatal morbidity. Fullerton *et al.* (2019:414) state that the use of U/S in late pregnancy should be used with caution, as benefits to the childbearing mother and baby have not been clearly indicated. Furthermore, it could contribute to an increase of the TMTS phenomenon/situation, which increases the cost of care without real benefit, or even increases the nocebo effect (Odent, 2011:91) of a childbearing family with the diagnosis of fetal anomalies (Abramowicz, 2009:296; Fullerton *et al.,* 2019:414).

Another concern with the use of U/S is the increase in terminations due to congenital abnormalities. The risk of creating a society where only a 'perfect child' is accepted, was raised by Ahman *et al.* (2019:8). Due to the personification of the fetus as a child with the use of U/S, ethical dilemmas may present themselves when fetal anomalies are identified (Holmlund *et a*l., 2017:2; Ahmen *et al*., 2019:9). The other side of the coin is underdiagnosed or underreporting of congenital abnormalities, where findings are missed or only partially diagnosed. This fact may worsen the disorder due to a lack of care available at birth, or influence the life quality and expectancy of the baby into adulthood (Abramowicz, 2009:297).

It is noteworthy to mention that a recent systematic review demonstrated that the U/S could affect the emotions, cognitions and behaviour of the mother. According to Harris, Franck, Green, Wilson and Michie (2015:36), the over-medicalised use of U/S remains a concern, irrespective of the influence of the number of U/S during pregnancy or birthplace preference of the mother.

Taking into consideration that the physical harm of the U/S has been disproven, the cost of care associated with implied management should be balanced with the benefit to the childbearing family. In the partnership model of care between a midwife and the mother (ICM, 2014:2), the informed decision should remain with the mother.

2.5 The midwife, the professional education and practice

The midwife, as described in Section 1.1., is a competent professional that applies the ICM's philosophy and model of midwifery care to midwifery care in the partnership between the midwife and the childbearing family (ICM, 2014:1-4). The midwife, as the professional of choice for the childbearing family (ICM, 2014:1), contributes to a positive pregnancy and childbirth experience (WHO, 2018:2). Midwifery care embodies holistic and continuous care that strives to empower women (Renfrew, McFadden, Bastos, *et al*., 2014:1129). A midwife respects human dignity and promotes the human rights for all persons while working in a culturally sensitive and diverse manner (ICM, 2014:online; WHO, 2018:2).

In the South African context, midwifery care often exists within the biomedical maternity model, where care relates to averting risk and preventing disease (Mathias, Davis & Ferguson, 2020:2). Despite the influence of the biomedical maternity model, midwifery care protects the normal physiological process of childbirth, supports and enhances the health and social status of women (ICM, 2014:1), by developing their capacities and confidence (Mathias *et al*., 2020:2). Therefore, midwifery care fits better in the salutogenic framework, which perceives the health of the chilbearer on a continuum from full health to the absence of health (Mathias *et al*., 2020:2). The salutogenic framework does not ignore the childbearer's disease or risk factors, but frames their care in terms of supporting beneficial factors in regards to their current place on the continuum of health.

According to SANC (2020(b):2), a midwife should have certain attributes. On a professional level, a midwife is a critical thinker who works independently within ethical and legal parameters. Therefore, the midwife may practice in any healthcare setting (SANC, 2020(b)), including the home, community, clinics and hospitals (ICM, 2017:1). According to the ICM (2017:1-2), the midwife renders continuous midwifery care during the antenatal, labour and postnatal period that includes:

- health education;
- support of the childbearing family;
- preventative measures;
- detection of complications;
- accessing medical care; and
- carrying out of emergency measures.

SANC, as the regulatory body for the midwifery and nursing profession in South Africa, is responsible for the regulation and accreditation of all midwifery education and practice. The professional registration as a basic midwife could be attained via three professional educational pathways. Basic midwifery was included in the combined four-year Diploma, or Baccalaureate Degree (Regulation 425). The third professional educational pathway was the one-year Diploma in Midwifery (Regulation 254) for the person that followed the bridging course to general nurse to subsequently midwifery. As from 2020, the new midwifery qualification for basic midwifery includes a three-year Diploma leading to the registration of only a general nurse (SANC, 2020(a):online). The general nurse may continue with the Advanced Diploma in midwifery

(Regulation 1497) to qualify as a basic midwife (SANC, 2020(a):online). The Bachelor's Degree provides professional registration as a general nurse and a midwife.

The second classification is the Midwife Specialist, which refers to the registered professional nurse and midwife that progressed from a basic midwife to a Specialist Midwife Neonatology (Regulation 368). One of the admission requirements for the Advanced Diploma in Midwifery and Neonatology is several years' practical experiences as a basic midwife to allow for maturation in the profession. A second postgraduate strand exists for a Midwife Specialist, namely a Clinical Magister (Masters in Nursing) that permits the midwife the title of Midwife Specialist.

The SANC refers to the Midwife Specialist (SANC, 2014(b):1-2) as a specialist clinician with a broad autonomous practice managing a specific caseload. The Midwife Specialist may function as first entry-point for woman, and needs the knowledge and expertise to be able to accurately assess, diagnose and manage the patient population in the speciality area (Duma *et al*., 2012:np). The care that the specialist midwife gives may include making a medical diagnosis and prescribing relevant treatment (Duma *et al*., 2012:np). Therefore the midwife usually requires expertise in diagnostic testing and treatment beyond the regular practice of the nurse/midwife (Duma *et al*., 2012:np).

Irrespective of the educational pathway that the person followed to qualify as a midwife, the ICM (2019) competence framework is clearly based on competence.

2.6 Competence-based education

In terms of midwifery, the ICM (2012:3) states that there is no common definition of competence-based education (Fernandez, Dory, Ste-Marie, *et al.,* 2012:357). However, the important aspects of competence-based education in midwifery are the acquisition of knowledge, skill and professional behaviour required to become competent (Fullerton *et al*., 2019:e414). The aim of competence-based education is to guide a person to competence. The act of being competent refers to a multi-layered concept that includes the combination of knowledge, psychomotor, communication, and decision-making skills that enable an individual to perform a specific task (ICM, 2013:19; Fullerton *et al.,* 2011:6). Competence is assessed, demonstrated or observed according to a defined level of proficiency (ICM, 2013:19). This should take into account fast-evolving technological advances, the emergence of knowledge and new evidence-based clinical practice (Fullerton *et al.*, 2011:6). However, the definition of competence is not stagnant (Fullerton *et al*. 2011:6).

In addition, competency is defined as the specific minimum set of characteristics/concepts related to the combination of knowledge, skill and professional behaviour that underpins the performance of tasks associated with competence (Fullerton *et al*., 2011:6; ICM, 2013:19). The ICM competencies are presented in a framework consisting of four categories (ICM, 2019:2), with specific competencies to link the content to the expected outcome of learning (ICM, 2012:3). It is positive to note that the competencies listed under the competency domain is not a task list but integrated statements (ICM, 2019:3). Therefore, competency-based education in midwifery, as for midwifery U/S education and practice, requires a description of the competencies needed to become a competent practitioner. Midwives who wish to incorporate the U/S as a diagnostic tool to include into their scopes of practice should have appropriate education and training, and acquire the necessary competence according to a defined level of competence.

2.7 Midwifery ultrasound competencies

As midwifery U/S competencies have yet to be described in South Africa, there is currently no expected standard for midwifery U/S education and practice. Therefore, the described competencies refer to generic competencies for U/S healthcare professionals (obstetricians and gynecologists, sonographers and midwives), which include, but are not limited to, basic U/S training course as described by the ISUOG Learning module (ISUOG, 2017). The literature search described in Section 2.7 was utilised for the development of the first round questionnaire, which was the tool used to reach consensus on midwifery U/S competencies for education and practice in South Africa (as described in Chapter 4).

In the description of U/S competencies, all available literature was included and reviewed. However, the focus was on South African midwifery U/S competencies, and therefore when available, South African literature was used to describe the U/S competencies. One such study was the post-qualification curriculum for midwifery U/S in South Africa developed by the National Centre for Fetal Medicine in Norway (Tegnander & Eik-Nes, 2008:3). The developed U/S curriculum, as part of the research, was specifically designed for South African midwives. The macro and micro midwifery U/S curricula were informed by ISUOG, the American Institute of U/S in Medicine (AIUM) and the WHO Technical Report Series 875 (Tegnander & Eik-Nes, 2014:4). The postgraduate educational programmes of U/S in obstetrics for nurse midwives at the National Centre for Fetal Medicine in Trondheim, Norway, also influenced the curriculum (Tegnander & Eik-Nes, 2014:4-5). Elements found in the literature informed the following competency domains. The domains identified in Table 2.5 include general principles of sonography, early and first trimester U/S, second and third trimester U/S, IP U/S, postpartum U/S, and gynaecological U/S.

Table 2.5 Description of the six proposed competency domains for midwifery U/S education and practice in South Africa.

Competency domains for midwifery U/S		**Broad description**
#1	General principles of U/S	Principles of physiology of instrumentation, knobology, safe use of U/S
#2	Early and first trimester U/S	Evaluation of early (up to 9 weeks and 6 days) and first-trimester U/S (10-13 weeks and 6 days) using fetometry. Identification of viability of pregnancy including tubal location.
#3	Second and third trimester U/S	Determining of fetal and placental position/ location, basic anatomy screening. Fetal age and growth evaluation with fetal surveillance per Doppler.
#4	Intrapartum U/S	Diagnosis of fetal and placental position during labour. Identification of labour progress with U/S measurements.
#5	Postpartum U/S	Evaluation of normal involution.
#6	Gynaecological U/S	Evaluation of normal non-pregnant structures related to reproductive health.

2.7.1 General principles of sonography

As the quality of U/S is operator-dependent, the person should be competent in the safe and effective use of the instrumentation (Abuhamad *et al*., 2018:30). Therefore a good understanding of the physics and instrumentation of the U/S is crucial, and not only the skill in performing the examination (Tegnander & Eik-nes, 2014:8; Swanson, Kawooya, Swanson *et al*., 2014:509; The American College for Nurse-Midwives, 2018:1; Abuhammed *et al*., 2018:30-31).

As the question of safety in the use of U/S during pregnancy is still rife today, the U/S healthcare professional should be competent in the safe use of U/S in various clinical situations (Tegnander & Eik-nes, 2014:8, 16; The American College for Nurse-Midwives, 2018:2; ISUOG, 2018:2). As highlighted by the current Covid-19 pandemic, infection control is a crucial part of performing a safe midwifery U/S. According to Abuhammed *et al.* (2018:31), a protocol for cleaning and disinfection of the transducer should be considered as part of the basic introduction of U/S education and practice.

Furthermore, being comfortable with the instrument is essential for the smooth completion of a U/S examination. Factors such as probe selection and instrument settings, amongst others, are necessary to ensure optimal visualisation of the subject being examined (Griksiatis, Scott & Finn, 2014:20, Tegnander & Eik-Nes, 2014:8, 13, 16, Abuhammed *et al*., 2018:31; ISUOG, 2018:online).

Apart from being able to work safely and effectively with the U/S instrument, the midwife should have in-depth theoretical knowledge of the anatomy and physiology of the female reproductive organs and fetal anatomy, physiology and development (Tegnander & Eik-Nes, 2014:8, 13-23, Abuhammed *et al*., 2018:31; The American College for Nurse-Midwives, 2018:2). The theoretical foundation allows for evaluation, which is vital for effective diagnosis.

Recording the data of the U/S examination provides a comprehensive report for professional use, and also protects the practitioner against possible medico-legal action. The U/S report is an important form of communication, especially in upward referral. The midwife should therefore be competent in writing a U/S report (Tegnander & Eik-Nes, 2014:23, Abuhammed *et al*., 2018:32; The American College for Nurse-Midwives, 2018:2).

2.7.2 Early and first-trimester ultrasound

Once the domain of general principles is mastered, examinations during different times in the continuum of the reproductive health life require specific competencies. Having knowledge about the indications for early and first trimester U/S may reduce the over-medicalisation of U/S during the first trimester. The indications for early and first trimester U/S according to AIUM (2018: E15), ISUOG (2013:102-113) and Curado and Bhide (2018:30) are:

- Confirmation of the presence of an intrauterine pregnancy
- Evaluation of a suspected ectopic pregnancy
- Confirmation of cardiac activity
- Evaluation of the viability of embryo/fetus
- Estimation of gestational age
- Diagnosis or evaluation of multiple gestations, including determination of chorionicity and amnionicity
- Evaluation of the cause of vaginal bleeding
- Evaluation of pelvic pain
- Evaluation of suspected gestational trophoblastic disease
- Evaluation of major fetal abnormalities

The ISUOG has stated that merely evaluating chorionicity and amnionicity during the first trimester is unacceptable, and that the U/S healthcare professional should also evaluate gross fetal malformation. According to Curado and Bhide (2018:301), the childbearer should be offered an early U/S between 10 weeks 0 days and 13 weeks 6 days for gestational dating and confirmation of a single or multiple pregnancy. The childbearing family should also be offered the opportunity to evaluate genetic screening by using U/S as one of the components in diagnosis the common trisomies (21, 18 and 13) (Curado & Bhide, 2018:301). With an increase in competence, half of the antenatal detectable fetal structural abnormalities could be diagnosed in the first trimester (Curado & Bhide, 2018:301). According to Liao, Wen, Ouyang, *et al.*(2020:13), the use of a standard anatomical protocol for routine first trimester U/S can detect half of all fetal anomalies found during pregnancy.

For competency of early and first trimester U/S, the U/S healthcare practitioner should have in-depth knowledge of the normal sonographic morphology for early (5-10 week) and first trimester (11-14 weeks) gestation (Tegnander & Eik-Nes, 2014:14; ISUOG, 2018:8-9; Abuhammed *et al*., 2018:31). Two of the basic knowledge applications required for this competency are the identification of the indications for an early and first trimester U/S and the criteria for the application of an appropriate probe (transvaginal or transabdominal) (Tegnander & Eik-Nes, 2014:13; Abuhammed *et al*., 2018:31; ISUOG, 2014:8). According to Mei *et al*. (2019:830), the transabdominal and transperineal U/S should be uitilised as the situation prescribes. To evaluate sonographic dating, the U/S healthcare professional needs to be familiar with fetometry, which is defined as the sonographic measurement of the fetus (Tegnander & Eik-Nes, 2014:13). This includes the evaluation of fetal growth restriction (Abuhammed *et al*., 2018:31; ISUOG, 2018:9). Not only does the indication for early or first trimester U/S hold medical and medico-legal implications, but the care and sensitive professional demeanour plays a significant role in the care of the mother, especially with the diagnosis of miscarriage (Jansson & Adolfsson, 2010:70).

The healthcare professional should be able to identify a singleton or multiple pregnancies (Tegnander & Eik-Nes, 2014; Abuhammed *et al*., 2018:31; ISUOG, 2018:9). The identification and early referral of abnormal findings such as ectopic pregnancy, sub-chorionic hematoma and a molar pregnancy are vital components of the competency for early and first trimester U/S (Swanson *et al*., 2014:509; Abuhammed *et al.,* 2018:31; ISUOG, 2018:9). The healthcare professional should be knowledgeable and skilled in the diagnosis and referral of abnormal findings, embryonic/fetal demise in the first trimester, and U/S findings in case of a threatened abortion (Tegnander & Eik-Nes, 2014; Abuhammed *et al*., 2018:31; ISUOG, 2018:9).

2.7.3 Second- and third-trimester ultrasound

According to Callen and Norton (2017:4), most congenital anomalies occur in the population with no known risk factors, and therefore the second trimester ultrasound screening should be offered routinely. The healthcare professional should be competent in the basic fetal anatomy of the second and third trimester U/S (Tegnander & Eik-Nes, 2014:18; Abuhammed *et al*., 2014:31). The ISUOG (2017:13-15) defines fetal anatomy as separate systems (encompassing the face and neck, thorax and heart, brain and central nervous system, skeleton and abdomen). The evaluation of U/S findings and their subsequent influence on clinical decision-making is an essential competence that every U/S healthcare professional should master in the care of each childbearer (Tegnander & Eik-Nes, 2014:19; Abuhammed *et al.,* 2014:31-32; ISUOG, 2018:16).

From the literature the assessment of fetal wellbeing with Doppler studies is seen as a vital inclusion. According to Tegnander and Eik-Nes (2014:18,19), the principles of Doppler, the spectral Doppler, the colour Doppler, and continuous-wave Doppler of the uterine arteries, and the umbilical arteries and vein should be evaluated for conditions related to fetal growth, twin-to-twin transfusion, and placental sufficiency (Nkosi *et al*., 2019:350). The Umbiflow®, as previously discussed in Section 2.2.3, could be an effective alternative to the traditional Doppler for all women in low resource settings (Nkosi *et al*., 2019:350). Placental insufficiency has been underappreciated as a cause of perinatal death (Pattinson, 2019:4).

During the second and third trimesters, the position and type of implantation of the placenta and umbilical cord (Swanson *et al*., 2014:509; Fullerton *et al*., 2019:), as well as the amniotic fluid volume, should be evaluated (Tegnander & Eik-Nes, 2014:18,19; Abuhammed *et al*., 2014:31, ISUOG, 2018:18). According to ISUOG (2014:114) and AIUM (2018:E14), placental assessment, including its relation to the internal cervical os, amniotic fluid estimation and conditions associated with abnormal amniotic fluid volume, are elements of a basic obstetric and gynecological U/S.

According to ISUOG (2018:13), the identification of preterm birth, including cervical assessment (Abuhammed *et al*., 2014:32), with predisposing factors such as gestational diabetes and fetal growth restriction in the third trimester, could be a valuable competence included for the basic U/S.

The U/S healthcare professional should be able to determine the lie, presentation, position (Tegnander & Eik-nes, 2014:19) and attitude of the fetus in the third trimester. This will allow the SBA to evaluate the biophysical profile of the fetus in preparation for birth. According to Abuhammed *et al*. (2018:41), the biophysical profile includes a series of evaluations that include the monitoring of fetal breathing, movement, tonus, flexion of extremities and the normal amniotic fluid index. The biophysical profile is classified as a specialist evaluation that does not form part of the basic U/S (Callen & Norton, 2017:5).

As a U/S healthcare professional, the foundational competence of managing ethical issues (ICM, 2014:2) associated with prenatal diagnostic procedures may lead to conflict of personal and professional opinion. An example of the appreciation of ethical issues pertaining to prenatal diagnostic procedures is the implementation of the Choice on Termination of Pregnancy Amendment Act (1 of 2008) which allows for termination up to 28 weeks of gestation.

The evaluation of the criteria for a second and the third trimester U/S should always be analysed according to the potential of the healthcare practitioner to effectively refer a person with a high-risk profile or abnormal finding (ICM, 2019:12) to appropriate healthcare. This is an essential competency in U/S.

2.7.4 Intrapartum ultrasound

According to Bellussi *et al.* (2017:633), IP U/S is found to be an objective, accurate and reliable diagnostic tool (Usman *et al.,* 2015:53). In South Africa, fresh SB, which represents mainly IP deaths, contribute to 23% of all perinatal deaths >1000g (Pattinson, 2019:5). Pattinson (2019:5) further states that IP asphyxia and birth trauma cause 18.6% of SB in South Africa. As previously discussed in Section 2.2.3, the burden of disease of asphyxia on live births contribute to life-long disability due to cerebral palsy with the added financial burden on both the childbearing family and the health system. The benefit of IP U/S lies within the spectrum of early referral, and the ability to reduce the impact of fresh SB and related asphyxia during labour.

According to Siergiej *et al.* (2019:296), the accuracy of digital vaginal assessment for labour progress has long been perceived as inadequate. The cumbersome deduction that the inadequate measurement of cervical dilatation has for many years been the cause for medical intervention leads the researcher to question the effectivity of plotting cervical dilatation on the partograph.

One of the vital benefits for a low-risk birth is the precise examination of the fetal station as an indicator of labour progress (Yousuf *et al*., 2013:429; Siergiej *et al*., 2019:295; Van Adrichem *et al*., 2018:252) for the progression of positions where the occiput as the denominator is anterior than vaginal examination. The IP U/S holds a high degree of precision of the fetal position (Siergiej *et al*., 2019:295). Therefore, the benefits include the identification of cephalic malpresentation such as occipital posterior or occipital transverse, anterior and posterior asynclitism, and deflexed presentations such as brow and face presentations (Bellussi *et al.,* 2017:633-637). The diagnosis of cephalic malpresentation during prolonged or obstructed labour (Bellussi *et al*., 2017:633-637) can lead to an early referral and access to appropriate emergency care. As malposition and malpresentation affect 10% of all pregnancies, the ability of the healthcare provider to determine abnormalities and implement timely referral (Bellussi *et al*., 2017:633) is critically important.

Evaluation of cervical assessment using IP U/S may be valuable where the digital vaginal exam is contra-indicated, such as with placenta praevia or preterm labour (Usman, 2015:53). Utilising a transvaginal or transperineal U/S, also referred to as a translabial U/S, may pose as an alternative and more acceptable means of evaluating the progress of the childbearing woman during labour. As midwives promote non-intervention with appropriate use of technology (ICM, 2014:2), transperineal IP U/S holds immense value for women that may experience vaginal examination as traumatic, degrading and offensive due to personal experience, beliefs or culture (Downe, Gyte, Dahlen & Singata, 2013:5). The acceptability of IP U/S between various cultures and beliefs are indicated, as childbearers in China, Turkey, Romania, Ghana and the United Kingdom collectively indicated a high acceptability (Wiafe *et al.,* 2019:4). Therefore the U/S healthcare professional should be competent in using the transabdominal, transvaginal or transperineal application of IP U/S (Khalil, Elbadawi, Abdelnaby & Zayed, 2012:298; ICM, 2014:2; Van Adrichem *et al*., 2018:252).

The angle of progression (AOP) is defined as the angle between the length axis of the symphysis and a line from the inferior border of the symphysis tangential to the fetal skull (Khalil *et al.,* 2012:298; Usman *et al.,* 2015:54; Van Adrichem *et al.,* 2018:252; Dall'Asta et al., 2019:5). As part of the IP U/S competency, the U/S healthcare professional should be able to evaluate the AOP and the implication of the outcome regarding the mode of birth (Khalil *et al.*, 2012:298; Van Adrichem *et al*., 2018:252). In addition to fetal surveillance, the U/S healthcare professional should be competent in the evaluation of the position of the placenta, umbilical cord and the measurement of the amniotic fluid (Ebrahim, Zaitn & Elkamash, 2013:658).

It cannot go unmentioned that prompt obstetrical intervention is crucial to prevent IP-related fetal hypoxic injury and related maternal mortality and morbidity associated with obstetrical emergencies (Hofmeyr *et al*., 2009:S21). In a country where resources to ensure accessible care is not readily available, the use of IP U/S has the potential to address IP stillbirths and birth asphyxia-related injuries. In addition, Siergiej *et al.* (2019:296) state that IP U/S is best applied as bedside point-of-care U/S, which points to the cost-effective implementation of IP U/S in a low resource county such as South Africa.

2.7.5 Postpartum ultrasound

The U/S healthcare professional should be able to select the correct ultrasound equipment for producing the optimal U/S image to evaluate the normal anatomy of the uterus, ovaries, cervix and adnexa during the postpartum period (Tegnander & Eik-Nes, 2014:25-26). The U/S healthcare professional should present with professional behaviour and provide quality care and communication during a gynaecological examination (Tegnander & Eik-Nes, 2014:25-26). Competency in the U/S examination of the perineal floor muscles and intactness of the anal sphincter should form part of the basic ultrasound (ISUOG, 2018:7,18). According to Wang, Shum and Kennedy (2019:436), evaluation of retained placenta increases risk for postpartum Haemorrhage and should therefore be included in the evaluation of uterus and adnexae for normal involution to ensure.

2.7.6 Gynaecological ultrasound

The basic gynaecological ultrasound focuses on examining and evaluating the normal structure of the uterus, ovaries, and adnexa during the non-pregnant state (Tegnander & Eik-Nes, 2014:18, 9; ISUOG, 2018:4). A U/S healthcare practitioners should be able to visualise and evaluate the normal structures of the pelvic floor (ISUOG, 2018:4,8) and refer a person with a high-risk profile or abnormal findings to an appropriate healthcare professional (ICM, 2014:2).

2.8 Midwifery ultrasound

Midwifery U/S has been practiced in Norway since 1973 (Molander *et al.*, 2010:19) and in various other countries around the world for several decades (Ahman *et al.*, 2019:2). The U/S skill set of the midwife has expanded to the estimation of gestational age, evaluating amniotic fluid, localisation of the placenta, early detection of multiple pregnancies, identification of fetal anomalies and Doppler assessment (Ahman *et al.*, 2019:2).

Midwives in various African countries such as Liberia (Bentley *et al.*, 2015:1567), Uganda (Swanson, Kawooya, Swanson, et al, 2014:512), and Tanzania (Ahman, *et al.*, 2018:28) and Mozambique (Greenworld *et al.*, 2014:274) have successfully implemented midwifery U/S education and practice. According to Carrera (2011:292), midwifery U/S has been positively experienced in Ghana, Kenya, Sudan, Ethiopia and Tanzania.

According to the ICM (ICM, 2013:online), a basic midwife should be able to use U/S for gestational dating and the skill to evaluate fetal growth placental location and amniotic fluid volume using U/S visualisation and measurement (Fullerton *et al.*, 2019:416). With a review of the Essential Competencies for Basic Midwives (ICM, 2017:online) differences in opinion were noted between low-to-middle-income countries and higher-income countries about midwifery U/S competency. The ICM concluded the difference in the opinion stating that pregnancy dating, identification of a single or multiple pregnancies, fetal anatomy, fetal position, placental placement and amniotic fluid volume via U/S is considered a basic skill for the basic midwife (Fullerton *et al.*, 2019:419). However, in South Africa, midwifery U/S regulation and accreditation has been met with resistance (Tegnander and Eik-Nes, 2008:6), and unequal education and practice opportunities for midwives.

The benefit of the diagnostic impact of midwifery U/S benefits the childbearer by increasing the safety of pregnancy and birth (Greenworld *et al.*, 2014:276). Identification of high-risk pregnancies and improved diagnosis of early pregnancy complications, twin pregnancies and malpresentation contributes to the diagnostic impact of midwifery U/S (Swanson, Kawooya *et al.*, 2014:512).

Midwifery U/S competence has been repeatedly demonstrated (Nathan *et al.*, 2017:210; Fullerton *et al.*, 2019:416; Mashamba, 2017:130). A variation of curricula have shown midwives with 90-100% similarity between the control and the experimental group's midwife placing the U/S competence midwives to identify fetal anomalies comparable with tertiary institutions (Fullerton *et al.*, 2019:416). Congruency between midwives U/S trainee and reviewer were confirmed by Nathan *et al.* (2017:210) as 99.4% for 41 trainees in five countries performing 3801 U/S for high-risk conditions. Interestingly, midwifery U/S competence is the same irrespective of auxiliary midwives or midwives functioning within the full scope of midwifery practice, as demonstrated by auxiliary midwives in Nepal exceeding 90% congruence compared to certified ultrasonographers (Fullerton *et al.*, 2019:416). The ability of midwives to demonstrate competence in U/S confirms the inclusion in the Essential competencies for the Basic Midwife (ICM, 2019:13,16). As the statistics mentioned indicates the ability of the basic midwife to be found competent in midwifery U/S, in addition to the ICM's Essential Competencies for the Basic Midwife (ICM, 2019:13,16), the question raised by SOMSA (2017:3) as to which of the midwifery categories should be the applicable cadre to perform U/S, seem to be answered.

Midwives in Tanzania view U/S as a crucial component of midwifery care that improves the management of pregnancy complications (Ahman *et al.*, 2018:30). Midwives in Mozambique reported feeling empowered, which translated into an increase in quality of midwifery care (Greenwold *et al.*, 2014:276). In Norway where midwives are the main providers of routine antenatal care, midwives describe U/S as very valuable and that it plays a vital role in pregnancy management by improving outcomes (Ahman *et al.*, 2019:1). The "magic of ultrasound" (Stewart, 2011:54) increases work satisfaction for midwives (Ahman *et al.*, 2019:8). Midwives acknowledge the value of U/S, as well as the impact on midwifery care. However, the additional responsibility which U/S places on midwives could conflict with the reward (Ahman *et al.*, 2019:8)

Despite midwives desire to reach competency in U/S, a perception exists in certain LMIC income countries that U/S is the work of the physician (Holmlund *et al.*, 2017:5). As U/S was also demanded by the childbearing family, midwives contested the system.

As no guarantee can be given for fetal health, an ultrasound may strengthen the expectancy of the childbearing family that the pregnancy or birth is progressing well. Identifying fetal anomalies increases the support, counselling for the childbearing family that may an ethical conflict for the midwife (Ahman *et al.*, 2019:6-8).

2.9 Concluding remarks

The benefits of U/S outweigh the risk of potential harm to the mother and fetus. The focus on the childbearer as participant in the midwifery care partnership (ICM, 2014:1) should be acknowledged in the process of development of new competencies. In the current technological era, midwives need to be mindful of doing too much too soon and too little too late. However, as midwives living in the time of the fourth industrial revolution, the midwifery care should evolve to the benefit of the childbearing family.

To answer the research question, the researcher compiled a set of six midwifery U/S competencies that were presented to the experts, founded on the principles of competency-based education and practice. In Chapter 3, the researcher discussed the research design and implementation that was used to reach the aim of expert consensus on competencies for midwifery U/S education and practice in South Africa.

Chapter 3 Research findings

"Two heads are better than one, not because either is infallible, but because they are unlikely to go wrong in the same direction." – C.S. Lewis

3.1 Introduction

There are various reasons why we do research. It is not intrinsically tied purely to knowledge development, but research can also be theory-orientated (knowledge for understanding), or to create knowledge for action relating to practice or policy (De Vos, 2011:80). The motivation for this study was guided by an aspiration to generate knowledge in support of quality midwifery U/S education and practice in South Africa. Midwifery U/S competencies are captured as one of the ICM's Essential Competencies for the Basic Midwife (Fullerton *et al*., 2019:e416; ICM, 2019:13, 16). Therefore, as group opinion is more valid than individual opinion (Keeney, 2015:275; Keeney *et al.,* 2011:3), or as C.S. Lewis quoted: "Two heads are better than one", reaching consensus on the competencies for midwifery U/S education and practice for South Africa will endorse global parity of competence.

As a concept, research methodology refers to the systematic process of conducting research (Creswell & Creswell, 2018:51; Mertens, 2015:50). Irrespective of the type of methodology, a research process is guided by a specific paradigmatic approach (Mertens, 2015:56). In this study, a postpositivist approach directed the selection of the overall research design, as discussed in Section 1.8. In this chapter, the researcher will describe, amongst others, the research design that was appropriate to answer the research question:

What is the consensus on competencies for midwifery U/S for education and practice in South Africa?

The description of the methodology in this chapter will further include the research technique, the development of the research instrument, the population and sampling, the process used to gather data, ethical considerations, and how methodological rigour was ensured (Cohen, Manion & Morrison, 2018:186).

3.2 Research design and approach

Grove and Gray (2019:68, 246) refer to the research design as the architectural plan of the study, while Creswell and Creswell (2018:38) prefer ‘a procedure of inquiry that answers the research question’. Nevertheless, the end game is to develop an empirical body of knowledge related to the field of study (Grove & Gray, 2019:22, 54; Mertens, 2015:63). In general, researchers make use of two main types of research design, namely quantitative and qualitative. According to Creswell and Creswell (2018:35), the methods are not polar-opposites from each other, but a study usually leans more towards the one method rather than the other (Creswell & Creswell, 2018:35). Cohen *et al*. (2018:173) emphasise that there is no single blueprint for planning research, and therefore the aim of the research should inform the research design.

Quantitative research is defined as the measure of variables in a calculable way (Mertens, 2015:54), or as defined by Maree (2020:184), as the objective use of numerical data from a selected subgroup of a population for generalisation. Grove and Gray (2019:54) add that the rigorous and systematic process of quantitative research explains new situations or concepts about the world in which we live. The researcher selected a quantitative, descriptive research design that uses objective-driven numerical data from a sample population to support the aim of the study (Burns & Grove, 2009:22). The numerical data used in this quantitative descriptive design is in essence non-experimental (Grove & Gray, 2019:246, 286; Maree, 2020:193), as the research focus was on the significance of consensus of expert opinion. A quantitative research design benefits a topic where little knowledge is available, as was the case in this study (Creswell & Creswell, 2018:168; Giannarou & Zervas, 2011:77; Grove & Grey, 2019:54, 68).

Descriptive studies allow a researcher to observe new meaning, describe what is currently available, and are useful in building foundational knowledge for future research projects on the topic by using a survey technique (Grove & Gray, 2019:54, 68, 286; Maree, 2020:193). Therefore, the benefit of a descriptive research design for this study was the identification and description of the consensus reached by expert opinion on midwifery U/S competencies for education and practice (Grove & Gray, 2019:55).

In contrast with quantitative research, qualitative research is defined as a systematic approach that describes experiences and situations from the perspective of the person in the situation (Grove & Gray, 2019:89; Taylor & Francis, 2013:3). The participants' words are studied to ensure a deeper understanding of the perspective of the person in the situation (Grove & Gray, 2019:89; Taylor & Francis, 2013:3). Qualitative research aims to make meaning out of participants' lived experiences (phenomenology), description of social processes (grounded theory), description of a culture (ethnography), or description of a research question or problem (Grove & Gray, 2019:95; Maree, 2020:50; Taylor & Francis, 2013:3). Due to the nature of the healthcare profession, understanding the lives and circumstances of the people to whom we render care can be very valuable. However, as this study focused on expert consensus and not the experts' experiences, a qualitative research design would not have adequately served the aim of the study.

The selected study design was appropriate to reach the aim of the study. A quantitative descriptive design allowed for new knowledge development in the area where gaps were identified regarding the concepts of midwifery U/S in South Africa (Grove & Gray, 2019:54; Hohmann, Cote & Brand, 2018:3278). The opinion of the experts in the field of U/S about the competencies for midwifery was important for the future development of midwifery U/S education and practice. Furthermore, the numerical significance of the consensus reached by the experts created an opportunity to identify each of the elements which form the content within the six domains applicable to midwifery U/S competencies in South Africa.

3.3 Research technique

The research technique refers to the tool or method used to gather data in line with the aim of the study within the research design (Grove & Gray, 2019:70; Polit & Beck, 2012:257). Due to the lack of knowledge on the required competencies for midwifery U/S education and practice, a group consensus method was most applicable to this study (Hohmann, Cote & Brand, 2018:3278).

The two consensus methods often used in research are the nominal group technique and the Delphi technique (McMillan, Kind & Tully, 2016:655). The nominal group technique is a structured process that includes face-to-face meetings during which participants generate ideas and reach consensus about solving a specific problem or issue (Hohmann, Cote & Brand, 2018:3278; McMillan *et al*., 2016:656). The disadvantage of using a nominal group technique for this study would have been the heterogeneous nature of the sample, as discussed in Section 3.4. The researcher anticipated peer domination due to the differences in the traditional perceived expertise between the two groups (Hohmann, Brand, Rossi & Lubowitz, 2018:350). In addition, the cost and logistical and time implications of arranging a group session for a geographically distributed group of experts would have been difficult to manage.

The characteristics of the Delphi technique made it the most appropriate consensus method to reach the aim of the study (Hsu & Sandford, 2012:2; Keeney, 2015:273). The Delphi technique is a flexible and adaptable tool to gather information about real-world knowledge in real-time (Louw, 2014:28; Hsu & Sandford, 2007:6). In addition, the egalitarian environment created by anonymity prevents group dominance or peer influence, and also prevents vocal minorities from influencing expert opinion (Hohmann, Brand *et al*., 2018:350; Shariff, 2015:2). According to Gill, Leslie, Grech & Latour (2013:1322) and Keeney (2015:268-269), a Delphi technique is frequently used for its advantages in health sciences research.

Since its development in the early 1950s, the original Delphi technique has been adapted to include several variations, such as the classical Delphi, the e-modified Delphi, the real-time Delphi and the policy Delphi, to name a few (Avella, 2016:306; Hasson & Keeney, 2011:1697; Yousuf, 2007:4). The main characteristics of a Delphi technique are the iterative rounds of questionnaires, with statistical aggregation of data and controlled feedback to experts between the rounds while ensuring participant anonymity (Gill *et al*., 2013:1322; Hasson *et al*., 2000:1009; Keeney, 2015:268). Although the variations of the Delphi technique all have the same aim, which is to reach consensus, the different variations are applied differently. Therefore it is beneficial to select the most appropriate type of Delphi technique for the topic under study (Keeney, 2015:272).

The original Delphi technique, also referred to as the classical Delphi, begins with a round of open-ended questions that produce relatively large amounts of data. The rounds continue until consensus is reached (Proctor & Hunt as cited in Keeney *et al.,* 2011:11; Linstone & Turnoff, 2002:225). The experts may develop fatigue due to the large amounts of data, or number of rounds, and this can lead to a decline in the response rate (Hsu & Sandford, 2012:20; Keeney *et al*., 2011:69-70). A modified Delphi differs from the classical Delphi by adapting the open-ended first-round questionnaire to statements that were developed from existing literature (Avella, 2016:8; Hasson & Keeney, 2011:1697; Keeney *et al.,* 2011:71). Instead of a continuation of rounds until consensus is reached, the modified Delphi limits the number of rounds to a maximum of three (Hasson & Keeney, 2011:1697; Linstone & Turnoff, 2002:225; Shariff, 2015:3).

The researcher selected a modified e-Delphi technique, which means that the questionnaire was administered via an online survey. In a country such as South Africa with its vast geographical distribution of experts, an online survey is easy to use, environmentally friendly and cost-effective (Louw, 2014:29). The online software programmes used to gather data is called Evasys®. A benefit of the online distribution of a questionnaire and data collection with a software programme such as Evasys® is the time-efficiency of distribution, and rapid feedback of experts. The distribution of the questionnaires and capturing of data, processing and storing of data, added to the quality of data using an online platform (Avella, 2016:314-315; Gill *et al.,* 2013:1321-1322; Hsu & Stanford, 2007:4). Therefore the modified e-Delphi was most suited to reach the research objectives as depicted in Table 3.1.

Table 3.1 Motivation for a modified e-Delphi technique for a quantitative, descriptive design.

Research objectives	**Modified e-Delphi motivation**
Identify competencies for midwifery U/S education and practice from literature	The first-round questionnaire was based on literature instead of being an open-question round • Decreased risk of long questionnaires • Increased participation and response rate
Compile a list of competencies for midwifery U/S education and practice in the continuum of female reproductive health	The first-round questionnaire was developed from a literature search by including available knowledge on the research topic • Increased reliability of the instrument
Describe competencies for midwifery U/S education and practice as validated by expert opinion	Expert consensus was reached based on a set of competencies developed from the literature • Increased anonymity • Expert opinion allows for judgement of subject with limited prior information

The first research objective was the identification of midwifery U/S competencies from existing literature, and the second objective was compiling a list of midwifery U/S competencies. The modified e-Delphi served the purpose of the first two research aims, allowing the researcher to develop a structured questionnaire, based on existing literature, for the purpose of the third research objective, namely validation of the midwifery U/S competencies by consensus of expert opinion. The modified e-Delphi contributed to the reliability of the research technique while allowing expert opinion on a subject with limited prior information. As the questionnaire did not consist of only open-ended items, it was not lengthy, and therefore had the benefit of an increased participation and response rate (Avella, 2016:312-313; Keeney *et al*., 2011:69-70; Linstone and Turnoff, 2002:225).

Information from the literature review was used to develop the first-round questionnaire, mostly including quantitative (closed-ended) questions and to a lesser extent qualitative (open-ended) questions (Hsu & Sandford, 2007:4; Millar *et al.,* 2007:18). The development of the questionnaire is discussed in detail in Section 3.4.

For this research, the consensus level was set at 70%, as suggested by the Biostatistics Department at the University of the Free State. Consensus at 70% is supported by literature stating that two-thirds of the responses for any particular statement should be set for the two highest levels of the interval scale (Avella, 2016:306; Du Plessis & Human, 2007:22). The researcher determined consensus by calculating the statistical aggregate of the group responses.

Although anonymity is discussed in Section 3.9 as an ethical consideration of the study, it is important to note that anonymity is a crucial characteristic of the Delphi technique (Keeney, 2015:273; Millar *et al*., 2007:10). Avella (2016:309) states very clearly that without anonymity, which he describes as being independent of individual personality and influence of professional reputation, the Delphi technique is flawed.

3.3.1 Development of the first-round questionnaire

The development of the first-round questionnaire, as the first step in the modified e-Delphi technique, was based on the literature review as described in Chapter 2. It was beyond the scope of this study to do a systematic review of the literature. The literature review did therefore not follow an all-inclusive approach. Instead, the researcher conducted a literature search with the assistance of an experienced librarian. The literature search encompassed midwifery ultrasound, pregnancy U/S, intrapartum U/S and curriculums of U/S. Databases included for the literature search was Academic Search Ultimate, Cochrane Review Library, Medline, Science Direct, the Wiley library and Google Scholar.

A total of six domains of midwifery U/S competencies were identified that formed the structure of the questionnaire, as indicated in Table 3.2. The various elements that relates to midwifery U/S were categorised under the six domains of midwifery U/S competencies. These included all possible content related to U/S that falls within the compounds of the basic U/S (ICM, 2017:13, 16). The related association between the six identified domains of midwifery U/S and the ICM's scope of practice of the midwife (ICM, 2017:1) is illustrated in Table 3.2. Although gynaecological U/S is not perceived as the traditional domain of the midwife, it is included in the basic U/S of ISUOG (ISUOG, 2014). Due to women's health and sexual or reproductive health being included in the scope of the midwife (ICM, 2017:1), gynaecological U/S was included as part of the six domains.

Table 3.2 The six domains of midwifery U/S competencies applicable to the midwifery scope of practice.

Domains of midwifery U/S competencies	**The Scope of Practice of a midwife (ICM, 2017:1)**
Competency ONE: General principles of sonography	
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to *safely and effectively perform* a midwifery U/S based on the general principles of sonography.	"The midwife is recognised as a responsible and accountable professional who works in partnership with women ...." "This care includes preventative measures, the promotion of normal birth, the detection of complications in mother and child, the accessing of medical care or other appropriate assistance and the carrying out of emergency measures."
Competency TWO: Early and first-trimester U/S	
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to perform an *early and first-trimester* midwifery U/S.	• "…give the necessary support, care and advice during pregnancy…" • "… detection of complications in mother and child…" • "…accessing of medical care or other appropriate assistance…"
Competency THREE: Second and third-trimester U/S	
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to perform a *second and third-trimester* U/S.	• "…give the necessary support, care and advice during pregnancy…" • "… detection of complications in mother and child…" • "…accessing of medical care or other appropriate assistance…"

Domains of midwifery U/S competencies	The Scope of Practice of a midwife (ICM, 2017:1)
Competency FOUR: Intrapartum U/S	
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to perform an *intrapartum* U/S.	• "…give the necessary support, care and advice during labour…" • "… detection of complications in mother and child…" • "…accessing of medical care or other appropriate assistance…"
Competency FIVE: Postpartum U/S	
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to perform a *postpartum* midwifery U/S.	• "…give the necessary support, care and advice during labour…" • "… detection of complications in mother and child…" • "…accessing of medical care or other appropriate assistance…"
Competency SIX: Gynaecological U/S	
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to perform a *basic gynaecological* midwifery U/S	"This work should involve antenatal education and preparation for parenthood and may extend to women's health, sexual or reproductive health and child care."

The six domains of midwifery U/S competencies relate directly to the ICM scope of practice of the midwife (ICM, 2017:1). The midwife as an accountable professional should hold adequate knowledge, skill and behaviour about the general principles of U/S to allow for safe and effective application. As such, the midwife should be able to apply the competencies related to the general principles of midwifery U/S to early and first-trimester, second and third trimester, intrapartum, postpartum period, and gynaecological U/S (ICM, 2017:1). The midwife should use the U/S as an appropriate technological measure to promote normal birth, as a measure to detect complications, and to advance timeous referral (ICM, 2014:1).

The elements for each of the six domains of midwifery U/S were captured as quantitative questions in the questionnaire (Addendum B). The questionnaire did not include any demographical questions. According to Keeney *et al*. (2011:86), it is not essential to collect demographical data of the experts. The target population was divided into two groups. The reason for this was to ensure a heterogeneous sample that was inclusive of the South African obstetrical and gynaecological U/S context, and therefore no distinction between Group A and B was needed on the basis of demographical data to reach expert consensus on the competencies of midwifery U/S education and practice.

The ICM (2019:5) emphasises that competency is not a list of tasks, but rather integrated statements referring to knowledge, skill and professional behaviour. Therefore, the six domains of the midwifery U/S competencies were divided into the three components of competency (Fullerton *et al*., 2011:6), namely knowledge, skill and behaviour. Refer to the example, as indicated in Table 3.3.

Table 3.3 Example of competency-based structure for first-round questionnaire development

Draft questionnaire				
Competency 1: **Within the midwifery scope of practice, a midwife has the knowledge, skill and professional behaviour to safely and effectively do a midwifery U/S based on the general principles of sonography.**				
Statement 1: A midwife has the foundational knowledge, skill and professional behaviour to perform a safe and effective midwifery U/S.	**Essential**	**Useful**	**Potential for inclusion**	**Not needed**
A midwife has foundational KNOWLEGDE about:				
1.1. physics of U/S related to instrumentation				
1.2. basic maintenance of:				
1.2.1.U/S instrumentation				
1.2.2.U/S safety				
1.2.3.infection control				
1.3. the principles of knobology				
1.4. writing a complete U/S report				
1.5. anatomy and physiology of the internal organs of the female reproductive system related to the reproductive age				

Draft questionnaire				
Competency 1: **Within the midwifery scope of practice, a midwife has the knowledge, skill and professional behaviour to safely and effectively do a midwifery U/S based on the general principles of sonography.**				
Statement 1: A midwife has the foundational knowledge, skill and professional behaviour to perform a safe and effective midwifery U/S.	**Essential**	**Useful**	**Potential for inclusion**	**Not needed**
A midwife has the SKILL AND PROFESSIONAL behaviour to:				
1.6. apply physics of U/S and related instrumentation				
1.7. apply basic maintenance				
1.8. apply the principles of knobology				
1.9. write a complete U/S report				
1.10. In your opinion, would you say that the components above capture the **foundational knowledge, skills and professional behavior of** midwifery U/S? If your answer is **NO**, please recommend additional components.	**Yes**		**No**	

As the example indicates, each of the six domains of midwifery U/S commenced with a statement describing what the domain entails. The questionnaire was structured according to the three components of competence (Fullerton, 2011:6; ICM, 2019:6). Despite this the competency components of skill and professional behaviour are classified as two different entities, so the researcher followed the example of combining skill and professional behaviour as in the updated version of the ICM Essential Competency for Basic Midwifery (ICM, 2019:6).

The first-round questionnaire consisted of 91 closed-ended questions, referred to as the elements of the six domains of midwifery U/S. The researcher used a ranking Likert scale to measure the consensus level (Grove & Gray, 2019:35; Maree, 2020:243; Millar *et a*l., 2007:18-20) of each the elements proposed for midwifery U/S. To exclude an option for a neutral opinion, a four-level Likert scale was used (Hohmann, Cote & Brand, 2018:3281; Millar *et al*., 2007:18-20). Accordingly, the experts were asked to rate the importance of inclusion of the elements for of the midwifery U/S according to essential (1), useful (2), the potential for inclusion (3) or not needed (4).

As a Delphi technique can generate both qualitative and quantitative data during each round (Hsu & Sandford, 2007:4; Millar *et al.,* 2007:18), a standard open-ended question was added at the end of each competency. The open-ended questions were formulated in the same way for each of the subsequent rounds. The purpose of these open-ended questions was to allow the experts to relate specific knowledge, skills and behaviour drawn from their expertise to the specific competency (Hsu & Sandford, 2007:4). The qualitative data collected per round was converted to closed-ended questions that were added to subsequent rounds. In this way, the experts were allowed to evaluate the data quantitatively in the consecutive rounds, while staying informed about the collective group opinion (Louw, 2014:26). The reliability and internal validity of the instrument were increased by utilising the experts as moderators of the instrument (Hasson & Keeney, 2011:1700-1701). The justification for the additional data/questions was that experts reached consensus on the additional questions in the subsequent rounds, as discussed in Chapter 4.

In addition to the standard six open-ended questions related to each of the competency domains, the researcher formulated two additional open-ended questions that emerged from the literature review. The questions were related to the South African midwifery U/S context as seen in Addendum B.

3.4 Population

The population is defined as a particular type of individual who is the focus of the research (Grove & Gray, 2019:293), or can also be referred to as the total population (Cohen *et al.,* 2019,203). The total population of this study therefore included obstetricians and gynaecologists, sonographers, and midwives who are healthcare workers with expertise in U/S during the child-birthing period (refer to Figure 3.1).

According to Grove and Gray (2019:292, 3) and Polit and Beck (2012:274), the target population is defined as the entire set of individuals who meet the sampling criteria of the population. As the study focused on reaching expert consensus, the researcher agrees with Yousuf (2007:6) that the information obtained from a Delphi technique can only be as good as the experts who contributed to the study (Keeney, 2015:269). It is therefore important to be very clear about the inclusion criteria for the target population. According to Shanteau, Weiss, Thomas and Pounds (2003:1), there is no universal manner to define an expert. However, Shantaeu *et al*. (2003:1) state that experience, accreditation, peer identification, expert reliability and being a subject matter expert are noted as previous approaches used to define an expert (2003:3-9). The researcher selected three of the approaches as described by Shantaeu *et al*. (2003:3-6) to define the inclusion criteria for an individual to be included in the target population. Therefore, an expert should be:

- *accredited by the applicable medical regulatory body,*
- *a member of the executive committee* of his/her professional society/association; and
- an expert by means of *peer identification*.

In addition to the above-mentioned features, the researcher included the following categories of expertise, as described by Shariff (2015:3):

a) Subjective expertise – a person who has knowledge due to being affected by the topic of the research
b) Mandated expertise – a person who has knowledge and experience related to the job description and role requirements (Giannarou & Zervas, 2011:67); and
c) Objective expertise – a person who has knowledge gained due to an academic position, education and research.

The combination between the inclusion criteria as adopted from Shantaeu *et al.* (2003:3-6) and the categories of expertise as described by Shariff (2015:3), has led the researcher to compile the inclusion criteria for experts in this study as depicted in Table 3.3.

Table 3.3 Inclusion criteria comprising specific features and categories of expertise

Category of expertise	**Inclusion criteria**
Subjective expertise	• Midwife with U/S experience or completed a U/S programme, and/or • Sonographer with U/S experience that practices in the field of obstetrical and gynaecological U/S, and/or • Obstetrician/gynaecologist with current U/S experience
Mandated expertise	• Executive member of an organisation related to the field of midwifery, and/or U/S, and/or midwifery education or U/S education, and/or • Registered professional in the field of midwifery, and/or • Registered professional in the field of U/S, and/or • Registered professional in the field of midwifery education or U/S education.
Objective expertise	• A minimum of one publication in the field of: o Midwifery, and/or o U/S, and/or o Midwifery U/S-related education

The subjective and mandated experts included midwives, sonographers, obstetricians and gynaecologists who complied with the inclusion criteria of organisation or committee membership, professional registration and clinical experience. Due to limited knowledge in the field of midwifery U/S, the category of an objective expert would exclude midwives with clinical experience of U/S in the target population of this study. As midwifery U/S education and practice in South Africa is unaccredited and unregistered, there are a limited number of clinically experienced midwifery U/S experts in South Africa. Including objective expertise with a publication in the field as inclusion criteria for the target population, would have silenced the voice of representation for midwifery U/S. Therefore, in order not to decrease the target population to the extent that the inclusion of midwives with U/S experience would be jeopardised, objective expertise was not included as an inclusion criteria as depicted in Figure 3.1.

The accessible population refers to the target population to which the researcher has reasonable access (Asiamah *et al.*, 2017:1612). Due to limited information about midwifery U/S in South Africa, it was not possible to identify only midwifery U/S experts. Therefore, traditional U/S healthcare practitioners such as obstetricians and gynaecologist, as well as sonographers, were included in the target population. Equal access to U/S experts in South Africa where ensured by dividing the accessible population into two groups. The researcher stratified the accessible population from the two groups into five strata that represented experts in South Africa (refer to Figure 3.1).

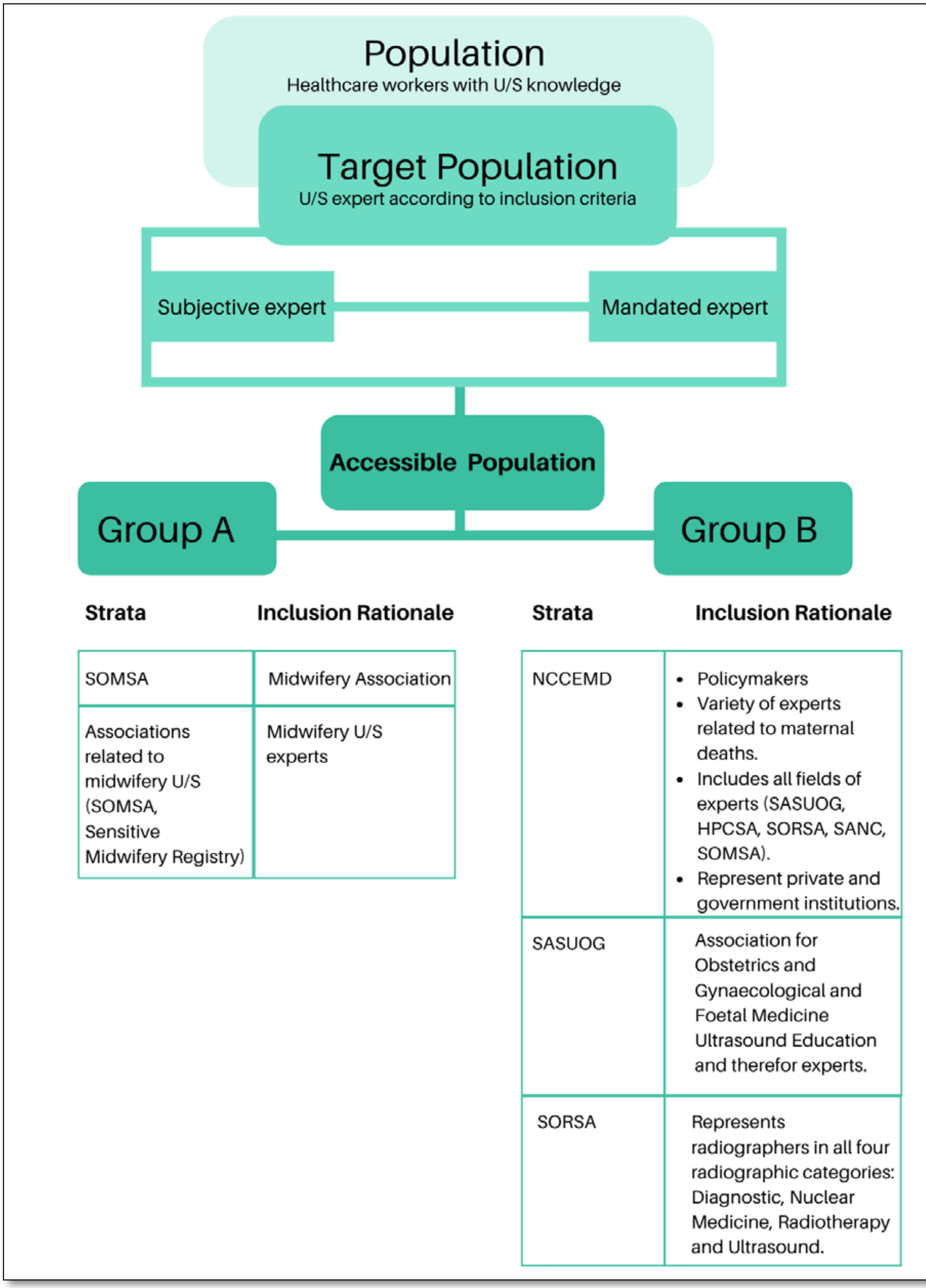


Figure 3.1 Classification of population, target population and accessible population.

Group A represented experts in midwifery U/S as per peer identification, clinical experience in midwifery U/S, and/or part of the executive committee representing SOMSA. Group A consisted of SOMSA executive members, SOMSA association members within the U/S working group, and independent midwives with U/S training or experience registered on the Sensitive Midwifery registry. The accessible population of Group A represented midwives with clinical experience in U/S. The inclusion criteria represented both public and private healthcare. In addition, Group A represented both public and private healthcare experts in the field of midwifery U/S education and practice. The experts included members of the executive committees that represent the midwifery profession on regulatory, leadership and education level in South Africa. The aim was to have 50% of the experts of the accessible population representing midwives in South Africa

Group B represented healthcare professionals within the related field of clinical obstetric and gynaecological U/S, U/S education or the policy making environment. Experts from SORSA (Society of Radiography in South Africa) represented sonographers that do not necessarily have experience in maternal and child health, but have expertise in obstetrical and gynaecological U/S. The aim was to ensure both public and private healthcare experts. The accessible population for Group B consisted of members of the National Committee on the Confidential Enquiry of Maternal Deaths (NCCEMD), which includes a variety of experts related to maternal deaths in South Africa. To include traditional U/S healthcare professional representation, executive committee members of the South African Society of U/S for Obstetricians and Gynaecology (SASUOG) and Society of Radiographers South Africa (SORSA) were included in the accessible population group. The aim was to have 50% of the experts of the accessible population representing traditional healthcare professionals in South Africa.

3.5 Sampling

A sampling method defines how the selection process of the experts was performed (Grove & Gray, 2019:293). According to Cohen *et al.* (2018:202), the sample is a smaller set or a subgroup of the total population from which consensus of expert opinion is gained, to represent the total population under study. The two main sampling methods are described as either probable (random) or non-probable (purposive) (Cohen *et al.,* 2018:214). With probability sampling methods, the random selection of experts creates an equal opportunity to be selected and represent the target population (Grove & Gray, 2019:304; Polit & Beck, 2012:280). Sampling allows the researcher to achieve statistical validity and to generalise the results of the study to the wider population (Cohen *et al*., 2018:214; Polit & Beck, 2012:273-5, 280). However, a Delphi technique does not intend to generalise, but actively pursues expertise (Avella, 2016:308; Keeney *et al*. 2011:7).

Purposive sampling seeks to select specific persons for the richness of the knowledge that they contribute to the study (Cohen *et al*., 2018:214; Mertens, 2015:397). Purposive sampling supports the research question and therefore not every member of the total population is selected (Grove & Gray, 2019:310).

A heterogeneous sample was chosen to ensure that a more comprehensive expert opinion is formed over the spectrum of the field of study (Gill *et al*., 2013:1324; Shariff, 2015:3). The identification of a pre-determined number of experts per professional body ensured a heterogeneous sample group. The heterogeneous sample included midwives, obstetricians and gynaecologists, and sonographers in the field of U/S. The identification of the experts in these strata determined the sample size, as discussed in Section 3.5.3. Inclusion criteria to identify the experts were used to increase validity and to deter from the possibility of ambiguous expertise (Keeney *et al*., 2011:8; Louw, 2014:49; Millar *et al.,* 2017:61). No exclusion criteria were necessary, as the population was specific to the study.

3.5.1 The sampling method: purposive stratified sampling

As not everyone in the target population of this study had the same opportunity to be selected for the sample due to the inclusion criteria and selection of specific strata, a stratified purposive sampling technique was the method of choice (Grove & Gray 2019:310, 317; Mertens 2015:399). A stratified sampling technique refers to the combination of sampling strategies where the researcher uses the subgroups based on specific criteria to sample several participants (Mertens, 2015:399). Maree (2020:178) confirms that non-probability sampling, such as stratified purposive sampling, applies in special situations where the researcher has a specific purpose in mind. A heterogeneous group was identified by means of stratified sampling of the accessible population (Grove & Gray 2019:310), discussed in Section 3.4, which allowed inclusivity of the various healthcare workers in the field of U/S in South Africa.

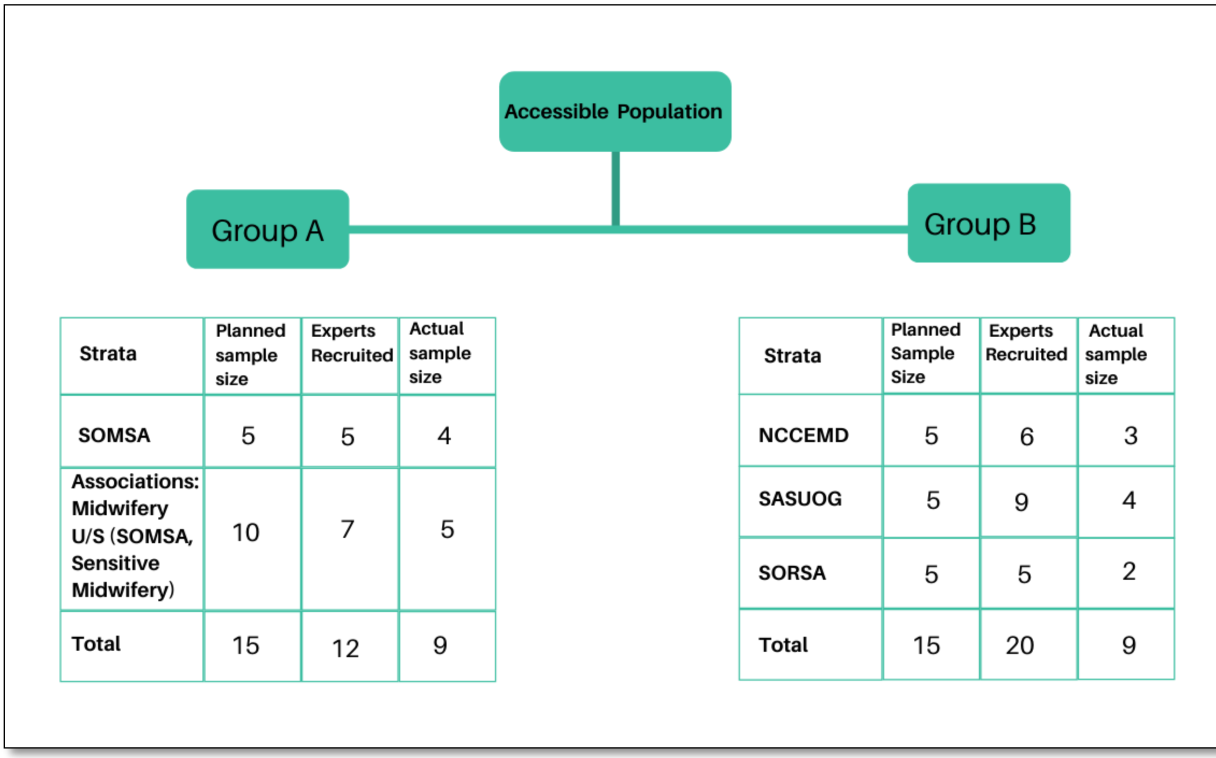
Although the sampling technique may be criticised due to the difficulty to evaluate the accuracy or relevance of the researcher's judgment in the selection process, specific characteristics as previously discussed in Table 3.4 gives a clear understanding of the reasons for sample selection (Grove & Gray, 2019:37). The ultimate goal for the researcher was to select experts with the ability to contribute information-rich data from which in-depth information could be retrieved (Grove & Gray, 2019:317).

3.5.2 Sample population recruitment process

The researcher identified five experts per accessible population strata. The contact details were accessed via open resources on the internet (website listings) or by requesting the information from the contact persons listed for the various strata. An email was sent to the experts by the researcher, explaining the aim of the study, the inclusion criteria and strata on which they were selected, the estimated timeframe of the study and the expected time occupancy per questionnaire. According to Keeney *et al.* (2011:12), personal communication increases the feeling of the partnership, while interest in the field ensures the longevity of the partnership. The experts were requested to respond to the email if they were interested in participating. The researcher continued with the recruitment process until the desired sample size was reached or the experts per strata were depleted.

3.5.3 Sampling size

Various authors agree that there are no concrete guidelines regarding sample size (Giannarou & Zervas, 2014:66; Hong, Pluye, Faregues *et al*., 2019:57; McMillan *et al.,* 2016:658). However, the smaller the sample size, the higher the risk for selection bias and group error (Gainnarou & Zervas, 2014:67; Keeney *et a*l., 2011:22). In determining the sample size, Giannarou and Zervas (2014:67) state that a homogenous sample of 10-15 is sufficient, and Shariff (2015:3) mention that selecting five to ten experts per professional group is sufficient for stratification. Therefore, the researcher aimed at 15-30 experts for a heterogeneous sample, as illustrated in Figure 3.2.



Strata	Planned sample size	Experts Recruited	Actual sample size
SOMSA	5	5	4
Associations: Midwifery U/S (SOMSA, Sensitive Midwifery)	10	7	5
Total	15	12	9

Strata	Planned Sample Size	Experts Recruited	Actual sample size
NCCEMD	5	6	3
SASUOG	5	9	4
SORSA	5	5	2
Total	15	20	9

Figure 3.2 Stratified purposive sampling: sampling size.

From Group A, the researcher was able to identify 12 out of the planned 15 experts. This was related to the limited number of experts in the field of midwifery U/S in South Africa. A total of nine experts from Group A agreed to participate in the study. From Group B, a total of 20 experts were identified, from which nine agreed to participate in the study. Group A and B were equally represented with nine experts each. The strata allowed for equal distribution in each group to ensure a heterogeneous sample group. The total of 18 experts was within the desired sample size.

3.6 Pilot survey

The questionnaire was tested with a small sample that was similar to the accessible population, following the same process of administration that the researcher planned to use in the study (Grove & Gray, 2019:583; Mertens, 2015:257). The benefit of a pilot survey is not necessarily to provide statistical validation and reliability (Avella, 2016:317), but rather to ensure the best possible methodology (Grove & Gray, 2019:583) for ease of application to the larger study. After the first-round questionnaire was developed, a pilot survey was implemented to evaluate content validity and to determine the functionality of the instrument for data collection (Hong *et al.,* 2019:52; Keeney *et al.,* 2011:144).

The three participants of the pilot survey were chosen according to the same inclusion criteria and recruitment process as the main study, as indicated in Table 3.4. The experts were informed via email of the study aim, and their role in the research.

Table 3.4 Distribution of pilot survey participants.

Nr	Accessible population strata	Constituency	Rationale
Group A: Experts in midwifery U/S			
2	Associations related to midwifery U/S (SOMSA, Sensitive Midwifery Independent Midwifery registry and Fetal Medicine Foundation	Midwifery U/S experts	Represents midwives with clinical experience in U/S
Group B: Healthcare professionals within the related field of U/S and/or U/S education or policy environment.			
1	SORSA	Association representing radiographers in South Africa	Represents radiographers in all four radiographic categories: Diagnostic, Nuclear Medicine, Radiotherapy and U/S

The Evasys® web link with an individual, auto-generated password was sent to all participants after confirmation via email. The experts were asked to complete the questionnaire and answer four additional questions. The applicable feedback from the pilot participants, as discussed in Table 3.5, was incorporated in the first-round questionnaire.

Table 3.5 Pilot survey feedback on the first-round questionnaire

Additional question	**Information acquired**	**Influence on the first-round questionnaire**
How long did it take you to complete the questionnaire?	20 -25 minutes	Information was shared in the initial email to experts participating in the study.
Are there any grammatical or technical mistakes that you noticed that I need to change?	Various issues were noted	The questionnaire was adjusted where needed to ensure a professional appearance
Is there anything that you did not understand?	• Certain terminology was unfamiliar to the participants • The levels of U/S training	• Terminology relates to the level of expertise. Different strata of the target population would have various levels of U/S experience, and the terminology was left unchanged. • An explanation of the levels of U/S was included in the participant information letter to ensure the same understanding for all participants.
Would you like to add anything to the content or competencies of midwifery U/S?	No additional information was added	None

The experts' main contribution to the pilot survey was regarding the time estimation and the professional appearance of the questionnaire. Although Avella (2016:308) debates the accuracy of estimation on the time commitment the experts were required to make, the benefit of giving a time estimation helps with recruitment and reducing attrition due to reality being different from the expectation.

Defining the levels of U/S for the South African context was added to the description of the question as a positive contribution of the pilot survey. No changes to the elements nor the six competency domains were necessary.

3.7 Data collection

The data collection process of a Delphi technique is a time-consuming process due to the iterative rounds. The iterative rounds call for the same process of data collection in all three rounds. The experts that completed the previous round were included in the subsequent rounds. The reason was to include experts where motivation still existed, instead of working with experts that were not motivated to continue (Shariff, 2015:4).

Preparing the expert group for the Delphi process is an important step, which if not carried out appropriately, could adversely affect response rates in subsequent rounds (Millar *et al*., 2007:17). When experts agree to participate, they need to be informed of exactly what they will be asked to do, the time occupancy expectation, what information they will be expected to contribute, and what use will be made of the information they provide (Keeney *et al*., 2011:83)

3.7.1 Instructions to participants

In cases where experts are given clear instructions on the completion of the rounds, the result is usually a more reliable response rate with a lower attrition rate in the different rounds (Millar *et al*., 2007:16). The researcher included instructions on how to access the Evasys® platform via the web link with the password that was sent to the experts via email. The date for completion, with a motivation for continuing participation, was included in the communication. On accessing the online questionnaire, instructions for the use of the Likert scale for the closed-ended questions, and completion of the open-ended questions, were given.

3.7.2 Timeframe for data collection

According to Louw (2014:43), the timeframe for a Delphi study is estimated to be on average eight weeks per round. However, Hohmann, Cote and Brand (2018:3279) mention that a total turnaround time of 45 days to five months is be acceptable. The data collection of the online questionnaires was planned to start in April 2020, as illustrated in Table 3.6.

Table 3.6 Data collection time-frame.

Rounds		Questionnaire distribution	Follow-up email	Completion of round	Controlled feedback
1	Planned	April 2020	As needed	Mid-April 2020 (2 weeks)	End of April 2020 (2 weeks)
	Actual	8-12 May 2020	22 May 2020	1 June 2020 (± 3 weeks)	12 June 2020 (2 weeks)
2	Planned	Beginning of May 2020	As needed	Mid-May 2020 (2 weeks)	End of May 2020 (2 weeks)
	Actual	16 June 2020	3 July 2020	9 July 2020 (± 3 weeks)	14 Aug 2020 (4 weeks)
3	Planned	Beginning of June 2020	As needed	Mid-June 2020 (2 weeks)	End of June 2020 (2 weeks)
	Actual	14 Aug 2020	26 Aug 2020	2 Sep 2020 (± 3 weeks)	End of November 2020

Although the distribution of the online questionnaires was planned to start in April 2020, uncertainty associated with the SARS-CoV-2 pandemic necessitated a postponement of the data collection to the 8th of May 2020. Despite giving the experts two weeks to complete the questionnaire, they did not comply with this. The researcher sent emails as reminders and motivation for the completion of each round. The emails were successful in achieving a lower attrition rate, as discussed in Chapter 4.

The researcher scheduled two weeks between rounds for data analysis and development of the subsequent questionnaire and feedback. The complete schedule for the distribution of the questionnaires was planned for 12 weeks, but ended at 19 weeks, which is in line with the suggested time-frames of both Louw (2014:43) and Hohmann, Cote and Brand (2018:3279).

3.7.3 Implementation of rounds

In this section, the researcher describes how the three rounds of the modified e-Delphi was implemented. A detailed discussion of the statistical analysis of consensus, including the frequency distribution, response rate, and feedback to the experts after each round, is given in Chapter 4.

3.7.3.1 Round 1

The researcher emailed a web link for the Evasys® programme to the experts. Each expert was granted access to Evasys® with an individual, auto-generated password which was included in the email. The information letter, informed consent and the first-round questionnaire were accessible with the password. As mentioned in Section 3.7.1, a poor response to the questionnaire was received after the initial two-week period. This led to the researcher sending an email to motivate for completion. The experts completed the first round after the motivation email was sent and an extension was given. After completion, data was retrieved by the researcher via the Evasys® programme. The researcher analysed the quantitative qualitative data and verified the results with the study leaders.

The consensus statements were removed from the first-round questionnaire. The non-consensus statements and the new questions, developed from the qualitative data from round1, collectively formed the second-round questionnaire. The researcher gave controlled feedback to the experts via email. All data and the second-round questionnaire were verified by the study leaders, as discussed in Chapter 4.

3.7.3.2 Round 2

The experts who completed the first round received a new auto-generated password with the Evasys® web link via email. The data collection process was identical to that of round 1. After the data collection, the researcher removed the consensus statements and developed one new open-ended question from the qualitative data. The non-consensus questions and 11 newly developed closed–ended questions collectively formed the third-round questionnaire, as discussed in Chapter 4. Controlled feedback was given to the experts via email.

3.7.3.3 Round 3

The experts who completed the second round received the Evasys® web link with a new auto-generated individual password for the third-round questionnaire. The process of data collection in round three was identical to that of rounds 1 and 2, as discussed in Chapter 4. Feedback of the final results was sent via email to the experts that completed round 3. As the modified e-Delphi consists of only three rounds, all data were analysed for consensus and stability, as discussed in Chapter 4.

3.8 Data analysis

Data analysis uses statistical techniques to give meaning to numerical data in a study (Grove & Gray, 2019:378). The researcher may then use descriptive or inferential statistics to report on the data. Descriptive statistics are a summary that allows the researcher to organise data in ways that give meaning and facilitate insight. Inferential statistics are designed to address objectives, questions and hypotheses to allow inference to the target population (Grove & Gray, 2019:378). The aim of the study was not to generalise findings, so descriptive statistics were used to report on the data.

The main statistics used in the Delphi technique measure central tendency (mean, median and mode), and the level of dispersion (standard deviation and interquartile range), to present information concerning the collective judgements of respondents (Du Plessis & Human, 2007:21; Keeney *et al*., 2011:84). However, other studies use a frequency distribution to determine consensus (Giannarou & Zervas, 2014:67). In Chapter 4, the researcher reports on consensus of the elements for each of the six competency domains, using measures of central tendency and level of dispersion to report on consensus. Stability, defined as no significant difference between the frequencies for the responses for two consecutive rounds (Keeney *et al.,* 2011:90), is described in Section 4.3. In addition, Keeney *et al*. (2011:90) indicate that many studies do not report on non-consensus elements. However, the researcher reported on significant outliers of non-consensus statements that were significant for the South African context of midwifery U/S education and practice.

Data analysis of qualitative data entails grouping similar themes together (Du Plessis & Human, 2007:21). The researcher verified the thematic analysis of the data with the supervisors of the study to ensure validity of the analysis (Hassan & Keeney*,* 2011:1699; Du Plessis & Human, 2007:21). Conceptualising the qualitative data into new closed-ended questions for subsequent rounds made it possible to:

- reiterate the experts' own words to them, which increased the reliability of the instruments, and
- allow for group judgement of individual expert opinion, despite infrequent-occurring items (Du Plessis & Human, 2007:21).

As previously discussed, anonymity is one of the key characteristics of a Delphi technique. Therefore, all raw data of the three rounds are password protected by Evasys®. The raw data were retrieved in a CSV Excel® file after each round closed for participation. The data retrieved from Evasys® were already coded. Therefore the researcher could not link any expert with a specific response. All data were managed confidentially, and data were password protected and stored securely on UFS password-protected computers. An independent academic researcher from the UFS with extensive statistical data expertise assisted the researcher to statistically analyse the data.

3.9 Methodological rigour

Methodological rigour is defined by Hasson and Keeney (2011:1675) as the responsibility of the researcher to ensure that all research procedures have been adhered to. Where possible, factors that could influence results should be removed to produce reliable results. In addition, Marquart (2017:online) stipulates that the soundness of a study in terms of planning, data collection, analysis and reporting, indicates the rigour of a study. The foundation of methodological rigour in quantitative research is indicated in the reporting of reliability and validity (Hasson & Keeney, 2011:1675).

The Delphi technique has been perceived as lacking methodological rigour. This notion can be contributed to two factors, namely selection of appropriate measurement and the continuing modifications of questionnaires (Hasson & Keeney, 2011:1696). Despite limited universal guidelines to guide a researcher implementing the Delphi in its application, administration and reporting (Hasson *et al.,* 2000:1009-1014), various indicators to increase the reliability and validity of the Delphi technique, and how these were applied to this study, are described below.

3.9.1 Reliability

Reliability is defined as the consistency of measurement over time (Grove & Gray, 2019:338). Various methodological approaches may enhance the reliability of a quantitative study, namely 1) the test-retest measure, 2) internal consistency, and 3) internal observer reliability.

The test-retest method, also referred to as stability reliability, is concerned with reproducing the same results of the same questionnaire in another period of time (Grove & Gray, 2019:340; Hasson & Keeney, 2011:1698). However, this study did not aim to measure the consistency of the expert opinion over time, and therefore the test-retest method was not applicable (Hasson & Keeney, 2011:1698-1699). The test-retest method may be recommended for further research to determine the stability of expert opinion on the competencies of midwifery U/S education and practice in South Africa.

The internal consistency refers to a high degree of similarity between several items that were formulated to measure the same construct (DeVillis, 2020:51; Maree, 2020:261). The construct for this study was consensus. The items that were formulated referred to the elements of the six competency domains (closed-ended questions). The questionnaires measured consensus of the elements of competency using a nominal Likert scale. The Cronbach alpha, which is used to measure the internal reliability of a questionnaire, can indicate internal consistency using interval and ratio-level data (Grove & Gray, 2019:341). Cronbach's alpha is the most widely used objective measure of reliability, and a measure of >0.7 indicates reliability of the questionnaire (Tovakol & Dennick, 2011:53). Cronbach's alpha is not traditionally used in a Delphi study, but as a point of interest, the researcher retrospectively calculated the Cronbach's alpha. The Cronbach alpha for the first-round questionnaire was 0.97, for the second-round questionnaire it was 0.96, and for the third-round questionnaire 0.97. Therefore the questionnaires for all three rounds were found to be reliable.

In addition, reporting on the response rate of the experts between rounds, feedback that was given by the researcher to the experts, and how consensus was achieved, all increase the methodological rigour of a study (Hohman, Cote & Brand, 2018:3281). Therefore, the researcher undertook additional measures to report on aspects as indicated by Hohman, Cote & Brand (2018:3281), and a detailed description of these measures follows in Chapter 4.

Inter-observer reliability measures the similarity between experts regarding a particular idea, using a percentage agreement (Hasson & Keeney, 2011:1695). During round 1, qualitative data indicated an expert's contribution to an already existing question. Although the question reached consensus in round 1, the question was rephrased and added to rounds 2 and 3. After the changes to the already consented-to element, stability was determined in round 3, as will be discussed in Section 4.4. Stability of the question in round 3 infers inter-observer reliability (Hasson & Keeney, 2011:1696).

Due to changes made to the subsequent questionnaires, based on the consensus statements and the data from the open-ended questions, the reliability of the instrument could be questioned. The study supervisors therefore validated the changes made by the researcher before sending the subsequent rounds of questionnaires to the experts. In addition, the evaluation of the quantitative data in the subsequent rounds increased the reliability of the questionnaire, as the experts themselves were included as internal moderators in the democratic process of the Delphi technique (Louw, 2014:26), as discussed in Section 3.3.1.

A threat to the reliability of the study was the anonymity of the expert responses, as it may not always be beneficial to a Delphi technique. The lack of responsibility or accountability should be considered in terms of receiving an unaffected opinion (Louw, 2014:25). To counter the effect of unreliable responses, the researcher chose experts who willingly agreed to participate (Louw, 2014:25).

3.9.2 Validity

The quality of the study design rests in the researcher's ability to identify the strengths of the design, and carefully evaluate any threats to validity (Grove & Gray, 2019:253).

Discussing multiple sources of evidence of validity indicates the appropriateness of a questionnaire for a particular purpose (Mertens, 2015:469). There are three types of validity applicable to the conventional interpretation of validity, namely content, criterion-related and construct validity (DeVillis, 2020:86). However, criterion validity is defined as the ability to measure the degree of correlation between the existing questionnaire and scores previously measured (Maree, 2020:262). As the questionnaire was newly developed, with no empirical knowledge available, criterion validity could not be proven.

According to Maree (2020:261), face validity should be included in the critique of validity of a study. Furthermore, discussing the internal and external validity of the questionnaire (Maree, 2020:43) may increase the validity of the conclusions or inferences drawn from the data. Although some of the evidence overlaps in the different types of validity, the researcher describes face and content validity, construct, internal and external validity, and how these were applied to this study.

3.9.2.1 Face validity and content validity

According to Maree (2020:262), face validity refers to whether an instrument appears to measure what it is supposed to measure. In contrast, content validity refers to the representativeness of the content of a questionnaire (De Vos, 2011:174). Therefore, in this study, content validity refers to the degree to which the elements of the six competencies of the questionnaire were relevant and representative of what it claimed to measure.

Both face and content validity were measured by submitting the first-round questionnaire to the School of Nursing Evaluation Committee, which comprised of experts in the field of Delphi research, research methodology and U/S experts. In addition, the first-round questionnaire was tested for face and content validity with a pilot survey, as discussed in Section 3.6. Contributing to content validity is the number of experts in the sample. According to Gill *et al*. (2013:1324) and Hong *et al.* (2019:57), no clear recommendations exist about the number of experts needed to determine content validity. However, a homogeneous sample of 10 to 15 experts are considered sufficient (Hong *et al*., 2019:57). Therefore, the sample ranging from 14-18 experts in a heterogeneous group was found acceptable for this study.

3.9.2.2 Construct validity

In the context of survey research, the construct is the underlying theme or subject that the researcher measures, using questions (Dew, 2008:2). Construct validity refers to the ability of an instrument to measure what it set out to measure (Grove & Gray, 2019:254). A quantitative research design with a modified e-Delphi technique allowed the quantification of consensus reached by expert opinion. This ensured the construct validity of the design. A key feature of the Delphi technique is that it contributes to construct validity, using confirmation of the individual elements through expert validation in the subsequent rounds (Okoli & Pawlowski, 2004:27).

A threat to the construct validity is the Rosenthal effect, defined as the researcher's expectation of the outcome that may influence the study (Grove & Gray. 2019:254). As the researcher was not able to withdraw from the data collection phase due to the Delphi technique construct validity was protected from the Rosenthal effect in a number of ways. The first was the School of Nursing Evaluation Committee, consisting of experts in the field of U/S and research, approval of the study design and first-round questionnaire. The second was participant anonymity by using the Evasys® programme. As the Evasys® programme coded the experts' responses before the researcher could access the data, the researcher could not be influenced by a particular individual's responses. Lastly, the thematic grouping of qualitative data was verified by the study leaders, and therefore the researcher's expectations of the outcome could not affect construct validity.

Apart from the pilot survey contributing to face validity, Okoli and Pawlowski (2004:19) state that the pilot survey further contributes to testing the questionnaire to ensure construct validity.

3.9.2.3 Internal validity

Internal validity ensures that the findings of the study are a true reflection of reality rather than the influence of external factors (Maree, 2020:191). The reliability of the questionnaire, as indicated in Section 3.9.1, can be a contributing factor in increasing internal validity (Maree, 2020:191). In addition, the questionnaire was validated by the School of Nursing Evaluation Committee, which comprised of clinical U/S and research experts.

Researcher bias is one of the main concerns of a Delphi technique (Avella, 2016:315). According to Gill *et al*. (2013:1324), clear selection criteria minimises the possibility of researcher bias. The selection criteria is discussed in detail in Sections 3.4. Researcher bias may become evident in the formulation of questions (Avella, 2016:315). To ensure the researcher stayed objective about the research, the validation of the first-round questionnaire by the School of Nursing Evaluation Committee, and the continuous evaluation of the adjustments to the subsequent rounds of questionnaires by the supervisors minimised the risk for researcher bias. In addition, using the experts' own words in the qualitative questions which served to reduce researcher bias and increase internal validity (Hasson & Keeney, 2011:1700-1701).

A high attrition rate may decrease the internal validity (Maree, 2020:192). A classical Delphi method, as with any other research method, runs the risk of attrition (Keeney *et al.,* 2011:70). Therefore, the benefit of the structured modified e-Delphi, as well as removing the consensus statements between rounds, kept the length of the questionnaire to a minimum. According to Grove and Gray (2019:255), an attrition rate of less than 25% is acceptable. For this study, the attrition rate was 22.2% between rounds and 3, which contributed to the interval validity of the study. In addition, the attrition rate between the rounds did not affect the distribution of experts between Groups A and B.

A major threat to internal validity is selection bias (Maree, 2020:192). The purposive sampling method could have been interpreted as a threat to internal validity, but the measure of pre-selection criteria minimised this risk (Grove & Gray, 2019:253).

3.9.2.4 External validity

External validity considers the degree of generalisation between the study and other variations of groups, settings, conditions, treatment and outcomes (Grove & Gray, 2019:255; Maree, 2020:191; Polit & Beck, 2012:250). Although generalisation was not the aim of this study, a heterogeneous group of healthcare professionals in the field of U/S related to midwifery provided valid consensus on the competencies of midwifery U/S for the South African context. The inclusion criteria of experts excluded bias and increased external validity. The attention to rigour throughout the research process will enable other researchers to duplicate the study in similar contexts.

According to Maree (2020:192), a major threat to external validity, amongst others, is insufficient realism. Purposive sampling is an example of insufficient realism due to the lack of generalisability. However, the apposition of generalisation and expert opinion has been discussed in detail in this study report.

The modified e-Delphi contributed in establishing an egalitarian environment, which increased external validity. According to Maree (2020:192), ecological validity refers to the research conditions that could influence a study. Conditions such as the presence of an experimenter, physical surroundings or pre-test or post-test sensitisation were not applicable. Although the researcher's background and interest in the field of midwifery were explained via email to the experts, the Hawthorne Effect was minimised by using an online research technique. Lastly, despite changes to the instrument (Maree, 2020:192) that was a crucial part of the study's design, the external validity was not diminished, as indicated by the stable Cronbach's alpha during the three rounds of questionnaires.

As a threat to external validity, item bias could be created, as the experts represented either midwives or traditional U/S healthcare professionals (Maree, 2020:263). It was, however, seen as both a strength and a threat to the external validity, due to the heterogeneous nature of the sample population. Although it was not the aim of the research to distinguish between the consensuses of Group A (midwives) and Group B (traditional U/S healthcare professionals), professional bias was possible in both groups. Consensus was therefore determined on the combined data to eliminate the high and low responses of both groups due to bias.

3.10 Ethical considerations

Due to the nature of research in health sciences, and also from a post-positivist point of view, the Belmont Report (The National Commission for the Protection of Human Services of Biomedical and Behavioral Research, 1979:online) was best suited to ensure sound ethical principles (Mertens, 2015:61). The conduct of the researcher was based on the underlying Belmont principles of a) Respect of person, b) Beneficence, and c) Justice (The National Commission for the Protection of Human Services of Biomedical and Behavioral Research, 1979:26-13; Mertens, 2015:61-62).

3.10.1 Respect for persons

The Belmont Report (The National Commission for the Protection of Human Services of Biomedical and Behavioral Research, 1979:26-13) elaborates on the right of the expert to be treated as an autonomous person, which includes being treated with respect and courtesy (Mertens, 2015:61). Therefore, the researcher included an information letter on Evasys® (Addendum B) which allowed for informed consent to be given. The completion of the questionnaire on the Evasys® system, as well as an individual auto-generated password, served as confirmation that informed consent was given.

Confidentiality of personal information and the data received during the study, were managed in a strictly professional and confidential manner. The information letter informed the participants that all data would be managed confidentially, due to the need for the researcher to track the data between rounds (Gill *et al*., 2013:1324). The researcher also reiterated this concept in the first email to the experts. No names or personal identifiers appear on any data sheet. All data stored by the researcher are password-protected. The researcher is aware of the identities of the experts, but cannot link any data sheet to any of the experts.

Due to the concerns of information privacy and security on the internet, the information letter included a statement to inform the experts that their responses were password-protected. All data were collected and hosted on secure web servers (Gill *et al.,* 2014:1325). The Evasys® programme is administrated by the domain of the University of the Free State, where the research was conducted. The programme license only allows for users within the University, and not public users. The security of the programme is therefore guaranteed by the University. Only participants that received an individual password that was auto-generated by Evasys® could access the programme, which contributed to the safety and quality of the data (Liebenberg, 2019:personal communication). The data retrieved from Evasys® was already number coded, and therefore the researcher could not identify a person or any other personal identifiers to a specific response.

Yousuf (2007:3), defines anonymity as the use of questionnaires or other communication, where expressed responses are not identified as being from a specific participant. Millar *et al*. (2007:60) refer to anonymity as the ability of each individual to submit their feedback on a questionnaire without the influence of peer domination in an exclusive group of experts. The importance of anonymity is emphasised by Millar *et al.* (2007:10) as an important feature to reduce bias. In addition, Avella (2016:309) clearly states that without anonymity, the Delphi technique is flawed. To ensure that the participants felt safe and had the freedom to express their opinions without fear of judgement or influence, participant anonymity was implemented (Hsu & Sandford, 2010:5; Shariff, 2015:5). The researcher emailed the participants individually with their passwords at the beginning of every round. Although the researcher could link the password to the participant, Evasys® is responsible for the data collection process, including the storing of the raw data, and does not have the option to allow for any identifiers (including password and respondent correlation) with data extraction. It is therefore not possible for the researcher to extrapolate data with any identifiers that could link the passwords to the responses.

The benefit of anonymity creates an egalitarian environment, and the suppression of bias due to external influence (Millar *et al*., 2007:10). As one of the reasons for choosing the modified e-Delphi was the ability to achieve subjective opinions from experts on a topic not widely researched before, it was crucial to minimise the possibility of conformity, or the bandwagon effect (Hsu & Sandford, 2012:4; Shariff, 2015:2; Yousuf, 2007:5). Due to the varied nature of the experts in the field of U/S, group pressure due to individual personalities and influence of professional reputation is a possibility (Avella, 2016:309; Hsu & Sandford, 2019:5). Even more so, participant anonymity (Yousuf, 2007:4) was crucial for the experts to be able to voice their opinion freely and without fear of reprisal. Adding to the egalitarian environment of the modified e-Delphi technique is the vast geographic distribution of the experts (Keeney *et al*., 2011:1; Hsu & Sandford, 2012:4-5; Yousuf, 2007:5). As such, the likelihood of experts being aware of each other's identities are small.

3.10.2 Beneficence

The principle of beneficence is based on doing good and not doing harm (The National Commission for the Protection of Human Services of Biomedical and Behavioural Research:26-12,13). According to Berg (2007:59-60) a positive offset of the risk and benefit scale, set in the utilitarian approach, is the establishing factor to determine if research is permissible or not. To confirm the application of the principle, the researcher ensured maximum benefit and reduced any possible risks for the experts.

Benefits for the experts participating in the study:

- Collaboration with peers to form a collective opinion on the subject matter in which they are perceived as experts;
- Forming part of an egalitarian group that stimulates new ideas and perspectives (Millar *et al.*, 2007:60);
- Contributing their expertise to the development of a standard of practice within the field of Health Sciences.

The researcher did not foresee any significant risk or injury to any party. Although the expert group was purposefully sampled, which may have posed a risk of selection bias, measures such as the pre-set criteria for inclusion minimised this risk. It served the purpose of the study to make use of the risk of bias to the benefit of the outcome of the expert opinion.

Another possible risk was that as the expert pool in South Africa is not large, the experts might have been aware of each other's participation in the study.

3.10.3 Justice

The principle of justice refers to the researcher's ability to apply fairness to issues such as the selection of participants (The National Commission for the Protection of Human Services of Biomedical and Behavioural Research, 1979:online). To ensure that no discrimination took place against any vulnerable groups such as minority groups or race classifications, the researcher identified the target population using a sampling technique that consisted of experts that complied with selection criteria from all healthcare fields related to the aim of the study (The National Commission for the Protection of Human Services of Biomedical and Behavioural Research, 1979:online).

3.11 Approval

Approval for the research project was obtained from the Ethics Committee of the Faculty of Health Sciences at the University of the Free State: UFS-HSD2020/0022/2104 (see Addendum A). As no patients were involved in this study, approval from the provincial Department of Health was not necessary (Bezuidenhout, 2018:34). Approval for the study was also given by the Head of the School of Nursing, from where this research was conducted.

3.12 Concluding remarks

A modified e-Delphi technique was applied in a quantitative descriptive design to reach consensus on competencies for midwifery U/S education and practice in South Africa. The experts were explicitly classified within the population of the study. Although purposive sampling could be seen as a limitation of the study, the significance of expert opinion on a subject where prior knowledge is limited, is of great value as it creates the foundation for further research. The methodological rigour of the study has indicated that reliable results were obtained, and done so in an ethical respected manner. In the data analysis in Chapter 4, the researcher discusses the findings of consensus of expert opinion on midwifery U/S education and practice.

Chapter 4 Data analysis

> **"Effectively,**
> **change is almost impossible without industry-wide**
> **collaboration, cooperation and consensus."**
> **-Simon Mainwaring**

4.1 Introduction

In Chapter 2, the literature review confirmed the positive contribution that midwifery U/S competence can have on maternal and child health in South Africa. To effect the needed change, experts in the field of U/S in South Africa voiced their opinion on elements which could constitute midwifery U/S competence. Reaching expert consensus could validate the use of midwifery U/S and therefor the change needed as indicated by the literature. Moreover, the global equivalence of midwifery U/S competence can be achieved.

According to Giannarou and Zervas (2014:67) there are no standard guidelines for data analysis of the Delphi technique. Authors refer to the use of descriptive statistics in a Delphi as using of the percentages, standard deviation, frequency distribution or the interquartile range (Giannarou & Zervas 2014:67; Milevska-Kostova and Dunn, 2010:431). However, the use of the median and the mode is also used to report on the data of a Delphi technique (Hsu & Sandford, 2007:4; Milevska-Kostova & Dunn, 2010:431). The mean refers to the arithmetic average or summary of the frequency distribution of the sample (*n*) in terms of the centrality tendency of the responses (Mertens, 2015:491). Furthermore, the median as a descriptive statistic in reporting on consensus refers to the midpoint of the data set, which is central from the lowest and highest scores (Mertens, 2015:491). However, the use of the mean or median to determine consensus with a Delphi technique could be misleading due to the possibility of convergence of opinion around two or more points (Hsu & Sandford, 2007:4).

Moreover, the mode is reported as the most frequently occurring score in the distribution of results (Mertens, 2015:491). Using the mode as a component of descriptive statistics to describe the central tendency (Hsu & Sandford, 2007:4) was best suited for a meaningful discussion on the expert consensus reached for this study. Although the researcher did not include the mean, median, mode, standard deviation and the range as part of the discussion of the data, a graphic representation of the descriptive statistics was included for each round and its related competency to enhance the overview of the data.

The researcher analysed a total of 118 elements involving the six competency domains of midwifery U/S per iterative round. Furthermore, two categories were compiled for the additional open-ended questions, 1) task shifting of midwifery ultrasound to the basic or specialist midwife, and 2) the level of midwifery U/S education and practice and discussed in rounds 2 and 3.

To increase the methodological rigour of a study, Hohman *et al.* (2018:3281) recommend reporting on the response rate of the experts between rounds and the feedback that was given by the researcher to the experts. Therefore, in a bid to comply with this recommendation by Hohman *et al.* (2018:3281), the researcher included the response rate and feedback that were given to the experts for the three rounds of the Delphi.

Lastly, the researcher reported of stability gained from non-consensus elements in repetitive rounds. According to Keeney *et al*., (2011:91), stability is inferred when there is no significant difference between the frequency of responses for two consecutive rounds of the Delphi.

The data collection process, concluded in Section 3.7, was followed by the data analysis as described in this chapter. As for this study utilised quantitative data, the open-ended questions served to augment the quantitative data that were generated and analysed in the iterative rounds. Therefore, the complete datasheet of all three rounds (Addendum C) and the tables included in this chapter, contains two sets of question numbers. The first set of question numbers is refers to the original question number (OQN) as indicated in the questionnaires that the experts completed per round. The three questionnaires with the OQN that were sent to the experts are included in Addendum B for reference purposes. For data analysis, the questions where re-numbered with a chronological question number (CQN) that is also displayed in the discussion. Due to the additional closed-ended questions included in the iterative rounds, the OQN and the CQN do not correlate. An open space with a CQN in some of the tables or figures represents additional closed-ended questions to follow in the subsequent rounds. In addition, Addendum D contains the data of the open-ended questions, and Addendum E the descriptive statistical graphs for reference.

4.2 Round 1

The experts for the first-round questionnaire were a heterogeneous group of n=18 experts with equal distribution between groups A and B of n=9 experts each. The first round yielded a 100% response rate.

The first round consisted of 91 closed-ended questions in the six domains of midwifery U/S competencies (refer to Addendum C). The 91 questions which formed the elements of the six domains were analysed. Consensus was reached in 27 (29.7%) of the 91 elements, with 0.7% incomplete answers reported. All the consensus levels were declared at 70%, as confirmed by a biostatician from the University of the Free State. Level 1 of the Likert scale, which represented elements deemed essential for inclusion, was the mode of choice that reached consensus.

Open-ended questions were included at the end of each of the six domains of midwifery U/S competencies to provide the experts with the opportunity to reflect on the comprehensive inclusion of all elements deemed necessary. An additional two questions were asked at the end of the questionnaire that referred to the context of midwifery U/S in South Africa, specifically pertaining to task shifting and the level at which the midwife should perform U/S.

The consensus elements were distributed between the first four midwifery U/S domains (general principles of sonography, early and first-trimester U/S, second and third-trimester U/S, and intrapartum U/S). No consensus was reached in competency five, (postpartum midwifery U/S), and competency six (gynaecological midwifery U/S). The intention was to carry over the non-consensus elements from round 1 to round 2. Therefore, the following report will include only the consensus elements per competency domain that were reached in the first round. The acronyms CQN and OQN refer to the chronological question number and the original question number, respectively. As mentioned earlier, a graphic illustration of the descriptive statistics is included for each round and the related competency.

4.2.1 Round 1, competency #1: General principles of sonography

Table 4.1 illustrates the consensus elements for competency #1, which refers to the general principles of sonography that was foundational to all the other competency domains. In total, there were 11 questions of which 6 (55%) reached consensus in the first-round.

As indicated in Table 4.1, the knowledge component of competency #1 had a total of 5 consensus elements, while skill and professional behaviour had only 1 consensus element. For ease of visual identification, the consensus elements are shaded in colour.

Table 4.1 Consensus elements of round 1 - competency #1: General principles of sonography.

CQN	OQN	Round 1, competency #1 elements	Essential		Useful		Potential for inclusion		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
A midwife has foundational knowledge about:										
2	2,2	basic maintenance of ultrasound instrumentation	13	72%	2	11%	3	17%	0	0%
3	2,3	ultrasound safety	15	83%	3	17%	0	0%	0	0%
4	2,4	infection control	18	100%	0	0%	0	0%	0	0%
5	2,5	the principles of knobology	15	83%	2	11%	1	6%	0	0%
7	2,7	anatomy and physiology of the internal organs of the female reproductive system related to the productive age	13	72%	1	6%	1	6%	3	17%
A midwife has the skill and professional behaviour to:										
10	2,10	apply the principles of knobology	13	72%	3	17%	2	11%	0	0%

CQN: Chronological question number

OQN: Original question number

The descriptive statistics for round 1, competency #1 is displayed in Figure 4.1.

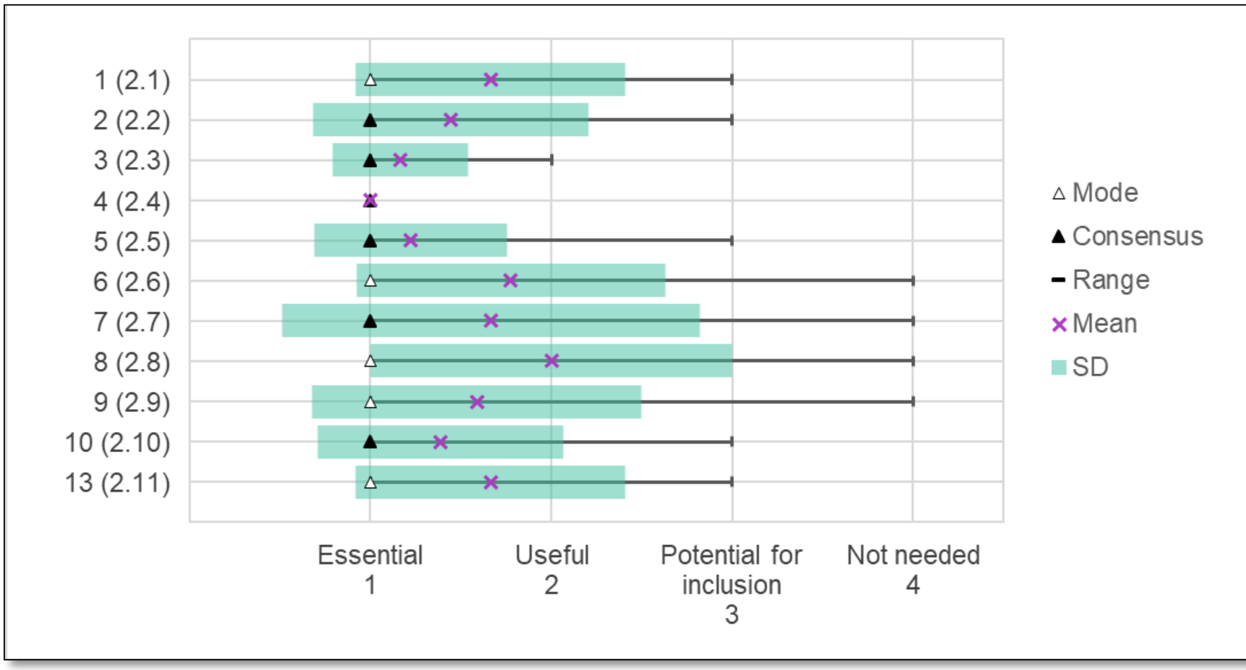


Figure 4.1 Descriptive statistics - round 1, competency #1

CQN 2 in Table 4.1 refers to the importance of general maintenance of equipment for midwifery U/S. In a developing country such as South Africa, expert consensus n=13 (72%) on the basic maintenance of U/S instrumentation indicates the importance of maintenance plans that are independent of service providers. The use of U/S includes aspects of safety related to amongst others, the precautions necessary to ensure the quality of U/S imaging (Tegnander & Eik-Nes, 2014:16).

The use of U/S is regarded as safe for the childbearer and fetus (Torloni *et al*., 2009: 604; Whitworth *et al*., 2010:2). However, as discussed in Section 2.3, U/S safety (CQN 3) refers to more than purely physical harm. Over-medicalisation of the use of U/S and under-reporting of findings which could influence management during the childbearing period represent safety risks. Furthermore, U/S safety risks could be caused by a lack of proper U/S training (Carrera, 2020:294), as is possible for unaccredited midwifery U/S training in South Africa. As the use of U/S also could affect litigation costs due to higher medico-legal risk (Snyman, 2019:4), the safe use of U/S by midwives as stated in CQN 3 in Table 4.1, are appropriately regarded as essential by expert consensus (n=15, 83%).

Infection control, CQN 4, reached 100% expert consensus (n=18). Abuhamad *et al.* (2018:31) affirm the importance of including a protocol for infection control measures of the U/S equipment as part of a U/S curriculum. Infection control measures during the childbearing period became even more important this year with the Covid-19 pandemic. The Royal College of Obstetrics and Gynaecology (RCOG) issued guidelines for the use of U/S during the current pandemic. The guidelines focused on reducing the risk of exposure to Covid-19 by combining essential U/S screening with other reproductive care activities (RCOG, 2020:6-7).

CQN 5 refers to the principles of knobology. Although technological advances have led to pre-set obstetrical and gynaecological functions and tele-radiography support, the fundamentals of U/S imaging has remained the same. Therefore, the importance of understanding the instrumentation and knobology for image generation, as discussed in Section 2.5.1, was reiterated by Enriquez and Wu (2014:26, 44). The experts confirmed the importance of knowledge of knobology (n=15, 83%). It was also the only element of skill and professional behaviour (n=13, 72%) to reach consensus in round 1.

The integration of anatomy and physiology as an existing body of knowledge in midwifery was confirmed by expert opinion (n=13, 72%). Specific anatomy and physiology of the internal organs of the female reproductive system related to the reproductive age (Abuhamad, 2018:30), was confirmed as essential by expert consensus.

4.2.2 Round 1, competency #2: early and first trimester midwifery U/S

Tables 4.2 and 4.3 show the consensus elements for competency #2, which refers to the early and first trimester midwifery U/S. In total, there were 30 questions of which 8 (27%) reached consensus in the first round. As indicated in Tables 4.2 and 4.3, both the knowledge, skill and professional behaviour elements had 4 consensus elements each.

Table 4.2 Consensus elements round 1 - competency #2: early and first trimester midwifery U/S (knowledge)

CQN	OQN	Round 1, competency #2 elements	Essential		Useful		Potential for inclusion		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
A midwife has foundational knowledge about:										
16	3,3	indications for an early and first-trimester ultrasound	14	78%	3	17%	0	0%	1	6%
17	3,4	criteria for a transabdominal early and first trimester ultrasound	14	78%	2	11%	1	6%	1	6%
21	3,8	components of sonographic dating in trimester	16	89%	2	11%	0	0%	0	0%
28	3,15	single intrauterine demise	14	78%	3	17%	1	6%	0	0%

Table 4.3 Consensus elements round 1 - competency #2: early and first trimester midwifery U/S (skills and professional behaviour)

CQR	OQR	Round 1,competency #2 elements	Essential		Useful		Potential for inclusion		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
A midwife has the skills and professional behaviour to recognise the sonographic presentation of normal embryonic and fetal development with regard to:										
30	3,17	single and multiple pregnancy	13	72%	3	17%	2	11%	0	0%
35	3,22	evaluate embryo/fetus cardiac activity and documenting	14	78%	2	11%	1	6%	1	6%
36	3,23	determine the indication for an early or first trimester ultrasound	15	83%	3	17%	0	0%	0	0%
44	3,30	refer persons with a high risk profile or abnormal findings to an appropriate healthcare professional	18	100%	0	0%	0	0%	0	0%

CQN: Chronological question number

QNR: Original question number

The descriptive statistics of round 1, competency #2 is presented in Figure 4.2.

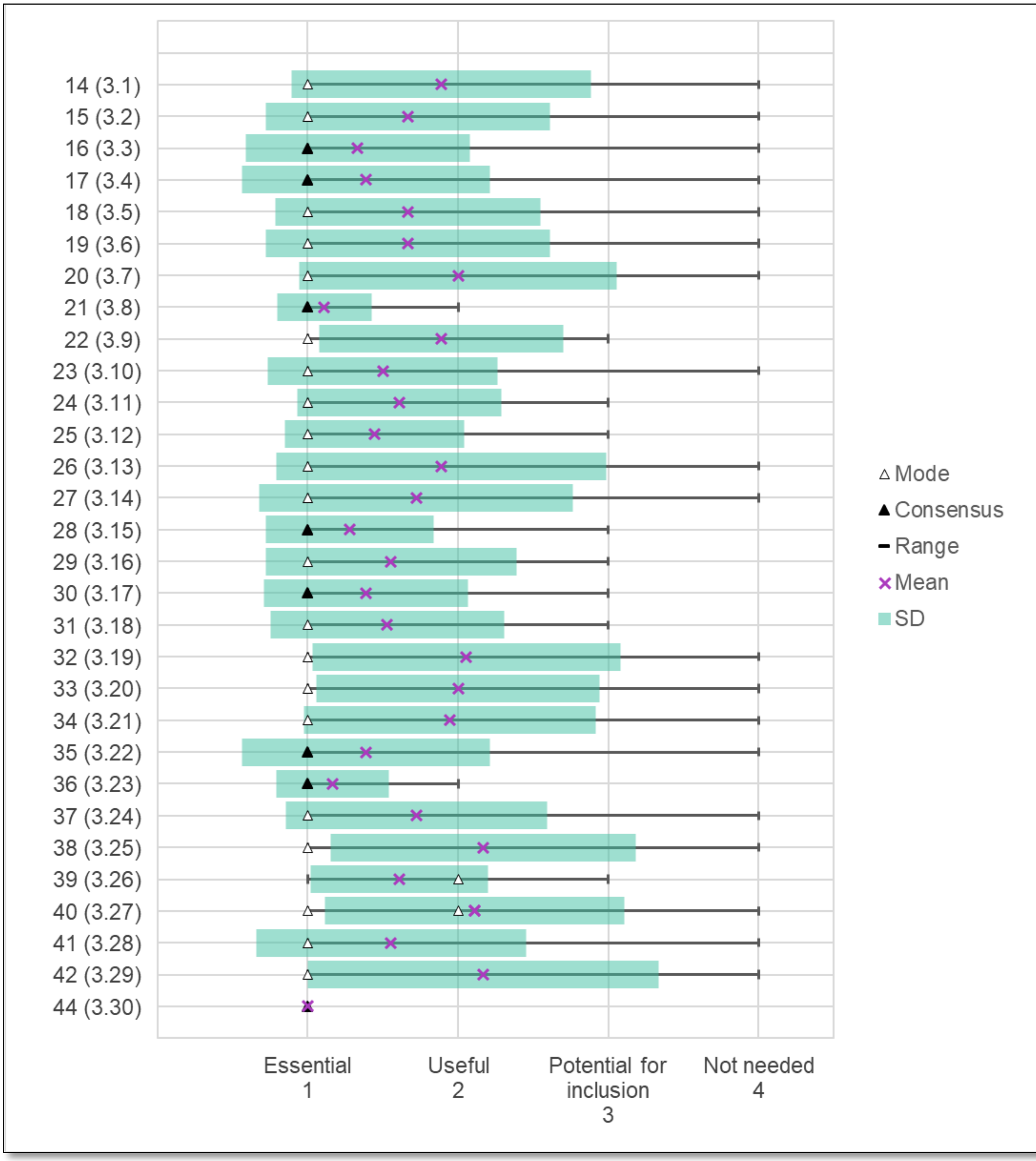


Figure 4.2 Descriptive Statistics - round 1, competency #2.

Over-medicalisation as a component of TMTS (Section 2.3.3) could be reduced by strengthening competence regarding the appropriate use of early and first-trimester U/S. A total of 78% (n=14) of the experts reached consensus on CQN 16, which refers to the indications for U/S use during the first trimester, for inclusion as an essential element of knowledge. In addition, 83% of experts (n=15) agreed on the importance of having skills and professional behaviour as a competency element for midwifery U/S education and practice. The indications for early and first trimester U/S was reiterated by RCOG who despite the Covid-19 pandemic, still emphasised the importance of the first trimester U/S for trisomy screening, anatomy screening in the second trimester, and growth U/S screening where indicated (RCOG, 2020:6-7).

Experts in this research are of the opinion that midwives should utilise transabdominal U/S and not transvaginal U/S. In round 1, consensus of 78% (n=14) was reached on the inclusion of the associated knowledge of transabdominal U/S. In contrast, the expert opinion did not reach consensus, and hence stability was declared in round 3 on the knowledge of transvaginal U/S, as illustrated in Figure 4.3.

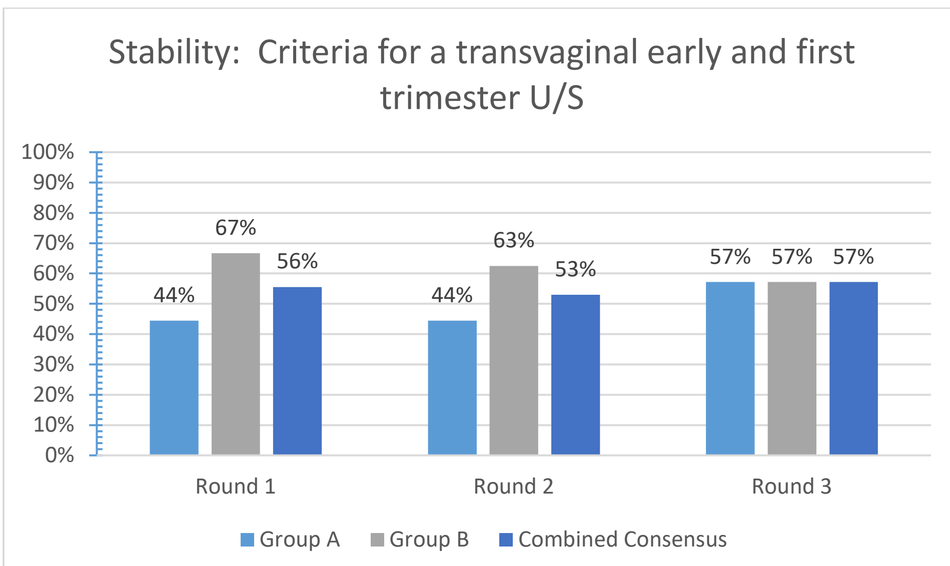


Figure 4.3 Stability, round 3, CQN 18, criteria for a transvaginal early and first-trimester U/S

The experts in group A had indicated lower consensus on the essential nature of transvaginal U/S during early and first trimester pregnancy. The consistency of the lower consensus level in group A could translate to non-intervention as a philosophical foundation of midwifery care (ICM, 2014:2). However, with the rate of advancements in high-resolution transvaginal U/S transducers, the ability to visualise key anatomic landmarks and major embryonic abnormalities during the first-trimester have enhanced the opportunity for early diagnosis (Mei, *et al.,* 2019: 829). In Southern

Africa, only 18% of the population in rural areas have at least one ultrasound during pregnancy, and 6% has more than three ultrasounds during pregnancy (Carrera, 2020:290). The importance of ensuring the best possible diagnosis with U/S irrespective of the gestational period in a demographical area where the childbearer has access to only one opportunity for diagnosis, should be taken into consideration. Despite non-consensus by the experts, the value of transvaginal U/S for midwives is strengthened by Murugan, Murphy, Dupuis, Goldstein and Kim (2020:178), as visualisation of cardiac activity is far superior with transvaginal viewing than with transabdominal U/S. According to Mei *et al*. (2019:830), the transabdominal and transvaginal U/S should be used in combination for the best results. ISUOG (2014:114) includes the recognition of the normal features of fetal viability as a part of the basic U/S. Expert consensus supports (n=14, 78%) knowledge of intrauterine demise and evaluating of embryonic and fetal cardiac activity as elements of competency #2.

Experts (n=13, 72%) agreed that the midwifery U/S diagnosis of single or multiple pregnancies during the early and first trimester is an essential component of midwifery U/S. As discussed in Section 2.7.2, early or first trimester ultrasound improves the early detection of multiple pregnancies, which directly influences the risk profile for midwifery management. Whitworth *et al.* (2010:2), further elaborate on the benefit of improved gestational dating with early and first trimester U/S that may result in fewer inductions for post maturity. According to Carrera (2020:261), a significant number of African women do not know their last menstrual period. Gestational age is crucial for the quality of antenatal care, as the lack of accurate dating leads to incorrect diagnoses IUGR and premature birth (Carrera, 2020:261). Consensus of 89% (n=16) indicated that the experts agree on the importance of including the knowledge element of sonographic dating in the first trimester.

Although midwives practice their profession autonomously, a midwife should always adhere to the boundaries of her competence and the midwifery scope of practice (ICM, 2019:10) and therefore be able to work effectively as part of the multidisciplinary team. It should come as no surprise, then, that timeous referral of the childbearer with a high-risk profile or abnormal findings to an appropriate healthcare professional (CQN 44) reached 100% consensus as an essential inclusion for midwifery U/S education and practice.

4.2.3 Round 1, competency #3: second and third-trimester midwifery U/S.

Tables 4.4 and 4.5 illustrate the consensus elements for competency #3, which refers to the second and third trimester midwifery U/S. In total, there were 28 questions of which 9 (32%) reached consensus in the first round. As indicated in Table 4.4, the knowledge component of competence reached 4 consensus elements. In Table 4.5, the skill and professional behaviour depicts 5 consensus elements.

Table 4.4 Consensus round 1 - competency #3: second and third trimester midwifery U/S.

CQN	OQR	Round 1, Competency #3 elements	Essential		Useful		Potential for inclusion		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
A midwife has foundational knowledge about:										
54	4,6	components of fetal biometry in sonographic dating in the second and third trimesters	14	78%	3	17%	1	6%	0	0%
55	4,7	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during fetal examination in the second and third trimesters	13	72%	2	11%	3	17%	0	0%
59	4,11	presentation, position and attitude of the fetus in the third trimester	17	94%	0	0%	1	6%	0	0%
61	4,13	indications for the referral to healthcare professionals	18	100%	0	0%	0	0%	0	0%

CQN: Chronological question number

QNR: Original question number

Table 4.5 Consensus round 1 - competency #3: second and third-trimester midwifery U/S

CQN	**OQR**	**Round 1, competency #3 elements**	**Essential**		**Useful**		**Potential for inclusion**		**Not needed**	
			1		**2**		**3**		**4**	
			n	**%**	**n**	**%**	**N**	**%**	**n**	**%**
A midwife has skill and professional behaviour to:										
68	4,20	measure the basic structures to estimate the age of the fetus	17	94%	0	0%	1	6%	0	0%
69	4,21	measure basic fetal morphology in the second and third trimesters for the purpose of establishing normal fetal growth	15	83%	0	0%	2	11%	1	6%
71	4,23	examine the placenta, umbilical cord and amniotic fluid and adnexa during fetal examination in the second and third trimesters	13	72%	2	11%	3	17%	0	0%
75	4,27	appreciate the ethical issues associated with prenatal diagnostic procedures	13	72%	3	17%	2	11%	0	0%
76	4,28	referral of a person with a high risk profile or of abnormal findings to an appropriate healthcare professional	17	94%	0	0%	1	6%	0	0%

CQN: Chronological question number

QNR: Original question number

The descriptive statistics for round 1, competency #3 is presented in Figure 4.4. All consensus elements reached was yet again indicated on level 1: essential, with only CQN 74 (biophysical profiling of a fetus) reflecting a mode preference of level 3: potential for inclusion.

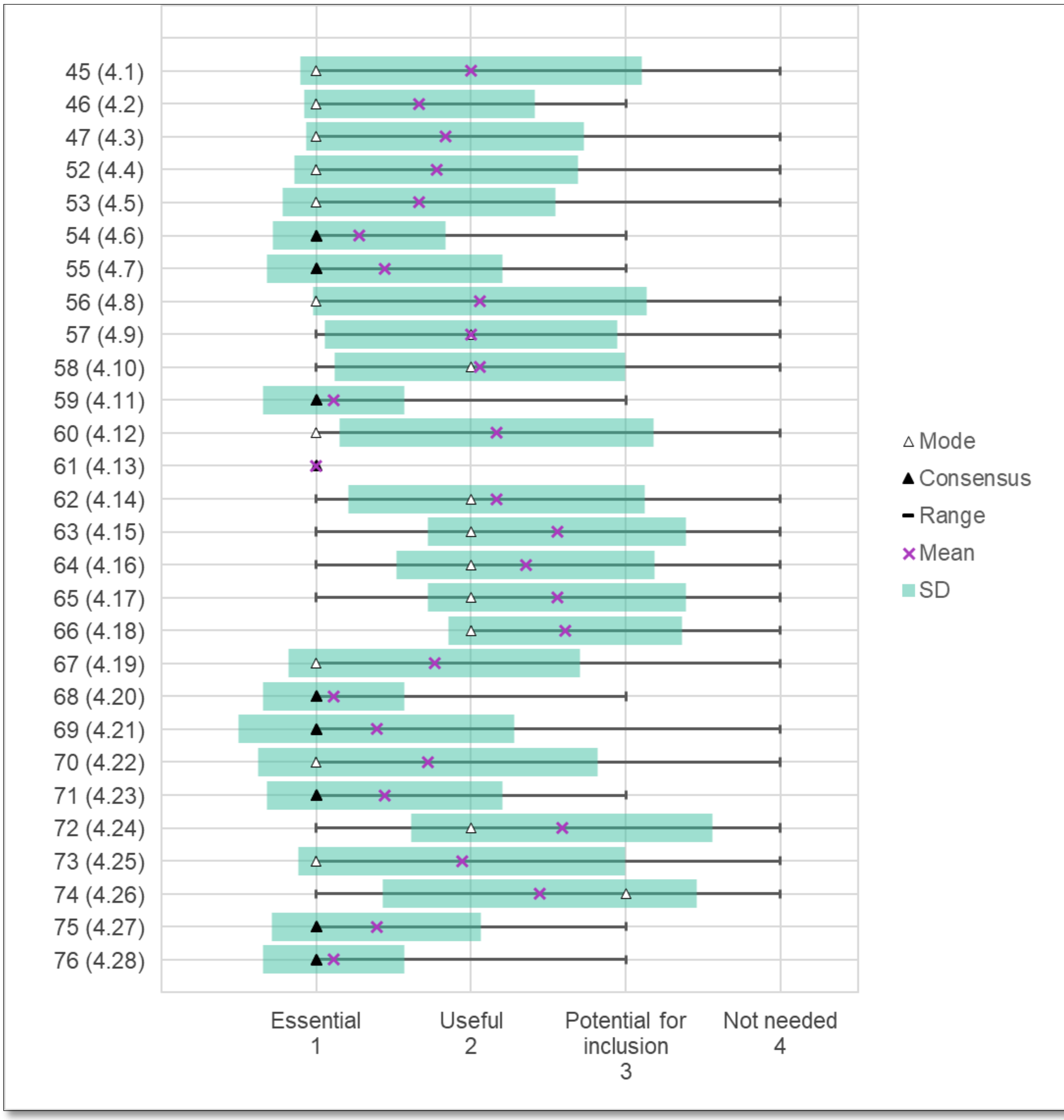


Figure 4.4 Descriptive statistics - round 1, competency #3.

CQN 54 of Table 4.4, referred to the knowledge component of fetal biometry in sonographic dating in the second and third trimesters. A total of 14 experts (78%) reached consensus and thereby indicated the essential inclusion of the competency element. A further 17% of experts indicated that the inclusion could be useful for midwifery U/S education and practice. In addition, in CQN 68, 94% of the experts (n=17) stated that it is essential for a midwife to have the skill and professional behaviour for estimation of the fetal age by measuring the basic anatomical structures. Furthermore, CQN 69 in Table 4.5 links with the previous elements, referring to the applicable measurements to establishing normal fetal growth. Experts reached 83% consensus on the essential inclusion of establishing fetal growth in the third trimester, which is a vital component of antenatal care of the midwife (ICM, 2019:13). In addition, CQN 55 and 59 refer to the evaluation of the fetal and placental presentation in the third trimester as risk stratification in preparation for labour is crucial (Ahman, 2019:8). Most of the experts (n=17, 94%) agreed with the importance of adding the two elements of fetal and placental identification to midwifery U/S competency #3.

The ICM (2014:2) states that midwives should practice their profession in an ethically sound manner. Midwifery care further supports the ICM Bill of Rights for women and midwives (2018[a]:2), that highlights the right of the childbearer to actively take part in the decisions about her health while receiving up-to-date health information without any discrimination. Therefore, midwifery U/S education and practice should encompass sensitive and ethically sound practice in dealing with prenatal diagnosis and diagnostics procedures. Experts agree (n=13, 72%) that midwives should appreciate the ethical issues associated with prenatal diagnosis.

As previously discussed in Section 4.2.2, the timeous referral of a person with a high-risk profile or abnormal findings to an appropriate healthcare professional, is part of the philosophical foundation of midwifery care. Experts agreed (n=18, 100%) that knowledge about the indications for the referral is crucial for midwifery U/S education and practice (CQN, 76 - Table 4.4.).

4.2.4 Round 1, competency #4: intrapartum midwifery U/S

Table 4.6 shows the consensus elements for competency #4, which refers to intrapartum midwifery U/S. In total, there were 7 questions of which 4 (57%) reached consensus in the first-round. As indicated in Table 4.6, both the knowledge component of competence and the skill and professional behaviour reached 2 consensus elements each.

Table 4.6 Consensus round 1 - competency #4: intrapartum midwifery U/S

CQN	**OQR**	**Round 1, competency #4 elements**	**Essential**		**Useful**		**Potential for inclusion**		**Not needed**	
			1		**2**		**3**		**4**	
			n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
A midwife has foundational knowledge about:										
77	5,1	the presentation, lie, position and attitude of the fetus during labour	16	89%	1	6%	1	6%	0	0%
78	5,2	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour	14	78%	3	17%	0	0%	1	6%
A midwife has the skill and behaviour to:										
81	5,5	examine the position of the placenta, umbilical cord and amniotic fluid	14	78%	2	11%	2	11%	0	0%
82	5,6	review the presentation, lie, position and attitude of the fetus	16	89%	1	6%	1	6%	0	0%

The descriptive statistics for round 1, competency #4 is presented in Figure 4.5. As competency of intrapartum measurements such as the angle of progression and the symphysis-head measurements as easily transferable (Fidalgo, 2020:307), other reasons for expert inclination toward not including transperineal U/S (CQN 85) as part on competency #4 should be examined.

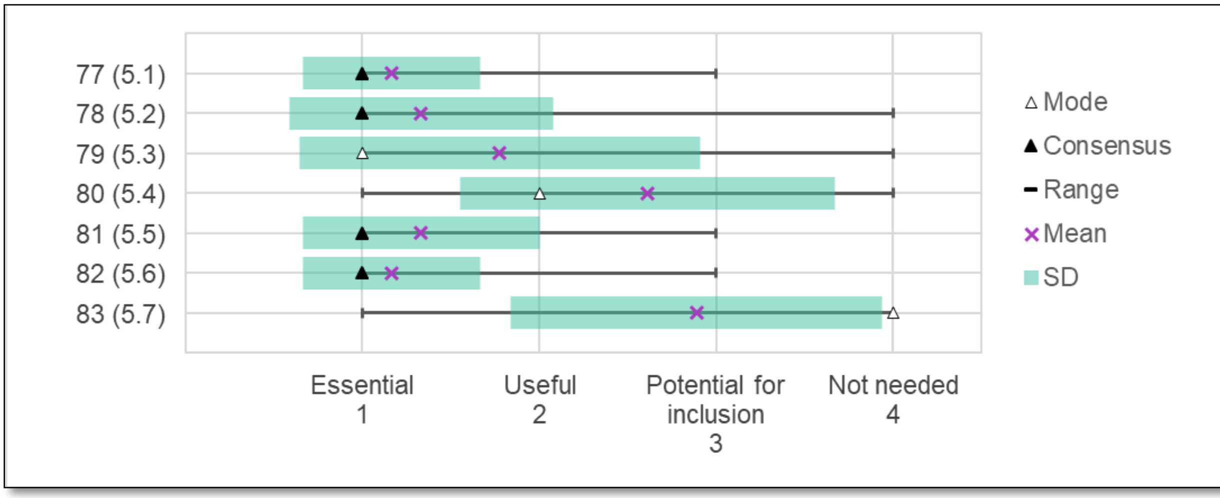


Figure 4.5 Descriptive statistics - round 1, competency #4.

From CQN 77 and 82 in Table 4.6, it is evident that the experts (n=16) agreed on the importance of including the evaluation of fetal presentation, lie and attitude during labour as part of midwifery U/S competence. The experts (n=14) agreed that midwives should be competent in U/S evaluation of the placenta, umbilical cord and amniotic fluid abnormalities during the intrapartum period. The practical implication of this including the competence for midwifery U/S relates to the prevention of obstetrical haemorrhage as the second-highest direct cause of maternal death in South Africa (SA DoH[b], 2017:7). With the limited number of U/S during the antenatal period in Southern Africa, as previously discussed in Section 4.2.2, intrapartum midwifery U/S could decrease maternal mortality and morbidity due to early diagnosis of placental, umbilical cord or amniotic fluid abnormalities.

4.2.5 Open-ended questions

In Addendum D, the data of the open-ended questions for round 1 are given. The experts contributed three additional elements in the domain-specific open-ended questions. Two of the elements were relevant to CQN 7, namely the inclusion of embryology as well as fetal anatomy and physiology. Although CQN 7 reached consensus in round 1, the addition of anatomy and physiology of the embryo and fetus to the question, compelled the researcher to repeat it in round 2. The third domain-specific element was related to clinical integration with imaging, which was developed into CQN 11 as a closed-ended question for expert consensus.

In the first-round, OQN 8.1 asked the experts if the basic or specialist midwife should be competent in midwifery U/S. The thematic analysis of the data (Addendum D) led to the development of eight additional close-ended questions related to task-shifting to be added to round 2, as indicated in the second-round questionnaire (Addendum B).

OQN 8.2 in the first-round questionnaire asked the experts that if midwives were to perform U/S, according to which level of obstetric and gynaecological U/S should midwifery U/S be performed. Similarly to OQN 8.2, the data analysis added four closed-ended questions relating to the levels of midwifery U/S education and practice to Round 2, as indicated in the second-round questionnaire (Addendum B).

Furthermore, the data reveal a supplementary theme that the researcher included in an additional question as part of task shifting in round 2. An expert stated that the midwife is best positioned to offer the service if they have been appropriately trained, while emphasising the time it takes to perform a U/S. Another expert alluded to the fact that the basic midwife has enough on her plate. Both of the statements by the experts led to the following question (Table 4.7) being added in Round 2.

Table 4.7 Open-ended question developed from data in round 1.

OQN 8.8: Please read the following statement and give your answer below:
The number of qualified health care professionals offering obstetric ultrasound services is grossly inadequate for the needs of the country. Midwives are best positioned to offer the service if they are appropriately trained. Due consideration should be given to the workload of the midwife.
In your opinion, how would you propose the midwife in the field should absorb this additional workload?

4.2.6 Round 1: feedback to experts

The researcher reported on the sample size and the response rate of the experts in the first round. A motivation was given for the extension on time to two experts to complete the questionnaire. The unique finding of the strong expert affinity for favouring level 1 as the highest confirmation of the competency elements for midwifery U/S was captured as essential for inclusion.

The open-ended questions yielded the contribution of three elements from experts that applied to competency #1 in Round 2. Although 5.5% of the experts in round 1 indicated that they are of the opinion that elements should be added to competency #4 (intrapartum U/S), competency #5 (postpartum U/S), and competency #6 (gynaecological U/S), no elements or statements were received in response.

4.3 Round 2

The experts that completed the first round (n=18) were invited to continue with the second round. The second round yielded a 94% response rate, which contributed to a heterogeneous group of n=17 experts. The frequency distribution for Group A was n=9 experts, and Group B consisted of n=8.

The second round contained 84 closed-ended questions and 6 open-ended questions across the six domains of midwifery U/S competencies. The exclusion of consensus elements of round 1 and the additional 12 questions, as discussed in Section 4.2.5 are indicated in Addendum B. However, two consensus elements were unintentionally included in the second-round questionnaire. The unintentional inclusion of the consensus elements created an opportunity to confirm consensus reliability (Hasson & Keeney, 2011:1695).

Round 2 yielded consensus on 16 (19%) of the elements with 1.4% incomplete answers reported. Yet again, the consensus levels were reached on level 1 of the Likert scale, indicating the essential inclusion of the elements for midwifery U/S education and practice. Similar to round 1, the consensus elements were distributed between the first four midwifery U/S domains (general principles of sonography, early and first-trimester U/S, second and third trimester U/S, and intrapartum U/S). No consensus was reached in competency #5 (postpartum U/S), and competency #6 (gynaecological midwifery U/S).

4.3.1 Round 2, Competency #1: general principles of sonography

In round 2, only one element of competency #1 reached consensus. CQN 10 refers to the skill and professional behaviour in the application of the principles of knobology (Addendum C). Although the question, as discussed in Section 4.2.1, reached consensus in Round 1, the repetition confirmed consensus reliability (Hasson & Keeney, 2011:1695), as the results reached consensus in both round 1 and 2.

The descriptive statistics for round 2, competency #1, as presented in Figure 4.6, indicated all elements favouring level 1: essential for inclusion irrespective of consensus.

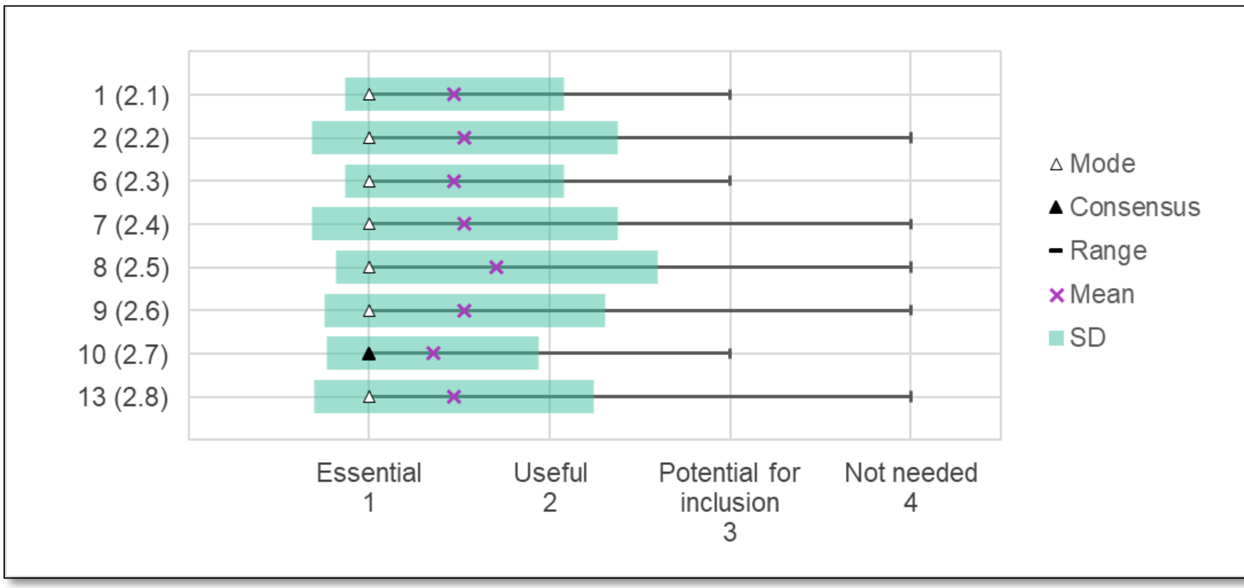


Figure 4.6 Descriptive statistics - round 2, competency #1.

4.3.2 Round 2, competency #2: early and first trimester U/S

Table 4.8 illustrates the consensus elements for competency #2, which refers to the early and first trimester midwifery U/S. In total, there were 22 questions of which 8 (36%) reached consensus in the second round. The experts reached consensus on 1 knowledge element and 7 skill and professional behaviour elements

Table 4.8 Round 2 - competency #2: early and first-trimester midwifery U/S

CQN	**OQN**	**Round 2, competency #2 elements**	**Essential**		**Useful**		**Potential for inclusion**		**Not needed**	
			1		**2**		**3**		**4**	
			n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
A midwife has foundational knowledge about:										
23	3,6	criteria for definitive diagnosis and referral of embryonic/fetal death in the first trimester	12	71%	4	24%	0	0%	1	6%
A midwife has the skills and professional behaviour to recognise the sonographic presentation of normal embryonic and fetal development with regards to:										
29	3,11	embryonic and fetal biometry	12	71%	2	12%	2	12%	1	6%
30	3,12	single and multiple pregnancy	16	94%	1	6%	0	0%	0	0%
31	3,13	gestational sac	12	71%	5	29%	0	0%	0	0%
32	3,14	yolk sac	12	71%	3	18%	1	6%	0	0%
37	3,17	distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound	13	76%	3	18%	0	0%	1	6%

CQN	OQN	Round 2, competency #2 elements	Essential		Useful		Potential for inclusion		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
A midwife has the skills and professional behaviour to recognise the sonographic presentation of normal embryonic and fetal development with regards to:										
39	3,19	distinguish between normal pathological ultrasound images for a transabdominal first-trimester midwifery ultrasound	12	71%	3	18%	1	6%	1	6%
41	3,21	use the principles of fetometry to estimate embryonic/fetal age in the first trimester by means of transabdominal ultrasound fetometry	12	71%	2	12%	2	12%	1	6%

CQN: Chronological question number

QNR: Original question number

The descriptive statistics for round 2 indicates frequency distribution between essential and useful for elements of competency #2 (Figure 4.7).

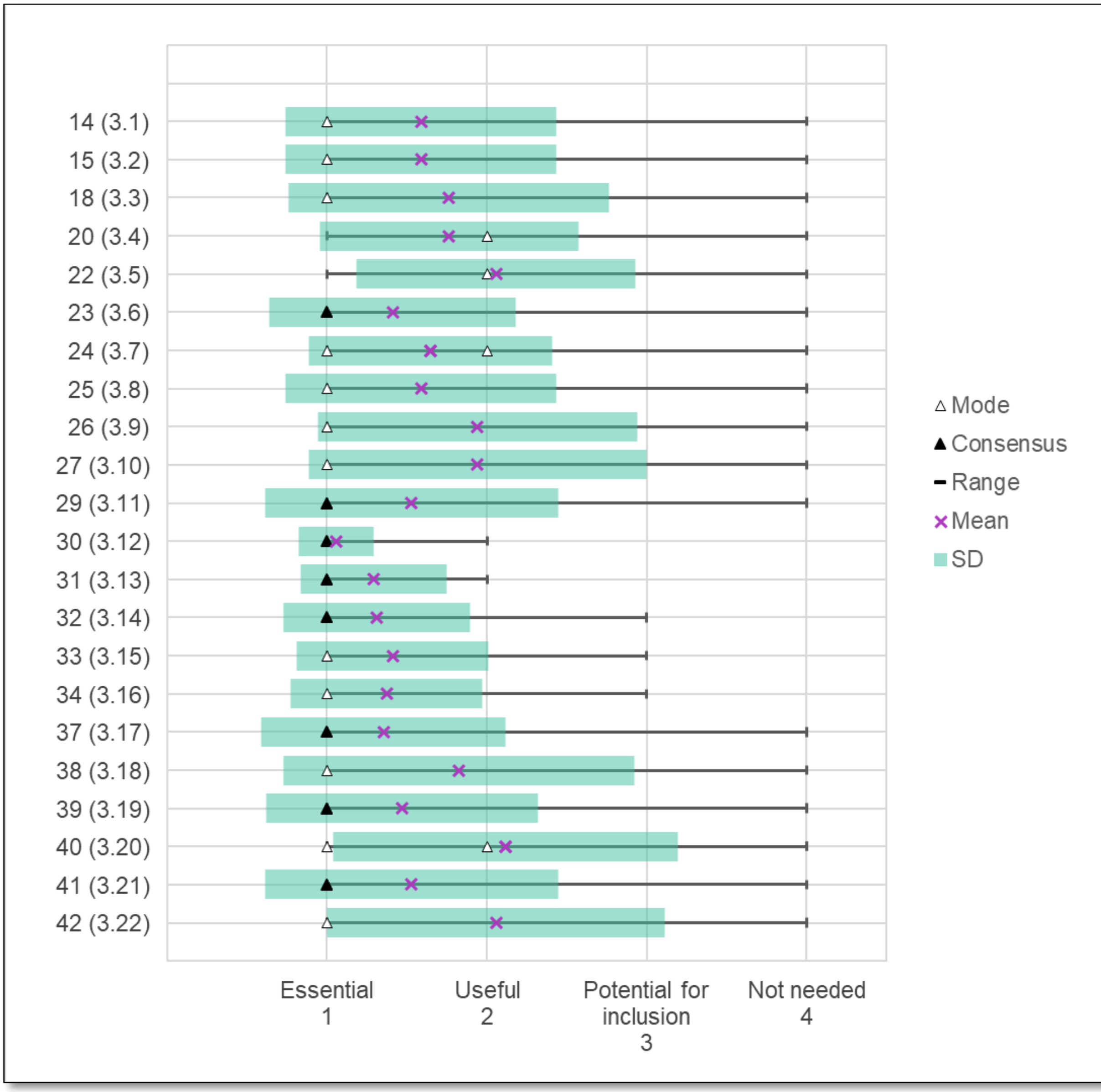


Figure 4.7 Descriptive statistics - round 2, competency #2

The element of definitive diagnosis and referral for embryonic or fetal death in the first trimester, indicated as question 23 in Table 4.8, reached 71% consensus in round 2. In round 1, question 28 in Table 4.2 reached consensus on the knowledge element of the diagnosis of single intrauterine demise. The content of CQN 23 and 28 is closely related. The loss of life can be diagnosed by a lack of cardiac activity, which is an element that the experts indicated as essential for midwifery U/S (CQN 35 in Table 4.2). However, the mean gestational sac diameter and crown-rump length ratio as a measurement during the early and first-trimester U/S has a high predictive value for spontaneous miscarriage (El-Mekkawi, El-Shahawy and Alyamni, 2015:17). The professional behaviour of midwives during a sensitive time, such as loss of life forms part of the core values of midwifery care (ICM, 2014:2; 2019:9). In addition, the mean gestational sac and crown-rump length are used as measurements for basic embryonic biometry. After 11 weeks of gestation fetal bi-parietal diameter and the head circumference are, added as measurement parameters for fetal biometry (Mei *et al*., 2019:833). Experts (n=12) agreed that embryonic and fetal biometry, CQN 29 in Table 4.7, is an essential competency for midwifery U/S education and practice.

The identification of the gestational sac, CQN 31, and the yolk sac, CQN 32 in Table 4.8 are important features of fetal biometry for dating. In addition, the visualisation of the gestational and yolk sac in the uterine cavity contributes to the exclusion of an ectopic pregnancy. According to Abramowicz, (2009:296), early U/S have shown to increase the diagnosis of ectopic pregnancy in Southern Africa (Abramowicz, 2009:296). Expert consensus (n=12, 71%) indicated the importance of the sonographic presentation of the gestational and yolk sac for midwifery U/S education and practice, while not reaching consensus on the evaluation of ampullary tubal and non-tubal ectopic pregnancy (CQN 20 in Addendum C).

CQN 30 in Table 4.8 is another example of consensus reliability (Hasson & Keeney, 2011:1695). In the first round, as discussed in Section 4.2.2, reached 72% (n=13) experts consensus on the identification of single and multiple pregnancy with an increase to n=16 experts (94%) in the second round.

As in the first round, the experts again indicated their preference for abdominal U/S for midwives. CQN 37 and 39 referred to the transabdominal U/S of the normal and pathological imaging during the early and first trimester U/S screening, as depicted in Table 4.8. Distinguishing between normal and pathological U/S images for the early and first-trimester U/S refers to the competence of the midwife to visualise normal U/S features, and the ability to refer a person when appropriate (ICM, 2019:9).

4.3.3 Round 2, competency #3: second and third -trimester midwifery U/S

Round 2, competency #3 refers to the second and third-trimester midwifery U/S. A total of 22 questions were included, of which 2 elements (9%) reached consensus in the second round (Addendum C). Both of the consensus elements were related to skill and professional behaviour.

Experts (n=13, 76%) agreed that it is essential for the midwife to review the basic fetal anatomy in the second and third trimester as part of midwifery U/S. An additional n=4 experts conferred on the usefulness for midwives to be competent in fetal anatomy screening during the second and third trimesters. According to the AIUM (2018:E14) and ISOUG, (2014:14), anatomic screening is part of the basic training in obstetric and gynaecological U/S. Furthermore, the recommended time for the anatomy screening is between 18 + 0 and 20 + 6 weeks (Curado & Bhide, 2018:301) which coincides with the timeframe for the one recommended ultrasound as prescribed by the Department of Health in South Africa (2015:155), and the WHO (2018(b):1). The childbearer should attend a routine antenatal visit, according to the Basic Antenatal Care plan in South Africa (SA DoH, 2016:33), between 20 – 24 weeks of gestation. As the majority (83.6%) of the South African population does not have medical aid coverage (Stats SA, 2020), midwifery management with the additional competence of antenatal U/S screening in the second and third trimesters creates the ideal opportunity to increase the limited number of antenatal U/S.

The value of including the identification of the placental position, umbilical cord and amniotic fluid as discussed Section 2.7.3, and reiterated by ISUOG (2014:114) as part the basic U/S, was supported by expert consensus of 94% (n=16).

The descriptive statistics for round 2, competency #3 is presented in Figure 4.8. Despite the range variance, the frequency distribution inclined toward essential and useful for the inclusion of elements for competency #3.

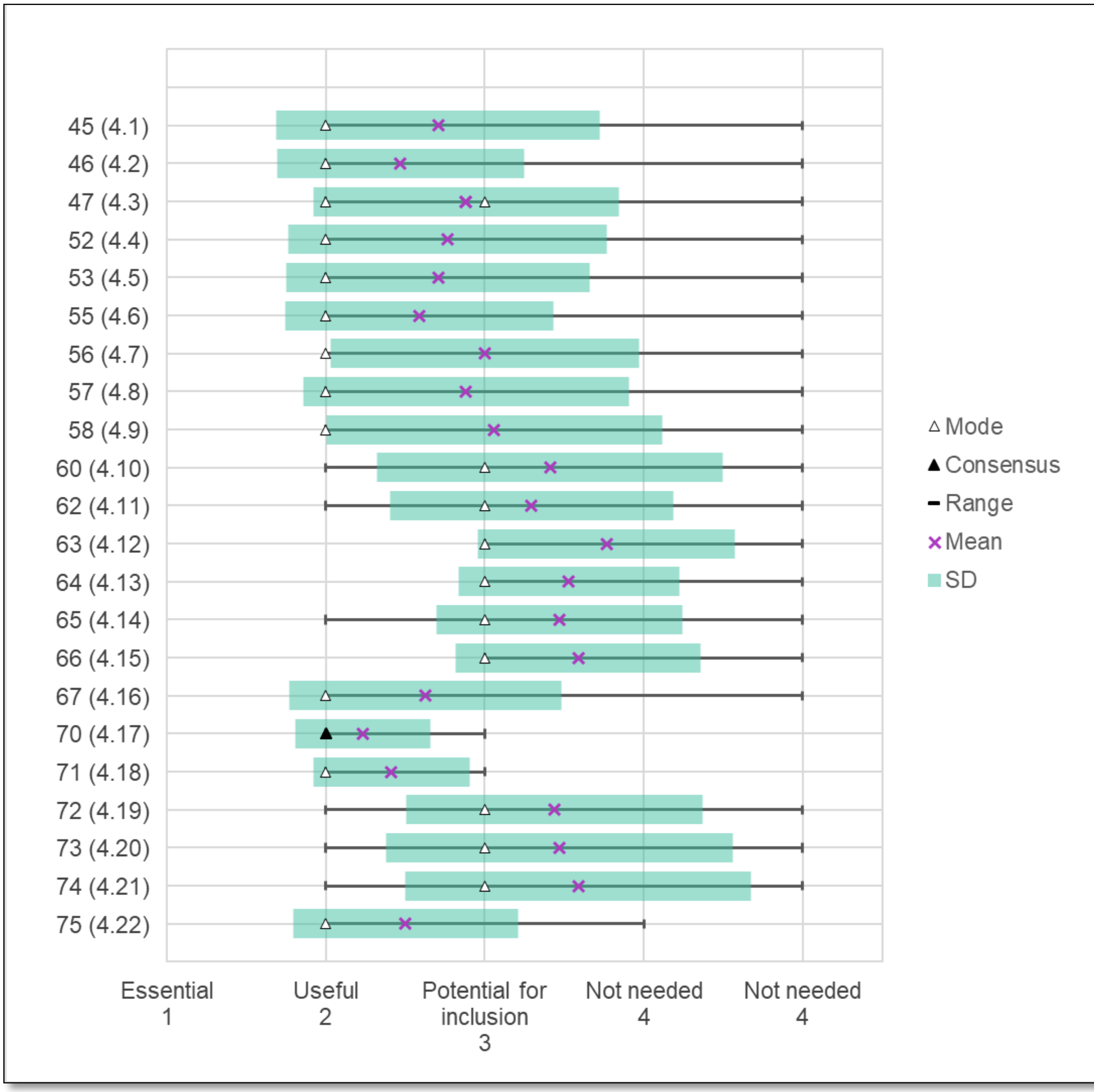


Figure 4.8 Description of statistics - round 2, competency #3

4.3.4 Round 2, competency #4: intrapartum midwifery U/S

Two elements of competency #4 reached consensus in Round 2. CQN 82 showed a 94 % consensus on the importance of the identification of the presentation, lie, position and attitude of the fetus during labour. As a skill, the U/S examination of the fetus during labour could lead to the timeous referral of malpresentation and malpositions such as posterior, brow or face presentation (ISUOG, 2018:129). Similarly to the antenatal application of the use of U/S for the identification of the placenta and amniotic fluid as in Section 4.2.3., the use of U/S during labour could capture missed opportunities for identification of placenta praevia and oligohydramnios that hold an increased risk during the intrapartum period.

The descriptive statistics for round 2, competency #4 is presented in Figure 4.9. Yet again, as discussed in Section 4.2.4, transperineal U/S indicated mode preference of level 4.

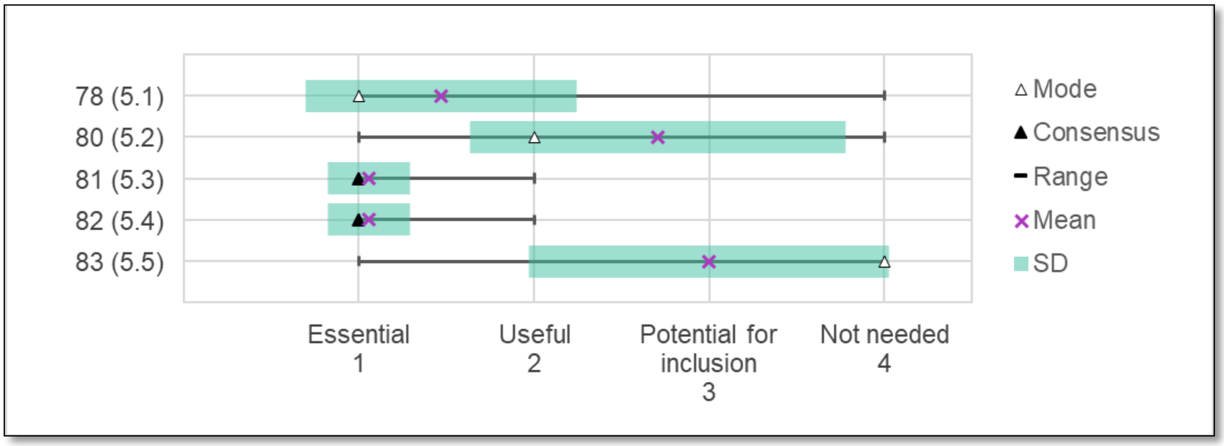


Figure 4.9 The descriptive statistics of round 2, competency #4

4.3.5 Round 2, competency #6: gynaecological U/S

Expert consensus (n=12, 76%) was reached in Round 2 on the first competency element for competency #6. The CQN 99, as illustrated in Addendum C, is concerned with the referral of a person with a high-risk profile or abnormal findings to the appropriate healthcare professional or level of healthcare. The ICM agrees that midwives should recognise situations where care is required above expertise of midwifery care, and should implement timely and appropriate intervention (ICM, 2019:12).

4.3.6 Round 2: additional questions

A total of 12 additional questions were included in Round 2. For the task shifting theme, 2 elements reached consensus, and 1 element reached consensus for the levels of midwifery U/S education and practice in South Africa.

For task shifting, the experts (n=13, 76%), indicated that the basic midwife working at primary health care level should be able to perform a basic U/S. The question was phrased by the expert's own words that the basic midwife is mostly the only person who performs a U/S, especially in rural areas, due to the shortage of appropriately qualified healthcare professionals. Furthermore, experts (n=15, 88%) expressed that the specialist midwifes should be allowed to add midwifery U/S as an additional skills set after their education, and should be allowed to train as a specialist midwife.

From the data received in Round 1 (Addendum D), 89% of the experts indicated that midwives should perform U/S at level 1, with the added requirement of referral to the appropriate healthcare professional or higher level of care if the childbearer presents with high-risk indicators or abnormal findings. Therefore, it is no surprise that 88% expert consensus were reached on CQN 110 indicating midwifery U/S on level 1, with the referral of abnormal findings or high-risk indicators as a part of midwifery care (ICM, 2019:12).

The descriptive statistics for round 2, related to task-shifting, is presented in Figure 4.11. CQN 102 referred to the basic midwife that should rather be encouraged to continue with routine midwifery care. The difference in opinion on the statement can be seen clustered around the two modes as bi-modal response (Figure 4.10.)

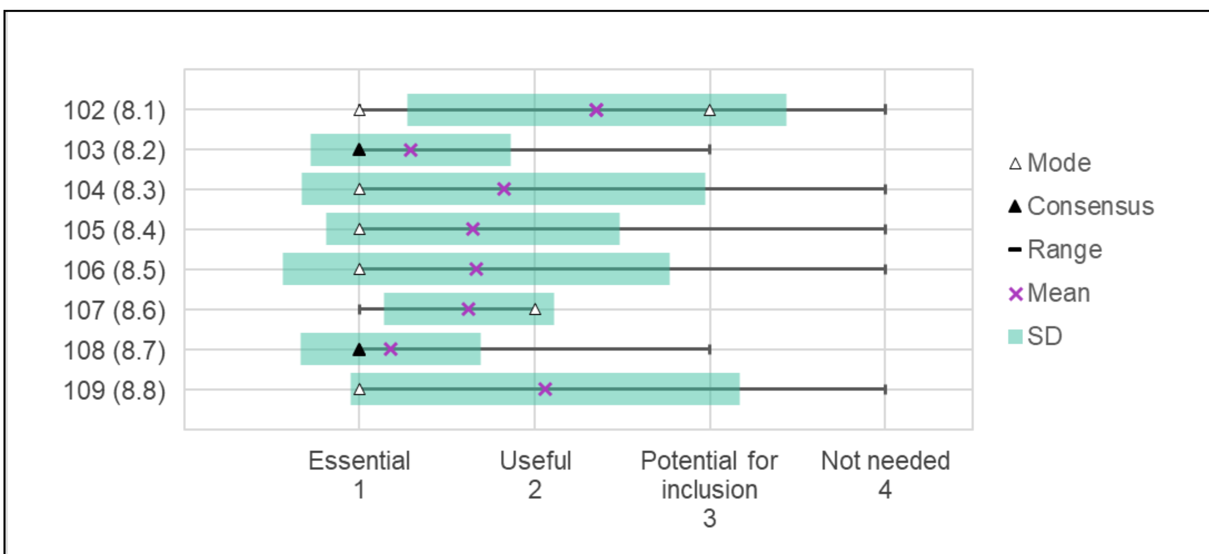


Figure 4.10 Descriptive statistics - round 2, task shifting

The descriptive statistics for round 2, related to the levels of midwifery U/S education and practice in South Africa, is presented in Figure 4.11.

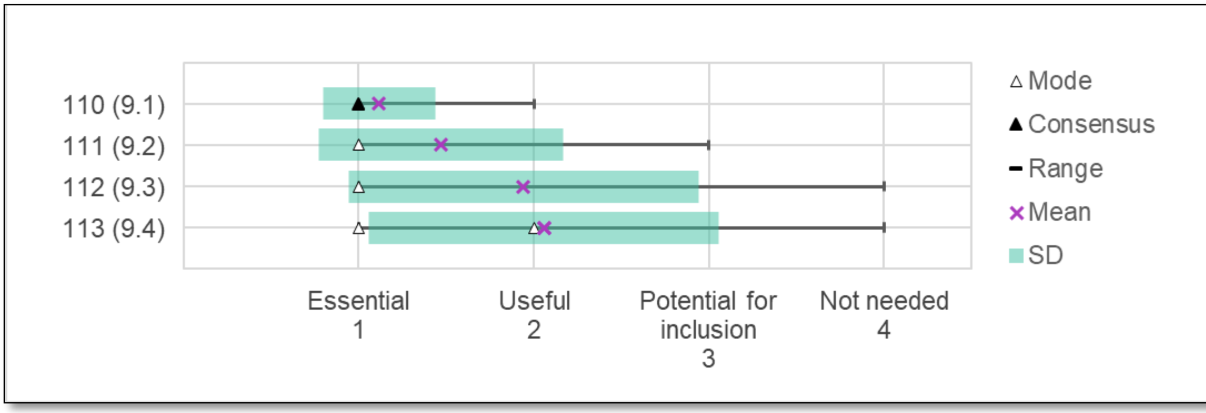


Figure 4.11 Descriptive statistics - round 2, levels of midwifery U/S education and practice in South Africa

4.3.7 Open-ended questions

In Addendum D, the data of the open-ended questions for round 2 are presented. The experts contributed seven additional elements in the domain-specific open-ended questions. Competencies #5 and #6 did not reach consensus on any of the elements in rounds 1 and 2. In addition, one expert referred to the steep learning curve involved in transvaginal screening as is required for postpartum and gynaecological U/S. The expert further elaborated that if competencies #5 and #6 should be included for midwifery U/S, sufficient hours for practice should be included to reach competence. Therefore, as indicated in Table 4.9 and Addendum C, the researcher opted for a yes/no question related to the inclusion of gynaecological U/S for midwifery U/S competence.

Table 4.9 Additional question for round 3, competency #6.

CQN 101/ OQN 7.8, round 3	Yes	No
A prerequisite for including gynaecological scanning for midwifery ultrasound should only be included if sufficient hours of clinical practice can be provided to achieve competency.		

No additional questions were included for task shifting, level of midwifery U/S education and practice in South Africa, nor for workload distribution of midwifery U/S.

4.3.8 Round 2: feedback to the experts

The researcher reported on the consensus percentage in Round 2. As motivation for completion of Round 3, elements that reached consensus were highlighted. The open-ended questions that yielded responses were acknowledged.

4.4 Round 3

The experts that completed the second round (n=17) was invited to continue with the third round. The third round yielded an 82% response rate, which contributed to a heterogeneous group of n=14 experts. There was an equal frequency distribution of seven experts in each group. In Section 3.9.2.3, the researcher indicated that an attrition rate of less than 25% is acceptable (Grove & Gray, 2019:255). The attrition rate between rounds 1 and 3 was 22%, and therefore declared to be within normal limits.

The second round consisted of 81 closed-ended questions and 6 open-ended questions across the six domains of midwifery U/S competencies. One additional open-ended questions was included, as illustrated in Table 4.9. Consensus was reached on 9 (11.1%) of the elements with 2.1% incomplete answers reported. All the consensus levels were reached on level 1 of the Likert scale, indicating the essential inclusion of the elements for midwifery U/S education and practice.

The consensus elements were distributed between all six of the midwifery U/S domains (general principles of sonography, early and first trimester U/S, second and third-trimester U/S, intrapartum U/S, postpartum and gynaecological midwifery U/S).

After data collection, the elements were analysed for stability. Stability refers to a measure that remains stable over time (Keeney *et al*., 2011:91). Stability was declared on the remaining elements that did not reach consensus. The expert opinion did however, remained constant over two or three rounds (Addendum F).

4.4.1 Round 3, competency #1: general principles of sonography

Round 3 contributed one consensus statement to competency #1. The identification of the normal embryology, and the maternal and fetal anatomy and physiology reached 71% consensus (n-10), as shown in Addendum C. This is supported by the ISUOG (2014:113).

The importance of knowledge on physics and related instrumentation remained stable between 59% in Round 2 and 57% in Round 3. However, the inner workings of U/S is crucial as a point of departure for basic U/S training (ISUOG, 2014:114). Although experts agreed that midwives should have knowledge about the maintenance of U/S machinery, midwives do not need to have the skill thereof. Stability between rounds 1 and 2 could be interpreted that the technical skill of U/S maintenance is not applicable to midwives, or it could refer to the skill to implement a maintenance plan.

Despite only one element reaching consensus in Round 3, as indicated Figure 4.12, the mode for the remaining elements was indicated as essential level 1. The descriptive statistics for round 3, competency #1, is was depicted in Figure 4.12.

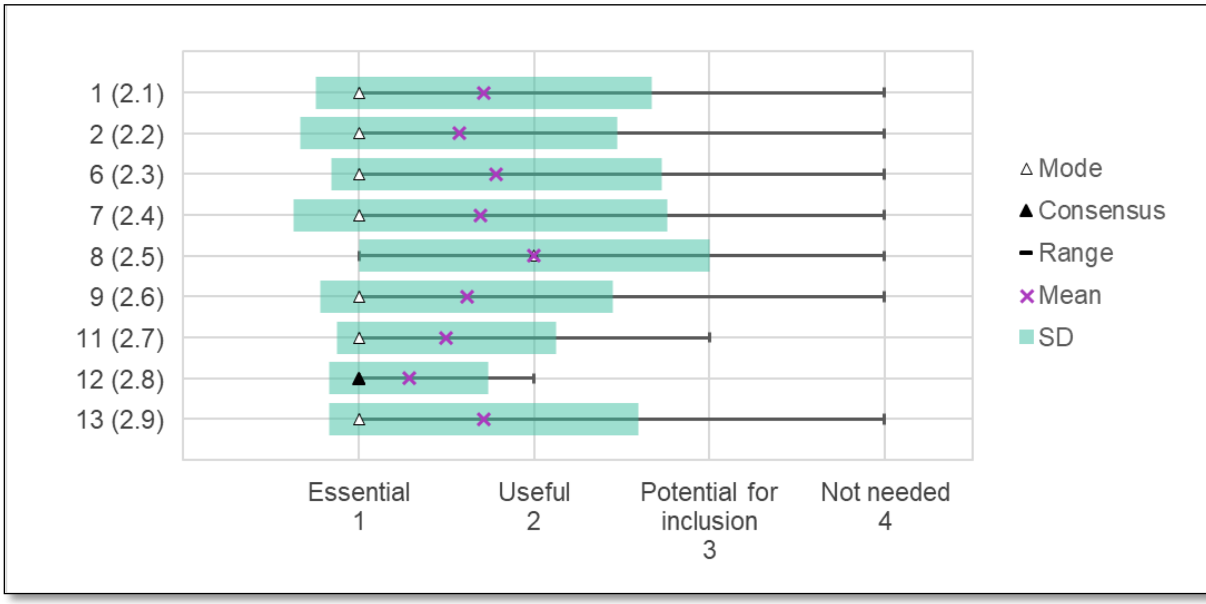


Figure 4.12 Descriptive statistics - round 3, competency #1

4.4.2 Round 3, competency #2: early and first trimester midwifery U/S

Consensus on the identification of normal sonographic morphology for 11 to 14 weeks gestation, as portrayed in Addendum C, confirmed the inclusion as ISUOG indicated the importance for the basic U/S. Being able to identify the normal structures will allow for referral of grossly abnormal findings (ISUOG, 2014:114).

The preference of transvaginal U/S with higher resolution images, especially for the use of the gynaecological examination, was yet again reiterated by ISUOG Education Committee (ISUOG, 2014:115). As indicated in Figure 4.13, CQN 18 reached stability in rounds 1, 2 and 3 between 53% and 56% consensus on level 1 of the Likert scale.

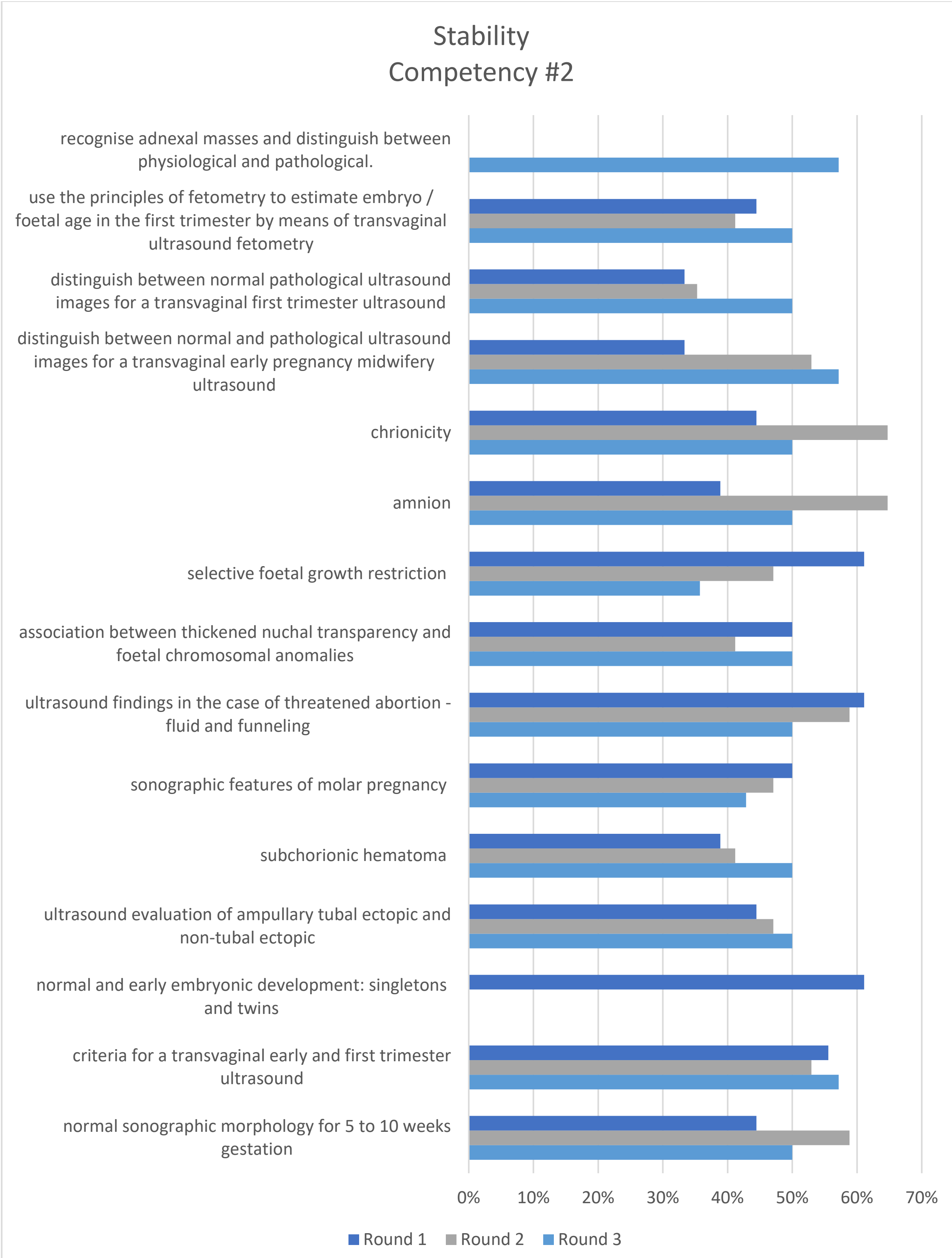


Figure 4.13 Stability round 3, competence #2

There was a slight increase in expert opinion on the inclusion of CQN 20 (evaluation of ectopic pregnancy) from 44% in Round 1 to 50 % in Round 3. As ectopic pregnancy is the third highest direct cause of maternal death reported in 2017 (SA DoH, 2017:7), the importance of ensuring competence in the identification of ectopic pregnancies in South Africa is crucial. The opposite is true for CQN 24 (molar pregnancy) and 25 (threatening miscarriage) with a decrease in opinion for both these questions.

The experts were indecisive about the inclusion of midwifery U/S for screening of genetic conditions during the first trimester. Rounds 1 and 3 both yielded a 50% response rate from the experts.

The use of transvaginal U/S for distinguishing between normal and pathological findings with transvaginal U/S (CQN 40) or for the use of fetometry (CQN 42) indicated stability between rounds 1 and 2. Both questions saw an increase in expert opinion in Round 3 to a 50% response rate. The descriptive statistics for round 3, competency #2 represented a positive inclination towards the inclusion of the element for competency #2 (Figure 4.14).

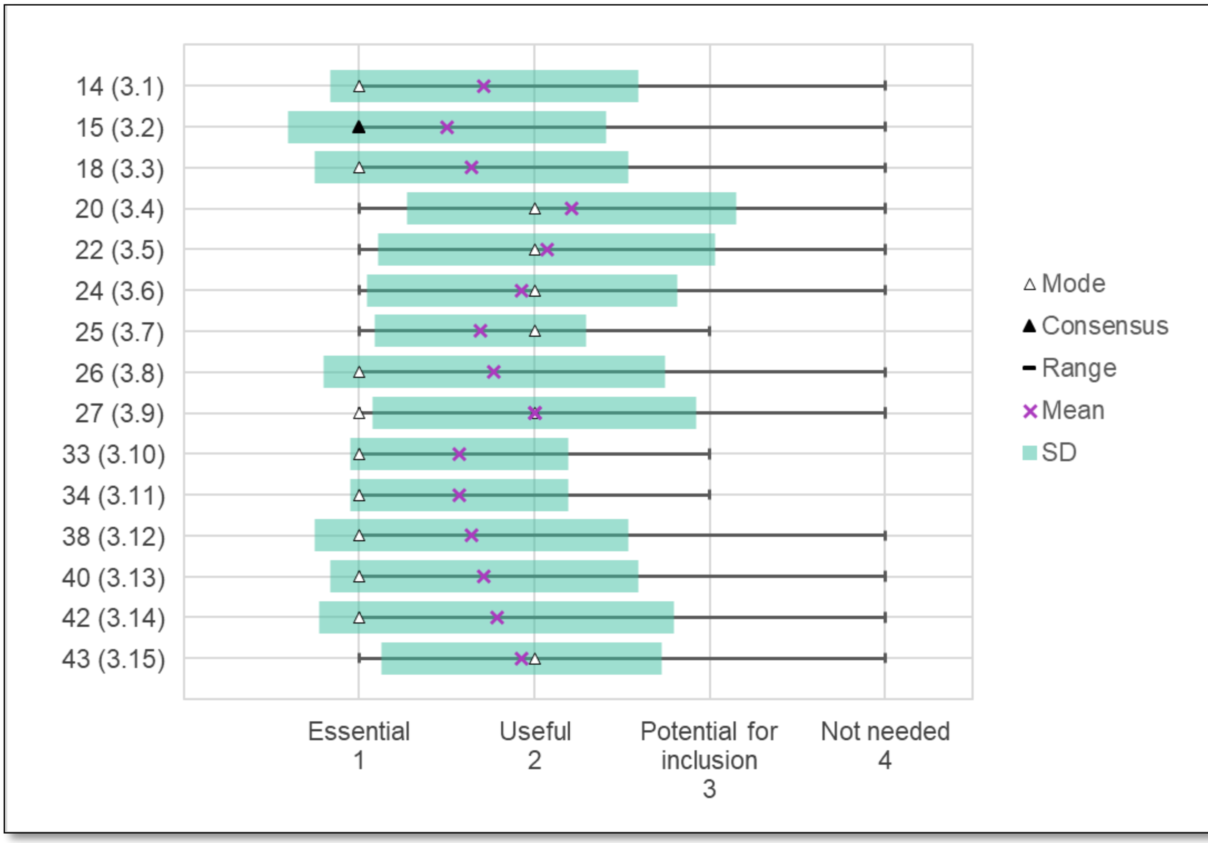


Figure 4.14 Descriptive statistics - round 3, competency 2#

In competency #2, contrary to competency #1, the mode was dispersed around level 1 and 2 on the Likert scale. The importance of the mode in the distribution of the responses leads to the inductive conclusion that the remaining elements, although not by consensus, is either essential or useful for midwifery U/S education and practice in South Africa.

4.4.3 Round 3, competency #3: second and third trimester midwifery U/S

In the last round, expert consensus on an additional 3 of competency #3 elements were given as indicated in Table 4.10.

Table 4.10 Round 3 - competency #3: second and third trimester midwifery U/S (consensus elements and data distribution)

CQN.	OQN	Round 3, competency #3 elements	Essential		Useful		Potential for inclusion		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
A midwife has foundational knowledge about:										
46	4,1	normal sonographic morphology	12	86%	2	14%	0	0%	0	0%
55	4,8	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during fetal examination in the second and third trimester	10	71%	3	21%	0	0%	1	7%
A midwife has the skill and professional behaviour to:										
75	4,23	appreciate the ethical issues associated with prenatal diagnostic procedures	10	71%	4	29%	0	0%	0	0%

CQN: Chronological question number

QNR: Original question number

CQN 46 refers to the detailed sonographic representation of all structures related to the second and third –trimester U/S. It is noteworthy that CQN 46 is a sub-question of CQN 13 (basic anatomy of the fetus) that reached consensus in round 2. The identification of the normal morphology is highlighted on the consensus on CQN 75 that relates to the ethical issues of prenatal diagnosis. As midwifery care is founded on the premise of being ethical and culturally sensitive (ICM, 2014:2), the professional behaviour and skill needed to appreciate the ethical issues related to prenatal diagnosis could be accepted as pre-existing midwifery knowledge.

Knowledge about the placenta, umbilical cord and amniotic fluid and adnexa (CQN 55) indicated consensus at 72% (n=13) in round 3. However, the skill and professional behaviour only reached stability in round 3 with a stronger inclination towards favouring level 1 as the mode as illustrated in Figure 4.15.

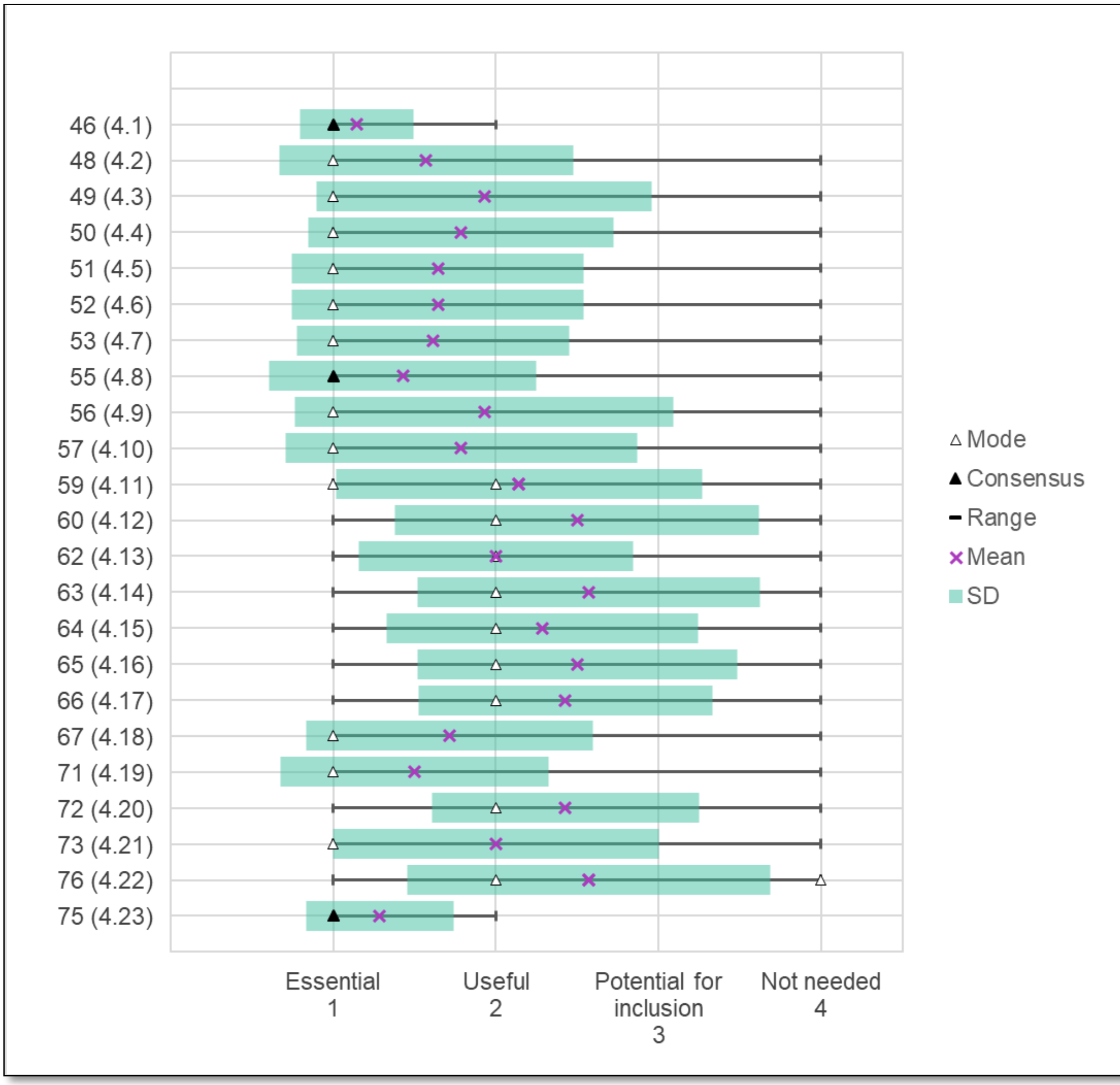


Figure 4.15 Descriptive statistics - round 3, competency #3

In total, 30 elements were included during the three rounds for competency #3, of which 30% reached expert consensus. Of the remaining 21 questions, 4 did not reach consensus or stability, as indicated in Addendum F. The biophysical profile (CQN 60) indicated the highest level of stability between all three rounds. According to ISUOG (2014), the biophysical profile is not indicated as part of the basic U/S training. Therefore, the exclusion of the biophysical profile as an element of competency #3 may be of value if experts agree on level 1 U/S education and practice for midwives in South Africa.

Furthermore, the knowledge on heart, face, neck and thorax, and the skeletal structure of the fetus reached stability. These individual elements form part of the anatomy screening (CQN 70) performed during the second and third trimester, on which consensus was established in Round 2.

U/S screening and evaluating the cervical condition and other related growth abnormalities which could influence preterm birth, showed a slight increase in opinion in round 3. According to ISUOG, the evaluation of fetal growth impairment is regarded as part of the basic U/S (2014:114).

CQNs 62 - 66 are the elements of Doppler fetal surveillance. Despite strong evidence for the benefit of Doppler evaluation, as discussed in Section 2.3.1, experts are of the opinion that the competence should not be included for midwifery U/S education and practice in South Africa.

4.4.4 Round 3, competency #4: intrapartum midwifery U/S

Consensus in Round 3, competency #4 included CQN 84 (confirmation of fetal heartbeat). ISUOG (2018:137) confirms the inclusion of the element as part of intrapartum U/S. Furthermore, CQN 79, measurement of the fetal skull during labour, was unintentionally omitted in rounds 2 or 3. As the element indicated consensus at 61%, CQN 79 was accounted for as a missed opportunity. In Figure 4.16, the stability of competency #4 is depicted.

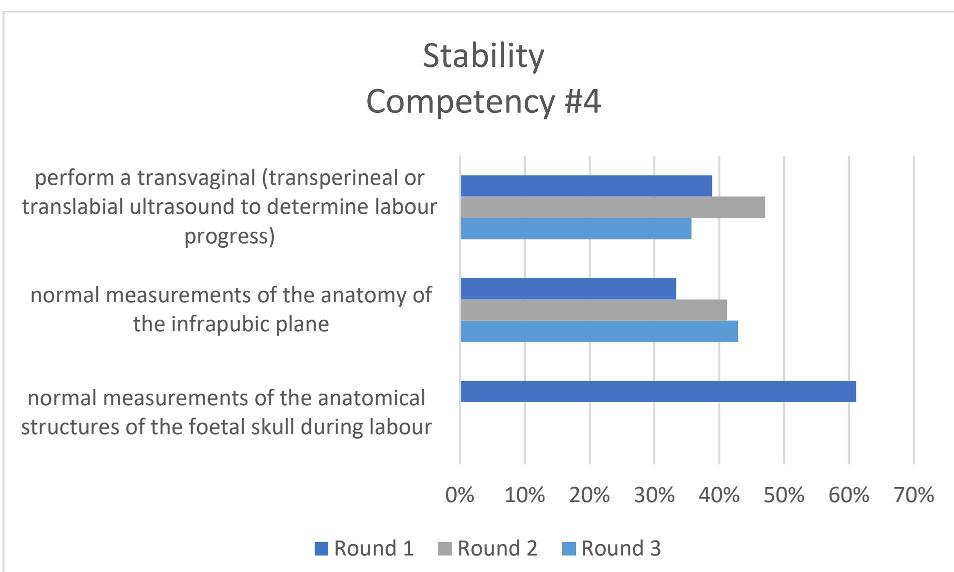


Figure 4.16 Stability round 3, competence #4

The descriptive statistics for round 3, competency #4, as illustrated in Figure 4.17.

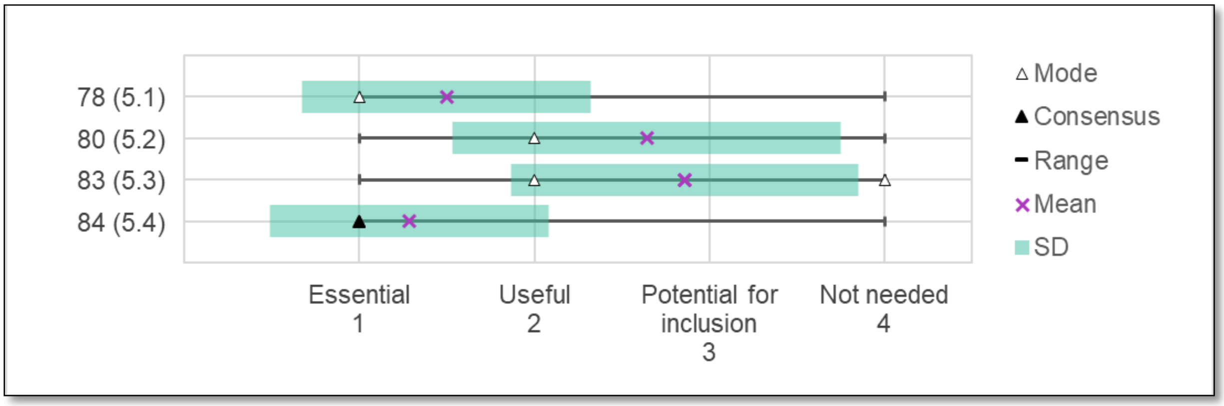


Figure 4.17 Descriptive statistics, round 3, competency #4

CQN 83, perform a transperineal U/S to determine the labour progress indicated the bi-model distribution of responses. As the use of transperineal U/S for measurements related to the labour progress is not widely practiced in South Africa, the distribution of responses may be linked to inexperience with the technique.

4.4.5 Round 3, competency #5: postnatal midwifery U/S

Competency #5 incorporated consensus elements for the first time in round 3, as depicted in Table 4.11. CQN 85 included consensus (n=10, 71%) knowledge of normal involution of the organs involved during the childbearing period (ICM, 2019:19). This is regarded as pre-existing midwifery knowledge. However, incorporating U/S imaging may contribute to the early identification and referral of obstetrical haemorrhage in the critical postpartum period (SA DoH, 2017:5).

In addition, CQN92 reiterated referral of a high-risk person to the appropriate healthcare professional or level of healthcare. As midwifery care promotes normal physiology, timely referral with access to medical care is promoted (ICM, 2019:12).

Table 4.11 Consensus round 3 – competency #5: postpartum midwifery U/S.

CQN	**OQN**	**Round 3, competency #5 elements**	**Essential**		**Useful**		**Potential for inclusion**		**Not needed**	
			1		**2**		**3**		**4**	
			n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
A midwife has foundational knowledge about:										
85	6,1	normal involution of the reproductive organs after childbirth	10	71%	3	21%	0	0%	1	7%
55	4,8	normal and potential pathological ultrasound appearance of the placenta, umbilical cord, amniotic fluid and adnexa during fetal examination in the second and third trimesters	10	71%	3	21%	0	0%	1	7%
A midwife has the skill and professional behaviour to:										
92	6,8	refer a person with a high-risk profile or abnormal findings to a medial healthcare provider	11	79%	2	14%	0	0%	1	7%

CQN: Chronological question number

QNR: Original question number

The descriptive statistics for round 3, competency #5, as illustrated in Figure 4.18.

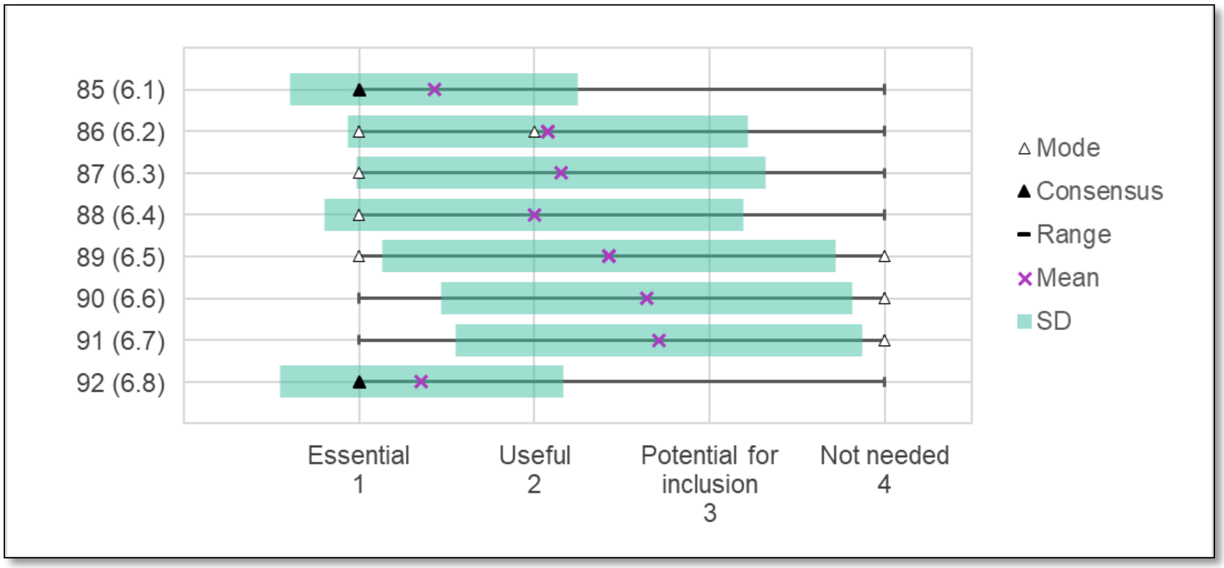


Figure 4.18 Descriptive statistics, round 3, competency# 5

The bi-modal distribution was yet again visible, indicating the pooling of expert responses around two core opinions (Hsu & Sandford, 2007:4). CQN 89, referring to the U/S screening of the vaginal canal during the postpartum period, reporting both essential inclusion (n=5) and not needed (n=5). The evaluation of the vaginal canal may be interpreted as a part of the gynaecological U/S, which experts continuously indicated as having a low probability of inclusion for midwifery U/S education and training.

Figure 4.19 depicts the stability of six elements of competence #5 during rounds 1 to 3.

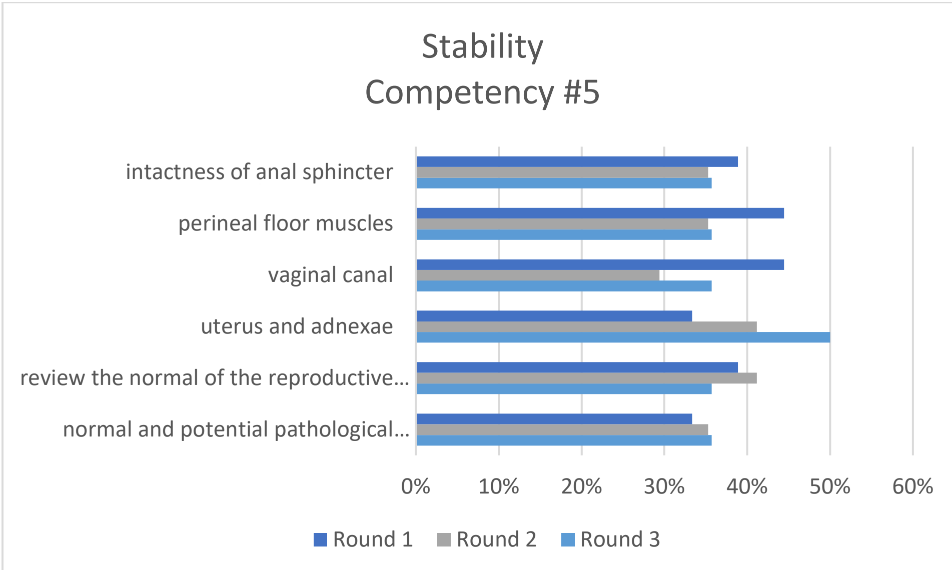


Figure 4.19 Stability round 3, competence #5

CQN 88 (examining the uterus and adnexae) indicated a steady increase in opinion from the first to the third rounds. As retained placenta increases postpartum haemorrhage, U/S imaging could influence effective management to prevent postpartum haemorrhage and sepsis (Jauniaux, Putri, Vasireddy, *et al*., 2020:online).

Furthermore, the U/S evaluation of perineal trauma that relates to CQN 86, 87, 89, 90, and 91 each resulted in an individual response of 36% in Round 3. Although it is not within the scope of a midwife to repair a third-degree tear, immediate diagnosis and referral is crucial in its management.

4.4.6 Round 3, competency #6: gynaecological midwifery U/S

In addition to the one competency element that reached consensus in round 2, the researcher converted an open-ended statement into a closed-ended question that was added to competence #6, as discussed in Section 4.3.7.

The question (CQN 101) asked the experts to indicate if they agreed that gynaecological U/S should not be included in the competence of midwifery U/S education and training in South Africa.

The majority of experts (n=9, 64%) agreed that gynaecological U/S should not form part of the midwifery U/S competence. However, the following question (CQN 102) asked the experts to re-evaluate their statement based on the inclusion of sufficient hours of clinical practice to provide and achieve competence in gynaecological midwifery U/S. The experts (n=12, 86%) then agreed.

Stability on the elements of competency #6 are indicated in Figure 4.20. The responses increased during the second round pertaining to the normal structures of the female reproductive organs. However, during the third round it stabilised below 45% in line with the remaining elements.

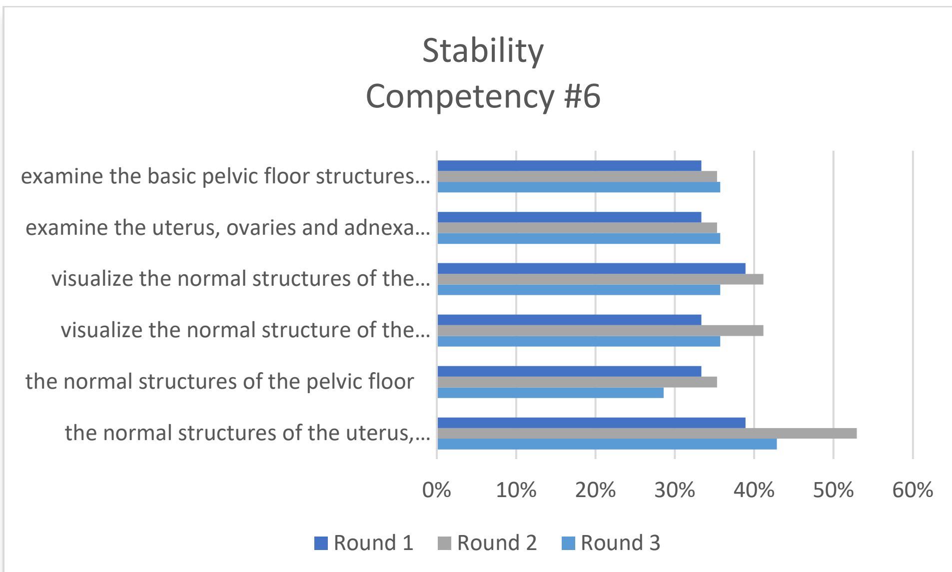


Figure 4.20 Stability round 3, competence #6.

The descriptive statistics for round 3, competency #6, as illustrated in Figure 4.20, clearly indicate the wide distribution of response. A total of three questions are categorised as not needed according to the mode. In contrast, only two elements are indicated as essential.

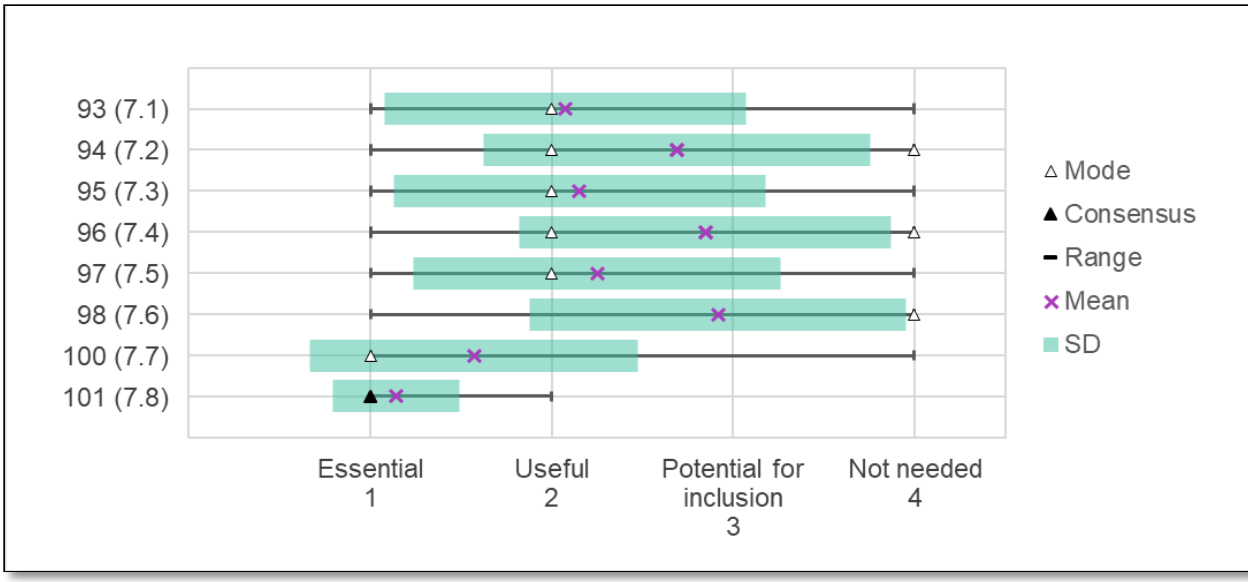


Figure 4.21 Descriptive statistics, round 3, competency #6. Stability of additional questions.

In round 3, an increase in expert opinion indicated that experts acknowledge the limited scope of practice of the basic midwife (Addendum F). CQN 102 motivates the exclusion of the basic midwife due to their close involvement with the clinical management of 'patients'. In addition, stability in the expert's opinion indicated that the specialist midwives' should rather have the ability to integrate expertise with U/S in CQN 107. This is in support of the SOMSA report (Section 1.1) that the specialist midwife should be the applicable midwife to integrate US with practice. However, CQN 105 confirmed that irrespective of qualification, passion should be the driving force behind competence of midwifery U/S education and practice in South Africa. Furthermore, an increase in experts' opinion during round 3 of 16% on CQN116 showed a positive trend toward favouring the basic midwife for level 1 U/S and the specialist midwife for level 2 education and practice, as included in the ICM's Essential competencies for the basic midwife (ICM, 2019).

As the elements relating to workload distribution was included for the first time in round 3, stability cannot be deducted. However, Figure 4.22 refers to the benefit of U/S that outweighs the workload.

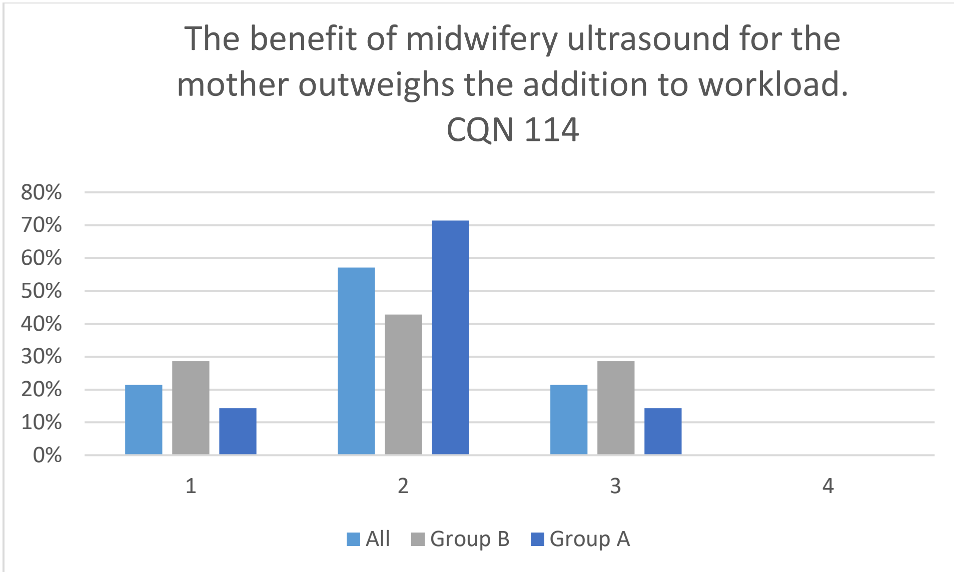


Figure 4.22 Additional question related to workload distribution of midwifery U/S.

Group A (midwives) are in unison regarding the benefit of U/S, despite the increase in workload. The positive attitude of midwives confirms the benefit of U/S in situations where complications were adverted in management of complication, despite the additional workload. How midwives perceive U/S as an additional skills set and the effect on the workload should be investigated in future after the implementation of an accredited midwifery U/S education programme.

4.4.7 Expert consensus reached on competence for midwifery U/S education and practice in South Africa.

Based on expert consensus, a total of 52% consensus was reached in this study, which established 61 competency elements for the six competency domains for midwifery U/S education and practice in South Africa. The open-ended questions about task shifting, the level of midwifery U/S and the expert opinion on the workload distribution created a platform to start the discussion about the landscape of midwifery U/S education and practice in South Africa. A summary of each of the competency domains are illustrated in Tables 4.12 – 4.16.

Table 4.12 Expert consensus on competency #1 for midwifery U/S education and practice in South Africa

Competency #1: General principles of sonography
Knowledge
• basic maintenance of ultrasound instrumentation • ultrasound safety • infection control • the principles of knobology
Skills and professional behaviour
• anatomy and physiology of the internal organs of the female reproductive system related to the productive age • apply the principles of knobology • identify the normal maternal and fetal anatomy, physiology and embryology.

The first domain focuses on using midwifery U/S effectively (knobology) and safely while ensuring the U/S equipment and instrumentation as an expensive and scarce resource is maintained. The functionality and longevity of the equipment will ensure increased access to quality healthcare. A further research avenue that arises from this research is the pre-requisite knowledge as a criterion for admission to a midwifery U/S programme (recognition of prior learning), or whether the anatomy and physiology component will have to be included as a refresher in the curriculum for midwifery U/S.

Table 4.13 Expert consensus on competency #2 for midwifery U/S education and practice in South Africa.

Competency #2: Early and first trimester midwifery U/S
Knowledge
• normal sonographic morphology for 11 to 14 weeks gestation • indications for an early and first trimester ultrasound • criteria for a transabdominal early and first trimester ultrasound • components of sonographic dating in trimester • criteria for definitive diagnosis and referral of embryonic/fetal death in the first trimester • single intrauterine demise

Competency #2: Early and first trimester midwifery U/S
Skills and professional behaviour
• embryonic and fetal biometry • single and multiple pregnancy • gestational sac • yolk sac • evaluate embryotic/fetal cardiac activity and documenting • determine the indication for an early or first trimester ultrasound • distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound • distinguish between normal pathological ultrasound images for a transabdominal first-trimester midwifery ultrasound • use the principles of fetometry to estimate embryotic/fetal age in the first trimester using transabdominal ultrasound fetometry • refer persons with a high-risk profile or abnormal findings to an appropriate healthcare professional

Competency #2, as depicted in Table 4.13, refers to a midwife's ability to ensure the appropriate use of U/S technology (ICM, 2014:2). Midwifery U/S is used to determine pregnancy viability by assessing the basic morphology of the fetus during the early and first trimester. The early identification of a singleton or multiple pregnancy, placental location and biometric measurements of age and size directly influences midwifery care. Despite expert consensus on the use of only transabdominal U/S, further investigation should be done about the applicable use of midwifery transvaginal U/S during the first trimester.

Table 4.14 Expert consensus on competency #3 for midwifery U/S education and practice in South Africa

Competency #3: second and third trimester midwifery U/S
Knowledge
• normal sonographic morphology • components of fetal biometry in sonographic dating in second and third trimesters • presentation, position and attitude of the fetus in the third trimester • indications for the referral to healthcare professionals
Skills and professional behaviour
• measure the basic structures to estimate the age of the fetus • measure basic fetal morphology in the second and third trimester for the purpose of establishing normal fetal growth • review the basic fetal anatomy in the second and third trimesters • examine the placenta, umbilical cord and amniotic fluid and adnexa during fetal examination in the second and third trimesters • appreciate the ethical issues associated with prenatal diagnostic procedures • referral of a person with a high-risk profile or with abnormal findings to an appropriate healthcare professional

Competence #3, as illustrated in Table 4.14, focuses on the use of midwifery U/S to identify normal morphology of the fetus, placenta, amniotic fluid and umbilical cord (including anatomical structures). The ethical issues related to diagnostic procedures and appropriate referral is captured within the skill and professional behaviour of midwifery U/S. The establishing of fetal age and weight directly impact midwifery care applicable to competency #4, as indicated in Table 4.15.

Table 4.15 Expert consensus on competency #4 for midwifery U/S education and practice in South Africa

Competency #4: Intrapartum U/S
Knowledge
• the presentation, lie, position and attitude of the fetus during labour • normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour • examine the position of placenta umbilical cord and amniotic fluid
Skills and professional behaviour
• examine the position of placenta umbilical cord and amniotic fluid • review the presentation, lie, position and attitude of the fetus • confirmation of a positive fetal heartbeat

The application of U/S during the intrapartum period has evolved over the last decade to include more than just the identification of fetal position, placental location and the presence of a fetal heartbeat, as indicated as competencies for midwifery U/S in Table 4.15. An array of measurement are now included in the ISUOG intrapartum guidelines (ISUOG, 2018:128-139), as discussed in Section 2.7.4. As the midwife is regarded as the most appropriate SBA to attend to women during childbirth (WHO, 2011:5; ICM, 2017:1), the researcher identified intrapartum U/S as a possible niche area for midwifery U/S in South Africa. However, gynaecological U/S as contained in competency #6 in Table 4.17, should debatably not be included within the midwifery U/S field.

Table 4.16 Expert consensus on competency #5 for midwifery U/S education and practice in South Africa

Competency #5: postpartum midwifery U/S
Knowledge
• normal involution of the reproductive organs after childbirth • refer a person with a high-risk profile or abnormal findings to a medical healthcare provider
Skills and professional behaviour
None

Elements regarding postpartum midwifery U/S is limited to knowledge about normal involution after childbirth. Knowing the sonographic imaging of normal involution will guide a midwife to appropriate referral of a person with a high risk or abnormal findings for further management. According to ISUOG (2014:115), the transvaginal U/S approach yields better results than transabdominal U/S due to the higher resolution of imaging. As experts' consensus indicated a preference to transabdominal midwifery U/S, the elements of the postpartum midwifery and gynaecological U/S (Table 4.17) should be considered for inclusion of U/S education and practice in South Africa.

Table 4.17 Expert consensus on competency #6 for midwifery U/S education and practice in South Africa

Competency #6: gynaecological midwifery U/S
Knowledge
None
Skills and professional behaviour
• refer a person with a high-risk profile or abnormal findings to an appropriate healthcare professional

Competency #6 indicated that midwives should refer a person with a high risk or abnormal findings in need of a gynaecological U/S to the appropriate healthcare professions. As discussed in rounds 3, Section 4.4.6, experts are in agreement that gynaecological U/S should only be included in midwifery U/S if sufficient time and practice are allocated for competence.

4.5 Comparison of ISUOG basic U/S training and intrapartum guidelines with expert consensus on competence for midwifery U/S education and practice in South Africa

The ISUOG is acknowledged as the international association that sets the golden standard for U/S. The ISUOG online learning module index for basic U/S training was utilised in Chapter 2 for the development of the first-round questionnaire. During the continuous process of searching for appropriate literature, the researcher incorporated the ISUOG basic U/S training recommendations (ISUOG, 2014) as well as the ISUOG intrapartum guidelines (ISUOG, 2018) in pursuing a complete representation of competency elements.

As the experts in Section 4.3.6 indicated that midwifery U/S in South Africa should be equivalent to a level 1 basic U/S, the researcher set off to compare the newly concurred competencies for midwifery U/S in South Africa with the ISUOG basic U/S training recommendations in Addendum H. In addition, the ISUOG Intrapartum guidelines were included in the comparison due to the midwife being the most appropriate SBA to implement the evolving competence.

The Likert scale was divided into a set of inclusion elements comprising of the combined consensus of the essential and useful categories. Furthermore, exclusion elements involved the elements pertaining to the potential for inclusion, and not needed on the Likert scale. The consensus levels were re-calculated to ensure the validity of results. In addition, the researcher aimed to identify any gaps in the competencies of midwifery U/S as caused by non-inclusion of the elements in the three questionnaires. The comparison yielded the following report as depicted in Table 4.18.

Table 4.18 Comparison of ISUOG basic U/S training and consensus of midwifery U/S education and practice in South Africa

ISUOG basic U/S recommendation	Competencies for midwifery U/S education and practice in South Africa.
Basic physical principles	Of 8 elements, 7 were included in competency #1 U/S artefacts were not described in competency #1
Theoretical teaching of the basics of diagnostic U/S	Of the 6 elements, 4 were included in competency #1 The elements not included referred to informed consent, image recording and storing, quality control and statistical tests to describe screening.
First-trimester U/S	Of the 9 elements, 8 were included in competency #2. The interpretation of serum human gonadotropin and progesterone in pregnancy of unknown location was not included in the questionnaire.
Second and third-trimester U/S	All elements were included in competency #3.
Intrapartum U/S	Of the 8 elements, 4 were included in competency #4 The elements referred to the indications for U/S, and the new generation measurements as indicated in Addendum H.
Gynaecological U/S	Most elements were not well described in the questionnaire or consensus could not be obtained.
General skills	Of the 11 elements, 9 elements were included. The elements not included were awareness of consent, and storing of data, as previously mentioned.

The triangulation of the expert consensus elements in Chapter 4 created the opportunity for further triangulation of the proposed midwifery U/S competence with the ISUOG's recommendations and guidelines (ISUOG, 2014 & 2018). The comparison allowed for the identification of gaps in the knowledge about the competence of midwifery U/S in South Africa. With minor adjustments to mostly competency #1, which refers to the general principles of sonography, the overview of consensus elements for midwifery U/S in South Africa mostly compares with the international standard for basic U/S. Two grey areas occurred within the boundaries of midwifery U/S in South Africa. The first is the possible addition of intrapartum U/S elements as arguably not part the basic U/S. The second is a stronger inclination toward the exclusion of gynaecological U/S due to the difficulty of reaching competence.

4.6 Concluding remarks

The experts reached consensus for the essential inclusion of elements within six competency domains for midwifery U/S education and practice in South Africa. With minor differences, the competency elements that were indicated as essential or useful for inclusion collectively compared with ISUOG's basic U/S training recommendations and could therefore be determined as valid for the use of curriculum development. In Chapter 5, the researcher reflects on the implementation of the research design and technique, identifies gaps in the knowledge, and recommends further research pathways.

Chapter 5 Conclusion

We need to change midwifery in the changing world we live in. And if the change is to the benefit of the childbearing family, why wouldn't you?

5.1 Introduction

The conceptual framework set out in Chapter 1 of this study illustrated that SOMSA endorses the ICM's philosophy and model of care. The ICM's philosophy and model of care are more than just the foundation for midwifery care. The ICM is the benchmark for midwifery with regard to education, regulation and practice, which could fill the void of leadership in this regard in many countries. SOMSA not only supports the ICM's ideology but sets the example for midwives to strive for competence instead of mediocrity in South Africa. For the researcher, as a midwife actively practising her profession as an independent specialist midwife according to the ICM's philosophy and model of care, the benefits of U/S has been tangible in many situations. In the current age of the 4IR, the appropriate use technology in midwifery care sparked a personal interest. The absence of an accredited and regulated midwifery U/S programme in South Africa became the impetus for this study.

As discussed in Chapter 2, a compelling body of knowledge confirms a range of benefits of U/S, its ease and quality of knowledge transfer, as well as the ability of midwives to become competent U/S practitioners. However, U/S education for midwives remains unaccredited and unregulated in South Africa, despite the implementation of midwifery U/S by various provinces in the public health domain.

In a bid to ensure quality education and standardisation, the researcher, also a midwife educator, set out to create an accredited midwifery U/S programme that would be able ensure midwifery competence applicable to the South African context. However, an obstacle to accreditation was the absence of consensus on the applicable competencies for the midwifery U/S education and practice. The discovery of this crucial gap in knowledge informed the research problem, which led to the following research question:

What is the consensus on competencies for midwifery U/S education and practice in South Africa?

The objectives that emerged from the research question were the following:

- *Identify from literature competencies for midwifery U/S education and practice.*
- *Compile a list of competencies for midwifery U/S education and practice in the continuum of female reproductive health.*
- *Describe the competencies for midwifery U/S education and practice as validated by expert opinion.*

The research question guided the research design and technique used to obtain the research objectives. A modified e-Delphi technique as the best applicable consensus method was utilised to gather data needed for consensus, as discussed in Section 3.3. Within the quantitative design, the consensus level was determined at 70% of the expert opinion on a given element. The sample population was well defined to include the highest obtainable category of experts in South Africa within the field of U/S. The experts represented a national heterogeneous group that included both midwives and traditional healthcare professionals (Section 3.4).

As no competencies for midwifery U/S education and practice in South Africa were available, the researcher set forth to compile a comprehensive list of elements from literature related to U/S. The result was a first-round questionnaire that comprised of six competency domains with 91 elements. Two open-ended questions that emerged from the literature were included to probe the experts on how midwifery U/S would fit into the context of South African healthcare. The iterative process of the three rounds with open-ended questions contributed to the addition of 27 questions that increased the number of elements to 118.

The modified e-Delphi lent itself to electronic data collection, which in the year of 2020 with the SARS-CoV-2 pandemic was a blessing in disguise. The data collected during the three rounds were analysed, and the findings were presented in Chapter 4.

In this chapter, the researcher summarises the research findings and contributions that emerged from seeking expert consensus about midwifery U/S practice and education. The limitations of the study are acknowledged followed by suggestions for future research. The researcher then shares ideas related to dissemination of the findings, and lastly, offers her reflections and concluding remarks about the journey in reaching the aim of this study.

5.2 Summary of findings

Consensus was reached on 54 elements included in five of the six competency domains. Although the researcher set out to determine consensus on six domains as was highlighted in the literature, gynaecological U/S reached consensus on only one element (referral of a person with high risk or abnormal findings). Therefore, this domain was excluded from the final consensus competencies for midwifery U/S education and practice in South Africa (refer to Table 5.1). Experts indicated that gynaecological U/S should not form part of midwifery U/S education and practice in South Africa. However, gynaecological U/S is part of the ISUOG's basic U/S recommendations (2014:115). It is noteworthy that experts indicated that only with sufficient clinical practice should competence in gynaecological U/S be reconsidered for midwifery U/S. The current organisation within different levels of health care in South Africa separate midwifery and gynaecological care and as such could be a possible reason for the exclusion by the experts.

The experts indicated that the basic midwife who practices at primary healthcare settings should be able to perform a level 1 U/S. In addition, experts agreed that the specialist midwife should be able to pursue midwifery U/S as an additional competency after their formal training. Furthermore, the experts' opinion was to restrict midwives to the utilisation of transabdominal U/S in the following five competency domains, as summarised in Table 5.1.

Table 5.1 Summary of midwifery U/S competency domains for education and practice in South Africa

Five midwifery U/S competency domains		Summary of elements
#1	General principles for sonography	• Principles of knobology, basic maintenance of U/S equipment, safety and infection control. • Related normal and abnormal maternal, embryonic and fetal anatomy and physiology
#2	Early and first trimester U/S	• Evaluation of normal and abnormal morphology of an in-utero positioned single/multiple embryo or fetus (including pregnancy viability) • Fetometry to determine embryonic/fetal age. • Timely and appropriate referral of a high risk or abnormal finding.
#3	Second and third-trimester U/S	• Evaluation of basic fetal anatomy screening. • Evaluate fetal age and growth • Examine placental, umbilical cord, amniotic fluid and adnexa. • Ethical issues related to prenatal diagnosis • Timely and appropriate referral of a high risk or abnormal finding.
#4	Intrapartum U/S	• Confirm fetal heartbeat, position, lie and attitude • Evaluate placental, umbilical cord and amniotic fluid for position and pathological appearance
#5	Postpartum U/S	• Identify normal involution of reproductive organs after childbirth. • Timely and appropriate referral of high risk or abnormal finding.

The general principles, early and first-trimester, and second and third-trimester U/S as midwifery competency domains are included in the internationally recognised ISUOG's basic U/S training (2014:113-116). The postpartum midwifery U/S competency is not necessarily described within intrapartum U/S, and an inclination towards inclusion as part of gynaecological U/S screening seems to be more appropriate. However, intrapartum U/S is described in ISUOG's basic U/S training (2014:114) as an extension of the competence into the birth room. It is only with the ISUOG's guidelines to intrapartum U/S (2018:128-139) where the specific competency elements are described. In this study, it became clear that intrapartum U/S elements have evolved far beyond the general identification of fetal, placental and amniotic features. The inclusion of transperineal measurements, such as AOP and SHD, would have a remarkable impact on the way midwives implement care during labour. Transperineal progression of labour is supported by the ICM's philosophical principle of technologically appropriate and non-intervention of midwifery care. More importantly, compelling evidence indicates that transperineal progression of labour is preferred by the childbearer.

The midwife is the most appropriate care provider to render care during the normal physiological childbearing period, (WHO, 2018[b]:2) and the ICM (2014:1). In addition to being the only healthcare professional continuously present for intrapartum progression of labour in all birth settings, the midwife can effectively utilise the full spectrum of intrapartum U/S as described by ISUOG (2018). The use of intrapartum U/S should be in the hands of the most appropriate care provider during childbirth, where the highest access of care will ensure the greatest benefit for the childbearing family. As discussed in Section 2.3.1 the systemic disempowerment of midwives and midwifery most probably contributed to the global underutilisation of intrapartum U/S, to the detriment of all involved. The same systemic injustice spilled over into the South African healthcare system, from where midwives and woman were excluded from the benefit of intrapartum U/S as a non-intrusive modality.

Figure 5.1 depicts a synopsis of the research and the findings.

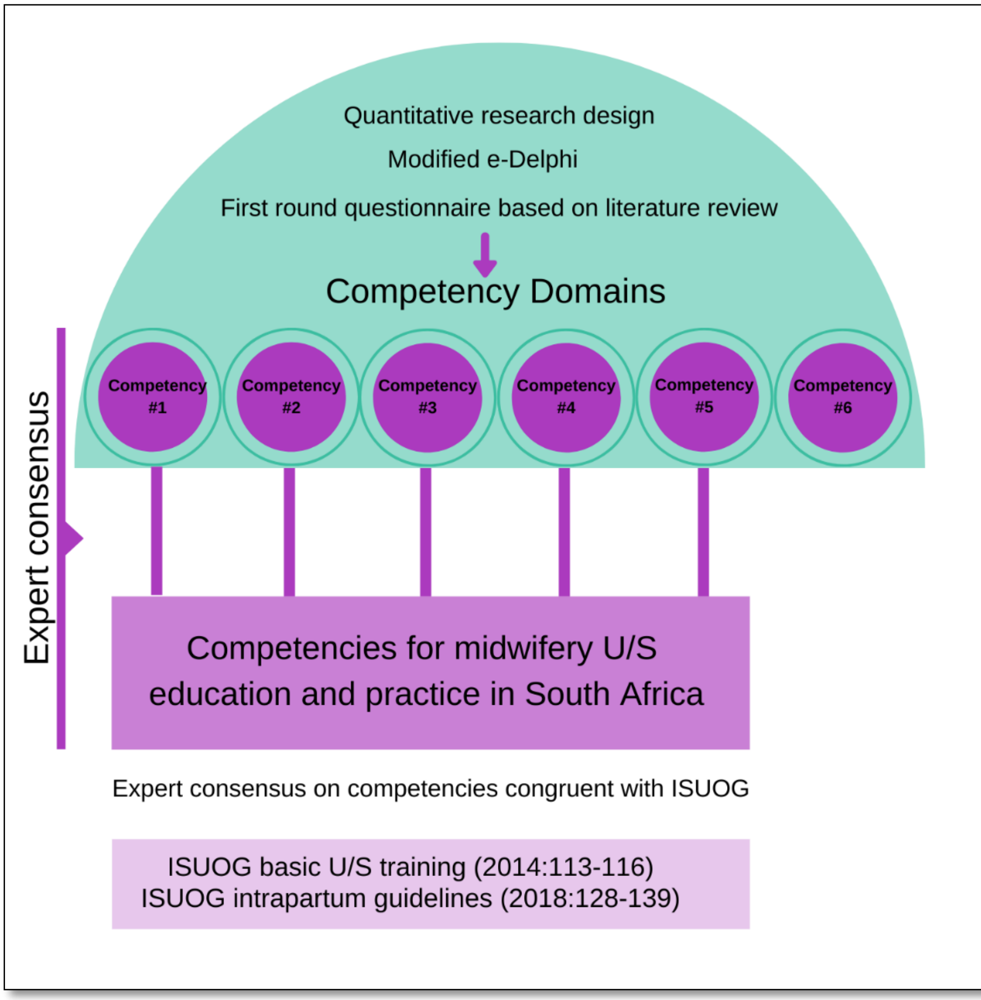


Figure 5.1 Synoptic representation of the research and findings.

Figure 5.1 represents an overview of the process that led to the discovery of the research findings. As discussed in Section 4.5, and indicated in a comprehensive comparison in Addendum H, the ISUOG basic U/S training recommendations and intrapartum U/S guidelines are comparable to the competencies for midwifery U/S education and practice in South Africa. The implication would be a midwifery U/S curriculum that is of international standard for a low-to-middle income country, such as South Africa.

5.3 Summary of contributions

This research established five competencies for midwifery U/S education and practice that can be instrumental in curricular development in South Africa. In addition, with minor additions to the elements contained in the five competency domains, the competencies for midwifery U/S education and practice are comparable to ISUOG's internationally recognised basic U/S and intrapartum U/S training programme. Therefore, it is possible for other low-to-middle income countries to adapt the South African midwifery U/S competencies in their healthcare context.

As the five midwifery U/S competencies are the first of its kind in South Africa, it could be adjusted into a quality-control instrument to measure the standard of midwifery U/S education and practice. The instrument could be used for self-evaluation or for determining of the proficiency level of competence.

Although it was not the aim of the study to determine the landscape in which midwives should practice U/S in South Africa, the additional questions on which the experts offered their opinion gave a sense of direction for further research. Expert opinion on the level of midwifery U/S education and practice is reported in the findings. This study's generation of new knowledge may serve the planning of curricular development and may contribute to further research on the subject. Another contribution of the research findings was the consideration of the potential increased workload for midwives.

Intrapartum midwifery U/S as a diagnostic tool, fits perfectly in intrapartum midwifery care. As U/S has only been introduced to selected midwives during the last two decades as an unregulated and unaccredited skills set, the majority of midwives might not be aware of the benefit of transperineal U/S during labour. This study was able to show the benefit of a known intrapartum U/S skills set, and highlight the additional measures that could benefit intrapartum care for women congruent with the ICM Philosophy and Model of Care (ICM, 2014:1-2).

5.4 Limitations

The questionnaire was developed on a four-level Likert scale with the third level descriptor as a *potential for inclusion*. Although the data analysis did not yield any evidence that the level descriptors influenced the consensus, the researcher questioned the likelihood of experts choosing the third descriptor if it had been described with a stronger negative connotation, for example, '*potential for exclusion'*.

A descriptive study using a Delphi technique could be considered by some critics as a reduced level of research (Grove & Gray, 2019:43; Hohmann *et al*., 2018:3281). Descriptive studies provide appropriate knowledge and serve as the basis for generating further research. Despite the criticism against the Delphi technique, the modified e-Delphi technique is a flexible and adaptable method (Hsu & Sandford, 2007:6) which served the research with the best possible outcome in a time where national lock-down and quarantine measures could have disrupted data collection. The iterative rounds as a key feature of the Delphi technique were arguably the main contributor to the depth of data that was collected regarding task shifting, level of U/S training and the workload distribution. Furthermore, in the South African context where no agreement was existed, the egalitarian solution was the use of an online meeting of experts, such as the modified e-Delphi.

The researcher identified a gap in the knowledge related to gynaecological U/S competence. However, the first round questionnaire was not comprehensive in capturing the essence of the gynaecological U/S. Due to the elements of gynaecological U/S competence that was not well defined, the question arose whether the opinion of the experts relating to the exclusion of gynaecological U/S would have been altered.

5.5 Future research pathways

The current research is one step on the road to the accreditation and regulation of midwifery U/S in South Africa. Apart from establishing the five competencies for midwifery U/S, several research pathways emerged from the study that may strengthen midwifery U/S education and practice.

Future research pathways are:

- Determine the landscape in which midwives should be able to practice U/S in South Africa.
- Determine the inclusion of postpartum and gynaecological U/S as part of midwifery U/S education and practice in South Africa.
- Describe the midwives' opinion regarding the inclusion of U/S as an addition to the midwifery care skills set.
- Compare the competence of midwifery U/S to that of traditional healthcare professionals in South Africa.

- Determine the integration of midwifery U/S in the workload of the different levels of care.
- Compare the findings of vaginal examination and intrapartum midwifery U/S during labour.
- Determine the barriers to intrapartum midwifery U/S in South Africa.
- Evaluate the implementation of intrapartum midwifery U/S in South Africa.
- Determine the impact of intrapartum midwifery U/S on referral, identification of obstetrical emergencies and the perinatal mortality rate.
- Determine the childbearer's and midwife's experience of intrapartum U/S.
- Evaluate the diagnostic accuracy of midwives U/S fetal morphology evaluation.
- Develop an accredited midwifery U/S curriculum and programme.
- Critique the contribution of midwifery U/S competence to maternal and child health in South Africa

Intrapartum midwifery care is the personal driving force and passion of the researcher. Ensuring a positive childbirth experience while rendering individualised, sensitive and culturally congruent care has been a lifelong passion and learning curve for the researcher. Therefore, midwifery intrapartum U/S as an addition to midwifery U/S competence is a personal calling for further research.

5.6 Suggestions for dissemination of research findings

The research findings will be shared with SANC as the regulatory body for midwifery and a stakeholder in midwifery education in South Africa. As midwifery U/S was identified as a mandate within the strategic objectives of SOMSA, with a working group allocated to it, the research findings will be shared with the professional association.

The NCCEMD, as a ministerial committee, advises the Minister of Health on issues related to maternal health. Therefore, in the interest of effecting change to the regulation of midwifery U/S in South Africa, the researcher will direct feedback via the National Department of Health and SOMSA to the NCCEMD.

The research findings will be presented at conferences and congresses such as the Perinatal Priorities, SOMSA, ICM, and the Sensitive Midwifery Symposium. In addition, the researcher, in association with the supervisors of this research has planned various articles for possible publication. In addition to publications, the researcher has planned to embark on further research to support midwifery U/S education and practice in South Africa.

5.7 Critique

As an adult midwifery scholar, the researcher has embraced lifelong learning. The journey of completing this research empowered the researcher in her personal and professional development which started as a novice and has evolved to a multilevel classification of competence. At the beginning of the process, experienced researchers attempted to motivate the researcher by indicating that the aim of a Magister degree is not to change the world, but merely to demonstrate the ability to perform research. On a personal level, it was a passion for midwifery and belief in the change that the findings may hold that led to the completion of the study. Indeed, we need to change the world of midwifery in the changing world, to the benefit of the childbearing family.

During the evolving personal and professional development throughout the journey, the researcher became more aware of the impact of the systemic disempowerment of women and midwives. This was most eminent in the underutilisation of midwifery U/S, more specifically intrapartum U/S. Retrospective reflection illuminated the confounding importance of advocacy for the ICM's core elements of midwifery care to the benefit of the childbearing family. Hence, the inclusion of an opportunity for experts to give their opinion on the barriers brought by the systemic disempowerment, would have provided insight to enhance utilisation of midwifery U/S in South Africa.

The researcher started the journey with the notion of employing the help of a biostatistician for data management and analysis. However, working side by side with an independent statistical expert instead of the biostatistician abled the researcher to engage with the data with greater awareness and a deeper understanding of the descriptive statistics applied to this study. If allowed the opportunity to continue with research, the same route for data analysis would be preferable. Although sometimes a daunting task, the process was an enriching experience.

5.8 Conclusion

This study yielded a comprehensive set of five midwifery U/S competencies – a first for South Africa. The competencies could be used as the foundation for curricular development or as a catalyst for further research and implementation on the topic. The WHO (2018[b]:2) urges stakeholders to plan for the introduction of the U/S during antenatal care. Policymakers should provide a conducive environment for the exploration of U/S to ensure universal access for the benefit of reducing maternal and child morbidity and mortality (Luntsi *et al.* 2020:5).

As a passionate midwifery scholar, the researcher, through this research journey arrived at an absolute credence that childbearing families are disadvantaged by the exclusion of midwifery U/S from maternal health care. This reality is even more atrocious in the changing world we live in. With the 4IR, the world of midwifery care could be revolutionised for the childbearing family. By using a diagnostic tool such as U/S we as midwives can contribute to non-intrusive midwifery care and thereby respect the confounds of the profession and women. Ultimately, U/S belongs to the women.

The findings of this research have surpassed any possible expectations that the researcher could have foreseen. The journey of completing this study has taken the researcher on long winding roads, high peaks of expectation and dark places of despair. One clear and consistent truth remained:

The LORD is my shepherd; He supplied all my needs. When my mind and body could not carry me any further, He made me rest in pastures green, to walk beside still waters. Today I can rejoice for He has restored my soul. The paths on which I walked and the steps I plan to take is only in His name's sake. I am not afraid; my Father comforts me. Even in the presence of enemies, He has kept not only me, but also my loved ones safe. He anointed my head with oil and has filled my cup with measures I cannot contain. My Father's ways are kind and true. His goodness and mercy follow me, always. My prayer is to dwell in the house of my Father, forevermore. –

Adapted from Psalm 23

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List of Addendums

Health Sciences Research Ethics Committee

20-Mar-2020

Dear **Mrs Charne Human**

Ethics Clearance: **COMPETENCIES FOR MIDWIFERY ULTRASOUND EDUCATION AND PRACTICE IN SOUTH AFRICA**

Principal Investigator: **Mrs Charne Human**

Department: **School of Nursing Department (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is:**UFS-HSD2020/0022/2104**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Faculty of Health Sciences C.E. Human

School of Nursing

Mark as shown: ☐ ☒ ☐ ☐ ☐ Please use a ball-point pen or a thin felt tip. This form will be processed automatically.

Correction: ☐ ■ ☐ ☒ ☐ Please follow the examples shown on the left hand side to help optimize the reading results.

1. INFORMED CONSENT

Title of research project: Competencies for midwifery ultrasound education and practice in South Africa.

Principal investigator: Charne E. Human
Reference number: 1999228818
Address: University of the Free State, School of Nursing, Bloemfontein, 9301.
Contact number: 0728262002

You are invited to take part in a research project. Please take time to read the information which will explain the details of this project. Please feel free to ask if you do not fully understand. Your participation is completely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way. You are also free to withdraw from the study at any point, even if you do agree to take part. This study has been approved by the Health Sciences Research Ethics Committee at the University of the Free State as well as The School of Nursing, Health Science Faculty, University of the Free State and will be conducted according to the set ethical guidelines and principles.

What is this research study all about
The study will be conducted as a Delphi questionnaire and the total number of participants will be determined by the total number of experts to partake in the study. The study aims to reach consensus, by means of expert opinion, about the recommended midwifery ultrasound competencies in South Africa. The questionnaires are based on the International Confederation of Midwives (ICM) philosophy and model of care and the midwifery scope of practice. Participants will be expected to complete three iterative rounds of questionnaires on which they will give their expert opinion about concepts related midwifery ultrasound. Participants will receive a link to the questionnaires to be completed with an online survey programme, Evasys®. The first round of questions are based on a literature search with open ended questions after each statement. The questionnaires in the following two rounds are based on the answers of the experts in round one. Participants has two weeks to complete each round of the questionnaires. Feedback to participants about the data collected in each round will be given within four weeks after the end of the previous round. No preparation is needed to participate.

Why have you been invited to participate? ·
The researcher wish to include experts that comply to the following inclusion criteria:
1) The participant has clinical experience in the field of midwifery/ obstetrical and gynaecological ultrasound.
2) The participant is an executive member or has a management role in a committee or organisation related to:

- midwifery and/or obstetrical and gynaecological ultrasound
- maternal and neonatal health care
- regulatory body/institution related to the field of study.

What will your responsibilities be?
You will be expected to complete the three rounds of questionnaires and provide your opinion.

Will you benefit from taking part in this research:
There are no tangible benefits to participating in this study. The valuable information gathered from your participation will be utilized to form a position statements for midwifery ultrasound based on expert opinion and describe competencies for midwifery ultrasound. Your participation gives you the opportunity to collaborate with peers in order to form a collective opinion on subject matter in which your are perceived as the expert. You will form part of an egalitarian group that stimulates new ideas and perspectives. Contributing your expertise may lead to the development of a standard of practice within the field of Health Sciences. There is no monetary funding offered for participants

Are there in risks involved in your taking part in this research?
The research study does not pertain any risks. Should you experience uneasiness at any stage, feel free to discuss it with the researcher.

If you do not agree to take part, what alternatives do you have?
The study is completely voluntary. Should you wish to not take part or withdraw, it will not influence you in any way.

1. INFORMED CONSENT [Continue]

Who will have access to your information?

- All information obtained during this study will be treated as confidential and protected by being stored on a password-protected computer.
- Participants are not known to each other.
- If data is used in a publication or thesis, the identity of the participant will remain anonymous.

What will happen in the unlikely event of some form of injury occurring as a direct result of your taking part in this research study?

- There are no known risks involved in this study.

Will you be paid to take part in this study and are there any costs involved?

- No, you will not be paid to take part in the study as there will be no costs involved for you.

Is there anything else that you should know or do?

You can contact the study supervisor Dr. C. Spies at (051) 401 9721 if you have any concerns or complaints that have not been addressed by the researcher. You may contact the Secretariat of the Health Sciences Research Ethics Committee, UFS at (051) 4017794/5 if you have questions about your rights as a research subject. Participation and completion of the Delphi questionnaire implies consent.

For additional information you may follow the links below:

ICM Definition of the midwife

Essential competencies for basic midwifery practice

Philosophy and model of midwifery care

2. Competency ONE :
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography.

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
2.1	physics of ultrasound related to instrumentation	☐	☐	☐	☐
2.2	basic maintenance of ultrasound instrumentation	☐	☐	☐	☐
2.3	ultrasound safety	☐	☐	☐	☐
2.4	infection control	☐	☐	☐	☐
2.5	the principles of knobology	☐	☐	☐	☐
2.6	writing a complete ultrasound report	☐	☐	☐	☐
2.7	anatomy and physiology of the internal organs of the reproductive female system related to the productive age	☐	☐	☐	☐
	A midwife has the skill and professional behavior to:				
2.8	apply physics of ultrasound and related instrumentation	☐	☐	☐	☐
2.9	apply basic maintenance of ultrasound machinery	☐	☐	☐	☐
2.10	apply the principles of knobology	☐	☐	☐	☐
2.11	write a complete ultrasound report	☐	☐	☐	☐

2. Competency ONE : Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography. [Continue]

		Yes	No
2.12	In your opinion, would you say that the components above are sufficient to capture the foundational knowledge, skills and professional behavior of midwifery ultrasound?	☐	☐

2.13 If your answer is **NO in question 2.12**, please recommend additional components.

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3. Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.

Statement 2: A midwife has the foundational knowledge, skills and professional behavior to perform an early and first trimester midwifery pregnancy ultrasound and evaluate findings

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
3.1	normal sonographic morphology for 5 to 10 weeks gestation	☐	☐	☐	☐
3.2	normal sonographic morphology for 11 to 14 gestation	☐	☐	☐	☐
3.3	indications for an early and first-trimester ultrasound	☐	☐	☐	☐
3.4	criteria for a transabdominal early and first trimester ultrasound	☐	☐	☐	☐
3.5	criteria for a transvaginal early and first trimester ultrasound	☐	☐	☐	☐
3.6	normal and early embryonic development: singletons and twins	☐	☐	☐	☐
3.7	ultrasound evaluation of ampullary tubal ectopic and non-tubal ectopic	☐	☐	☐	☐
3.8	components of sonographic dating in trimester	☐	☐	☐	☐
3.9	subchorionic hematoma	☐	☐	☐	☐
3.10	criteria for definitive diagnosis and referral of embryonic/ foetal death in first trimester	☐	☐	☐	☐
3.11	sonographic features of molar pregnancy	☐	☐	☐	☐
3.12	ultrasound findings in the case of threatened abortion - fluid and funneling	☐	☐	☐	☐
3.13	association between thickened nuchal transparency and foetal chromosomal anomalies	☐	☐	☐	☐
3.14	selective foetal growth restriction	☐	☐	☐	☐
3.15	single intrauterine demise	☐	☐	☐	☐
	A midwife has skills and professional behavior to:				
	Recognise the sonographic presentation of normal embryonic and foetal development with regard to:				
3.16	embryonic and foetal biometry	☐	☐	☐	☐
3.17	single and multiple pregnancy	☐	☐	☐	☐
3.18	gestational sac	☐	☐	☐	☐
3.19	yolk sac	☐	☐	☐	☐
3.20	amnion	☐	☐	☐	☐
3.21	chrionicity	☐	☐	☐	☐

3. **Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.** [Continue]

3.22 evaluate embryo/fetus cardiac activity and documenting	☐	☐	☐	☐
3.23 determine the indication for an early or first trimester ultrasound	☐	☐	☐	☐
3.24 distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound	☐	☐	☐	☐
3.25 distinguish between normal and pathological ultrasound images for a transvaginal early pregnancy midwifery ultrasound	☐	☐	☐	☐
3.26 distinguish between normal pathological ultrasound images for a transabdominal first trimester midwifery ultrasound	☐	☐	☐	☐
3.27 distinguish between normal pathological ultrasound images for a transvaginal first trimester ultrasound	☐	☐	☐	☐
3.28 use the principles of fetometry to estimate embryo/foetal age in the first trimester by means of transabdominal ultrasound fetometry	☐	☐	☐	☐
3.29 use the principles of fetometry to estimate embryo / foetal age in the first trimester by means of transvaginal ultrasound fetometry	☐	☐	☐	☐
3.30 refer persons with a high risk profile or abnormal findings to an appropriate healthcare professional	☐	☐	☐	☐

3.31 In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of early and trimester midwifery ultrasound?

Yes ☐ ☐ No

3.32 If your answer is NO in question 3.31, please recommend additional components.

4. Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.

Statement 3: A midwife has the foundational knowledge, skills, and professional behavior to perform a second and third trimester midwifery ultrasound

A midwife has foundational knowledge about:

Basic foetal anatomy in the second and the third trimester with specific reference to normal ultrasound morphology of:

		Essential	Useful	Potential for inclusion	Not needed
4.1	the heart	☐	☐	☐	☐
4.2	normal sonographic morphology	☐	☐	☐	☐
4.3	face, neck, and thorax	☐	☐	☐	☐
4.4	abdomen	☐	☐	☐	☐
4.5	skeleton	☐	☐	☐	☐
4.6	components of foetal biometry in sonographic dating in second and third trimesters	☐	☐	☐	☐
4.7	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	☐	☐	☐	☐
4.8	identification of preterm birth with specific reference to cervical assessment.	☐	☐	☐	☐
4.9	identification of preterm birth with specific reference to predisposing factors for foetal macrosomia and foetal growth restriction in third trimester	☐	☐	☐	☐
4.10	identification of preterm birth with specific reference to risks and indications for genetic amniocentesis	☐	☐	☐	☐
4.11	presentation, position and attitude of the foetus in the third trimester	☐	☐	☐	☐
4.12	biophysical profile of the fetus	☐	☐	☐	☐
4.13	indications for the referral to healthcare professionals	☐	☐	☐	☐
4.14	fetal well-being assessment with Doppler studies	☐	☐	☐	☐
4.15	spectral Doppler	☐	☐	☐	☐
4.16	pulsatility Index (PI)	☐	☐	☐	☐
4.17	colour Doppler	☐	☐	☐	☐
4.18	doppler recordings of velocity tracing in maternal arteries feeding the uterus as well as tracings of the arterial of the venous vessels in the umbilical cord	☐	☐	☐	☐
4.19	basic concepts related to foetal anomaly screening	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
4.20	measure the basic structures to estimate the age of the fetus	☐	☐	☐	☐
4.21	measure basic foetal morphology in the second and third trimester for the purpose of establishing normal foetal growth	☐	☐	☐	☐
4.22	review the basic fetal anatomy in the second and third trimester	☐	☐	☐	☐
4.23	examine the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	☐	☐	☐	☐
4.24	perform a pulsed and color Doppler ultrasound and evaluate the findings	☐	☐	☐	☐
4.25	recognise the range of compromised pregnancies and undertake the necessary observations using ultrasound techniques	☐	☐	☐	☐
4.26	perform a biophysical profile and evaluate the findings	☐	☐	☐	☐
4.27	appreciate the ethical issues associated with prenatal diagnostic procedures	☐	☐	☐	☐

4. Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound. [Continue]

4.28 referral of a person with a high risk profile or of abnormal findings to an appropriate healthcare professional ☐ ☐ ☐ ☐

	Yes	No
4.29 In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of second and third trimester midwifery ultrasound?	☐	☐

4.30 If your answer is NO in question 4.29, please indicate the recommended additional components.

5. Competency FOUR: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an intrapartum ultrasound.

Statement 4: A midwife has the foundational knowledge, skills and professional behavior to perform an intrapartum ultrasound.

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has founational knowledge about:				
5.1	the presentation, lie, position and attitude of the fetus during labour	☐	☐	☐	☐
5.2	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour	☐	☐	☐	☐
5.3	normal measurements of the anatomical structures of the foetal skull during labour	☐	☐	☐	☐
5.4	normal measurements of the anatomy of the infrapubic plane	☐	☐	☐	☐
	A midwife has the skill and behavior to:				
5.5	examine the position of placenta umbilical cord and amniotic fluid	☐	☐	☐	☐
5.6	review the presentation, lie, position and attitude of the fetus	☐	☐	☐	☐
5.7	perform a transvaginal (transperineal or translabial ultrasound to determine labour progress)	☐	☐	☐	☐

		Yes	No
5.8	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills, and professional behavior of** an intrapartum midwifery ultrasound?	☐	☐

5.9 If your answer is **NO in question 5.8**, please recommend additional components .

6. Competency FIVE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a postpartum midwifery ultrasound.

Statement 5: A midwife has the foundational knowledge, skills and professional behavior to perform a postpartum ultrasound

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
6.1	normal involution of the reproductive organs after childbirth	☐	☐	☐	☐
6.2	normal and potential pathological ultrasound appearance of uterus and adnexae, vaginal canal, perineal floor and anal sphincter	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
6.3	review the normal of the reproductive organs after childbirth	☐	☐	☐	☐
	Review the normal anatomy of the following:				
6.4	uterus and adnexae	☐	☐	☐	☐
6.5	vaginal canal	☐	☐	☐	☐
6.6	perineal floor muscles	☐	☐	☐	☐
6.7	intactness of anal sphincter	☐	☐	☐	☐
6.8	refer a person with a high risk profile or abnormal findings to a medial healthcare provider	☐	☐	☐	☐

		Yes	No
6.9	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of a postpartum midwifery ultrasound?	☐	☐

6.10 If your answer is **NO in question 6.9,** please recommend additional components.

7. Competency SIX: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound

Statement 6: A midwife has the foundational knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound

		Essential	Useful	Potential	Not need
	A midwife has foundational knowledge about:				
7.1	the normal structures of the uterus, ovaries and adnexa for normal non-pregnant findings	☐	☐	☐	☐
7.2	the normal structures of the pelvic floor	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
7.3	visualize the normal structure of the uterus, ovaries and adnexa with transabdominal ultrasound	☐	☐	☐	☐
7.4	visualize the normal structures of the basic pelvic floor structures with transabdominal ultrasound	☐	☐	☐	☐
7.5	examine the uterus, ovaries and adnexa for normal non-pregnant findings during the reproductive age	☐	☐	☐	☐
7.6	examine the basic pelvic floor structures for normal findings during the reproductive age	☐	☐	☐	☐
7.7	refer a person with high risk profile or abnormal findings to an appropriate healthcare professional	☐	☐	☐	☐

		Yes	No
7.8	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of a gynaecological midwifery ultrasound?	☐	☐

7.9 If your answer is **NO in question 7.8**, please recommend additional components.

7. Competency SIX: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound [Continue]

Additional questions

8. Additional questions:

The following question is related to the context of midwifery ultrasound in South Africa

8.1 In your opinion, should the basic midwife or the midwife specialist be competent in midwifery ultrasound? Please motivate your answer.

A Level I ultrasound training curriculum for sonographers and other allied health professionals is to ensure that users of diagnostic ultrasound have sufficient training to provide high-quality health care. Training in the curriculum should result in an appropriate level of technical and clinical knowledge.

In level I settings, the use of ultrasound for diagnostic purposes performed by a general physician are likely to be using a general-purpose ultrasound scanner. These physicians will be expected to perform safely and accurately a variety of examinations of all parts of the body. The curriculum for training physicians must, therefore, include instruction in the performance and interpretation of diagnostic ultrasound examinations, and related areas of physics and instrumentation.

Sonographers and other allied health professionals will need additional training to be able to use diagnostic ultrasound in specialized clinical areas requiring real-time, Doppler, duplex, and colour Doppler techniques. Such applications include cardiac, ophthalmic, and vascular ultrasonography.

Level II and III advanced ultrasonography curriculum is to ensure a level of training sufficient to perform high-quality ultrasound examinations, using, when necessary, the more sophisticated ultrasound equipment available at levels I and II (which may correspond to the secondary and tertiary levels of health care in some countries). The person successfully completing the curriculum should be able to perform all routine ultrasound examinations and also receive referred patients.

8.2 In your opinion, should midwifery ultrasound be classified according to level one, two or three obstetric and gynaecological ultrasound? Please motivate your answer.

EvaSys	Competencies for midwifery ultrasound education and practice in South Africa Second Round	Electric Paper

Faculty of Health Sciences C.E. Human

School of Nursing

Mark as shown: ☐ ☒ ☐ ☐ ☐ Please use a ball-point pen or a thin felt tip. This form will be processed automatically.

Correction: ☐ ■ ☐ ☒ ☐ Please follow the examples shown on the left hand side to help optimize the reading results.

1. INFORMED CONSENT

Title of research project: Competencies for midwifery ultrasound education and practice in South Africa.

Principal investigator: Charne E. Human
Reference number: 1999228818
Address: University of the Free State, School of Nursing, Bloemfontein, 9301.
Contact number: 0728262002

Thank you for taking part in the second round of the research project. Please take time to read the information which will explain the details of this project. Please feel free to ask if you do not fully understand. Your participation is completely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way. You are also free to withdraw from the study at any point, even if you do agree to take part. This study has been approved by the Health Sciences Research Ethics Committee at the University of the Free State as well as The School of Nursing, Health Science Faculty, University of the Free State and will be conducted according to the set ethical guidelines and principles.

What is this research study all about
The study will be conducted as a Delphi questionnaire and the total number of participants will be determined by the total number of experts to partake in the study. The study aims to reach consensus, by means of expert opinion, about the recommended midwifery ultrasound competencies in South Africa. The questionnaires are based on the International Confederation of Midwives (ICM) philosophy and model of care and the midwifery scope of practice. Participants will be expected to complete three iterative rounds of questionnaires on which they will give their expert opinion about concepts related midwifery ultrasound. Participants will receive a link to the questionnaires to be completed with an online survey programme, Evasys®. The first round of questions are based on a literature search with open ended questions after each statement. The questionnaires in the following two rounds are based on the answers of the experts in round one. Participants has two weeks to complete each round of the questionnaires. Feedback to participants about the data collected in each round will be given within four weeks after the end of the previous round. No preparation is needed to participate.

Why have you been invited to participate? ·
The researcher wish to include experts that comply to the following inclusion criteria:
1) The participant has clinical experience in the field of midwifery/ obstetrical and gynaecological ultrasound.
2) The participant is an executive member or has a management role in a committee or organisation related to:

- midwifery and/or obstetrical and gynaecological ultrasound
- maternal and neonatal health care
- regulatory body/institution related to the field of study.

What will your responsibilities be?
You will be expected to complete the three rounds of questionnaires and provide your opinion.

Will you benefit from taking part in this research:
There are no tangible benefits to participating in this study. The valuable information gathered from your participation will be utilized to form a position statements for midwifery ultrasound based on expert opinion and describe competencies for midwifery ultrasound. Your participation gives you the opportunity to collaborate with peers in order to form a collective opinion on subject matter in which your are perceived as the expert. You will form part of an egalitarian group that stimulates new ideas and perspectives. Contributing your expertise may lead to the development of a standard of practice within the field of Health Sciences. There is no monetary funding offered for participants

Are there in risks involved in your taking part in this research?
The research study does not pertain any risks. Should you experience uneasiness at any stage, feel free to discuss it with the researcher.

If you do not agree to take part, what alternatives do you have?
The study is completely voluntary. Should you wish to not take part or withdraw, it will not influence you in any way.

1. INFORMED CONSENT [Continue]

Who will have access to your information?
- All information obtained during this study will be treated as confidential and protected by being stored on a password-protected computer.
- Participants are not known to each other.
- If data is used in a publication or thesis, the identity of the participant will remain anonymous.

What will happen in the unlikely event of some form of injury occurring as a direct result of your taking part in this research study?
- There are no known risks involved in this study.

Will you be paid to take part in this study and are there any costs involved?
- No, you will not be paid to take part in the study as there will be no costs involved for you.

Is there anything else that you should know or do?
You can contact the study supervisor Dr. C. Spies at (051) 401 9721 if you have any concerns or complaints that have not been addressed by the researcher. You may contact the Secretariat of the Health Sciences Research Ethics Committee, UFS at (051) 4017794/5 if you have questions about your rights as a research subject. Participation and completion of the Delphi questionnaire implies consent.

For additional information you may follow the links below:

ICM Definition of the midwife

Essential competencies for basic midwifery practice

Philosophy and model of midwifery care

2. **Competency ONE :**
Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography.

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
2.1	physics of ultrasound related to instrumentation	☐	☐	☐	☐
2.2	basic maintenance of ultrasound instrumentation	☐	☐	☐	☐
2.3	writing a complete ultrasound report	☐	☐	☐	☐
2.4	anatomy and physiology of embryology, fetal anatomy and physiology and the internal organs of the reproductive female system related to the reproductive age.	☐	☐	☐	☐
	A midwife has the skill and professional behavior to:				
2.5	apply physics of ultrasound and related instrumentation	☐	☐	☐	☐
2.6	apply basic maintenance of ultrasound machinery	☐	☐	☐	☐
2.7	apply the principles of knobology	☐	☐	☐	☐
2.8	write a complete ultrasound report	☐	☐	☐	☐

2. Competency ONE : Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography. [Continue]

		Yes	No
2.9	In your opinion, would you say that the components above are sufficient to capture the foundational knowledge, skills and professional behavior of midwifery ultrasound?	☐	☐

2.10 If your answer is **NO in question 2.9**, please recommend additional components or comments.

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3. Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.

		Essential	Useful	Potential for inclusion	Not needed
	Statement 2: A midwife has the foundational knowledge, skills and professional behavior to perform an early and first trimester midwifery pregnancy ultrasound and evaluate findings				
	A midwife has foundational knowledge about:				
3.1	normal sonographic morphology for 5 to 10 weeks gestation	☐	☐	☐	☐
3.2	normal sonographic morphology for 11 to 14 gestation	☐	☐	☐	☐
3.3	criteria for a transvaginal early and first trimester ultrasound	☐	☐	☐	☐
3.4	ultrasound evaluation of ampullary tubal ectopic and non-tubal ectopic	☐	☐	☐	☐
3.5	subchorionic hematoma	☐	☐	☐	☐
3.6	criteria for definitive diagnosis and referral of embryonic/ foetal death in first trimester	☐	☐	☐	☐
3.7	sonographic features of molar pregnancy	☐	☐	☐	☐
3.8	ultrasound findings in the case of threatened abortion - fluid and funneling	☐	☐	☐	☐
3.9	association between thickened nuchal transparency and foetal chromosomal anomalies	☐	☐	☐	☐
3.10	selective foetal growth restriction	☐	☐	☐	☐
	A midwife has skills and professional behavior to:				
	Recognise the sonographic presentation of normal embryonic and foetal development with regard to:				
3.11	embryonic and foetal biometry	☐	☐	☐	☐
3.12	single and multiple pregnancy	☐	☐	☐	☐
3.13	gestational sac	☐	☐	☐	☐
3.14	yolk sac	☐	☐	☐	☐
3.15	amnion	☐	☐	☐	☐
3.16	chrionicity	☐	☐	☐	☐
3.17	distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound	☐	☐	☐	☐
3.18	distinguish between normal and pathological ultrasound images for a transvaginal early pregnancy midwifery ultrasound	☐	☐	☐	☐

3. Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound. [Continue]

3.19 distinguish between normal pathological ultrasound images for a transabdominal first trimester midwifery ultrasound	☐	☐	☐	☐
3.20 distinguish between normal pathological ultrasound images for a transvaginal first trimester ultrasound	☐	☐	☐	☐
3.21 use the principles of fetometry to estimate embryo/foetal age in the first trimester by means of transabdominal ultrasound fetometry	☐	☐	☐	☐
3.22 use the principles of fetometry to estimate embryo / foetal age in the first trimester by means of transvaginal ultrasound fetometry	☐	☐	☐	☐

3.23 In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of early and trimester midwifery ultrasound?

Yes ☐ ☐ No

3.24 If your answer is NO in question 3.23, please recommend additional components or comments.

4. Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.

Statement 3: A midwife has the foundational knowledge, skills, and professional behavior to perform a second and third trimester midwifery ultrasound

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
	Basic foetal anatomy in the second and the third trimester with specific reference to normal ultrasound morphology of:				
4.1	the heart	☐	☐	☐	☐
4.2	normal sonographic morphology	☐	☐	☐	☐
4.3	face, neck, and thorax	☐	☐	☐	☐
4.4	abdomen	☐	☐	☐	☐
4.5	skeleton	☐	☐	☐	☐
4.6	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	☐	☐	☐	☐
4.7	identification of preterm birth with specific reference to cervical assessment.	☐	☐	☐	☐
4.8	identification of preterm birth with specific reference to predisposing factors for foetal macrosomia and foetal growth restriction in third trimester	☐	☐	☐	☐
4.9	identification of preterm birth with specific reference to risks and indications for genetic amniocentesis	☐	☐	☐	☐
4.10	biophysical profile of the fetus	☐	☐	☐	☐
4.11	fetal well-being assessment with Doppler studies	☐	☐	☐	☐
4.12	spectral Doppler	☐	☐	☐	☐
4.13	pulsatility Index (PI)	☐	☐	☐	☐
4.14	colour Doppler	☐	☐	☐	☐
4.15	doppler recordings of velocity tracing in maternal arteries feeding the uterus as well as tracings of the arterial of the venous vessels in the umbilical cord	☐	☐	☐	☐
4.16	basic concepts related to foetal anomaly screening	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
4.17	review the basic fetal anatomy in the second and third trimester	☐	☐	☐	☐
4.18	examine the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	☐	☐	☐	☐
4.19	perform a pulsed and color Doppler ultrasound and evaluate the findings	☐	☐	☐	☐
4.20	recognise the range of compromised pregnancies and undertake the necessary observations using ultrasound techniques	☐	☐	☐	☐
4.21	perform a biophysical profile and evaluate the findings	☐	☐	☐	☐
4.22	appreciate the ethical issues associated with prenatal diagnostic procedures	☐	☐	☐	☐

		Yes	No
4.23	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of second and third trimester midwifery ultrasound?	☐	☐

4. Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound. [Continue]

4.24 If your answer is NO in question 4.23, please indicate the recommended additional components or comments.

5. Competency FOUR: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an intrapartum ultrasound.

Statement 4: A midwife has the foundational knowledge, skills and professional behavior to perform an intrapartum ultrasound.

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has founational knowledge about:				
5.1	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour	☐	☐	☐	☐
5.2	normal measurements of the anatomy of the infrapubic plane	☐	☐	☐	☐
	A midwife has the skill and behavior to:				
5.3	examine the position of placenta umbilical cord and amniotic fluid	☐	☐	☐	☐
5.4	review the presentation, lie, position and attitude of the fetus	☐	☐	☐	☐
5.5	perform a transvaginal (transperineal or translabial ultrasound to determine labour progress)	☐	☐	☐	☐

		Yes	No
5.6	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills, and professional behavior of** an intrapartum midwifery ultrasound?	☐	☐

5.7 If your answer is **NO in question 5.6**, please recommend additional components or comments.

6. Competency FIVE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a postpartum midwifery ultrasound.

Statement 5: A midwife has the foundational knowledge, skills and professional behavior to perform a postpartum ultrasound

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
6.1	normal involution of the reproductive organs after childbirth	☐	☐	☐	☐
6.2	normal and potential pathological ultrasound appearance of uterus and adnexae, vaginal canal, perineal floor and anal sphincter	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
6.3	review the normal of the reproductive organs after childbirth	☐	☐	☐	☐
	Review the normal anatomy of the following:				
6.4	uterus and adnexae	☐	☐	☐	☐
6.5	vaginal canal	☐	☐	☐	☐
6.6	perineal floor muscles	☐	☐	☐	☐
6.7	intactness of anal sphincter	☐	☐	☐	☐
6.8	refer a person with a high risk profile or abnormal findings to a medial healthcare provider	☐	☐	☐	☐

		Yes	No
6.9	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of a postpartum midwifery ultrasound?	☐	☐

6.10 If your answer is **NO in question 6.9,** please recommend additional components or comments.

7. Competency SIX: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound

Statement 6: A midwife has the foundational knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound

		Essential	Useful	Potential	Not need
	A midwife has foundational knowledge about:				
7.1	the normal structures of the uterus, ovaries and adnexa for normal non-pregnant findings	☐	☐	☐	☐
7.2	the normal structures of the pelvic floor	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
7.3	visualize the normal structure of the uterus, ovaries and adnexa with transabdominal ultrasound	☐	☐	☐	☐
7.4	visualize the normal structures of the basic pelvic floor structures with transabdominal ultrasound	☐	☐	☐	☐
7.5	examine the uterus, ovaries and adnexa for normal non-pregnant findings during the reproductive age	☐	☐	☐	☐
7.6	examine the basic pelvic floor structures for normal findings during the reproductive age	☐	☐	☐	☐
7.7	refer a person with high risk profile or abnormal findings to an appropriate healthcare professional	☐	☐	☐	☐

		Yes	No
7.8	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of a gynaecological midwifery ultrasound?	☐	☐

7.9 If your answer is **NO in question 7.8**, please recommend additional components or comments.

8. Task shifting of midwifery ultrasound to the basic or specialist midwife.

The following motivations for basic or specialist midwives to perform ultrasound, based on the experts opinion in round one, are given. Indicate if you agree that the following statement:

8.1	The basic midwife's scope is wide enough (she has enough on her plate) and should primarily manage patients clinically.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.2	The basic midwife working at primary health care level, especially rural areas, is sometimes the only person who performs an ultrasound due to the shortage of appropriately qualified healthcare professions and should be able to do a basic obstetric ultrasound.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.3	The basic midwife should have the basic competencies (level 1) and the specialist midwife should have more advanced skills.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.4	Midwives, irrespective of being a basic or specialist midwife, who has a keen interest in the field of ultrasound, should be allowed to prove themselves competent in midwifery ultrasound.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.5	Considering the shortages of sonographers and other appropriately qualified healthcare professionals, specialist midwives' roles should include midwifery ultrasound education and training as diagnostic ultrasound is a scarce skill in SA.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.6	The specialist midwife has the expertise to effectively integrate the use of midwifery ultrasound into practice.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.7	The specialist midwife should be allowed to add midwifery ultrasound as an additional skill set after their training as a specialist midwife.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.8	The current workload of a midwife (basic and/or specialist midwife) allows for midwifery ultrasound to be added as an additional competency.	Strongly agree ☐	☐	☐	☐	Strongly disagree

8.9 In your opinion, if midwifery ultrasound should be added to the competency list of a midwife (basic and/or specialist midwife), how would you propose the additional workload be absorbed in practice?

9. Level of midwifery ultrasound education and training (Level I, II, III)

The following motivations for the level of midwifery ultrasound practice, based on the experts opinion in round one, are given. Indicate if you agree that the following statement:

9.1	LEVEL 1, as this will ensure greater primary healthcare (PHC) access, primarily to basic sonographic services. Should the mother present with any high risk indicators or require further investigation through specialised evaluation, referral is needed.	Strongly agree ☐	☐	☐	☐	Strongly disagree
9.2	LEVEL 1, because ultrasound equipment is a scarce resource and level 2 and 3 needs advanced technology which is not available at PHC level.	Strongly agree ☐	☐	☐	☐	Strongly disagree
9.3	LEVEL 1 for a basic midwives and LEVEL 2 for a midwife specialist.	Strongly agree ☐	☐	☐	☐	Strongly disagree
9.4	LEVEL 1, with the ability to continue to level 2 or 3 for the midwife specialist working at secondary or tertiary	Strongly agree ☐	☐	☐	☐	Strongly disagree

End of Questionnaire

EvaSys	Competencies for midwifery ultrasound education and practice in South Africa Round Three	Electric Paper

Faculty of Health Sciences C.E. Human

School of Nursing

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1. INFORMED CONSENT

Title of research project: Competencies for midwifery ultrasound education and practice in South Africa.

Principal investigator: Charne E. Human
Reference number: 1999228818
Address: University of the Free State, School of Nursing, Bloemfontein, 9301.
Contact number: 0728262002

Thank you for taking part in the ***third and LAST*** round of the research project. Included is the information which will explain the details of this project, just for incase you haven't read it yet. Please feel free to ask if you do not fully understand. Your participation is completely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way. You are also free to withdraw from the study at any point, even if you do agree to take part. This study has been approved by the Health Sciences Research Ethics Committee at the University of the Free State as well as The School of Nursing, Health Science Faculty, University of the Free State and will be conducted according to the set ethical guidelines and principles.

What is this research study all about
The study will be conducted as a Delphi questionnaire and the total number of participants will be determined by the total number of experts to partake in the study. The study aims to reach consensus, by means of expert opinion, about the recommended midwifery ultrasound competencies in South Africa. The questionnaires are based on the International Confederation of Midwives (ICM) philosophy and model of care and the midwifery scope of practice. Participants will be expected to complete three iterative rounds of questionnaires on which they will give their expert opinion about concepts related midwifery ultrasound. Participants will receive a link to the questionnaires to be completed with an online survey programme, Evasys®. The first round of questions are based on a literature search with open ended questions after each statement. The questionnaires in the following two rounds are based on the answers of the experts in round one. Participants has two weeks to complete each round of the questionnaires. Feedback to participants about the data collected in each round will be given within four weeks after the end of the previous round. No preparation is needed to participate.

Why have you been invited to participate? ·
The researcher wish to include experts that comply to the following inclusion criteria:
1) The participant has clinical experience in the field of midwifery/ obstetrical and gynaecological ultrasound.
2) The participant is an executive member or has a management role in a committee or organisation related to:

- midwifery and/or obstetrical and gynaecological ultrasound
- maternal and neonatal health care
- regulatory body/institution related to the field of study.

What will your responsibilities be?
You will be expected to complete the three rounds of questionnaires and provide your opinion.

Will you benefit from taking part in this research:
There are no tangible benefits to participating in this study. The valuable information gathered from your participation will be utilized to form a position statements for midwifery ultrasound based on expert opinion and describe competencies for midwifery ultrasound. Your participation gives you the opportunity to collaborate with peers in order to form a collective opinion on subject matter in which your are perceived as the expert. You will form part of an egalitarian group that stimulates new ideas and perspectives. Contributing your expertise may lead to the development of a standard of practice within the field of Health Sciences. There is no monetary funding offered for participants

Are there in risks involved in your taking part in this research?
The research study does not pertain any risks. Should you experience uneasiness at any stage, feel free to discuss it with the researcher.

If you do not agree to take part, what alternatives do you have?
The study is completely voluntary. Should you wish to not take part or withdraw, it will not influence you in any way.

1. INFORMED CONSENT [Continue]

Who will have access to your information?

- All information obtained during this study will be treated as confidential and protected by being stored on a password-protected computer.
- Participants are not known to each other.
- If data is used in a publication or thesis, the identity of the participant will remain anonymous.

What will happen in the unlikely event of some form of injury occurring as a direct result of your taking part in this research study?

- There are no known risks involved in this study.

Will you be paid to take part in this study and are there any costs involved?

- No, you will not be paid to take part in the study as there will be no costs involved for you.

Is there anything else that you should know or do?

You can contact the study supervisor Dr. C. Spies at (051) 401 9721 if you have any concerns or complaints that have not been addressed by the researcher. You may contact the Secretariat of the Health Sciences Research Ethics Committee, UFS at (051) 4017794/5 if you have questions about your rights as a research subject. Participation and completion of the Delphi questionnaire implies consent.

For additional information you may follow the links below:

ICM Definition of the midwife

Essential competencies for basic midwifery practice

Philosophy and model of midwifery care

2. Competency ONE : Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography.

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
2.1	physics of ultrasound related to instrumentation	☐	☐	☐	☐
2.2	basic maintenance of ultrasound instrumentation	☐	☐	☐	☐
2.3	writing a complete ultrasound report	☐	☐	☐	☐
2.4	anatomy and physiology of embryology, fetal anatomy and physiology and the internal organs of the reproductive female system related to the reproductive age.	☐	☐	☐	☐
	A midwife has the skill and professional behavior to:				
2.5	apply physics of ultrasound and related instrumentation	☐	☐	☐	☐
2.6	apply basic maintenance of ultrasound machinery	☐	☐	☐	☐
2.7	apply appropriate midwifery ultrasound techniques and/or protocols for image formation.	☐	☐	☐	☐
2.8	identify the normal maternal and fetal anatomy, physiology and embryology.	☐	☐	☐	☐
2.9	write a complete ultrasound report	☐	☐	☐	☐

2. Competency ONE : Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography. [Continue]

		Yes	No
2.10	In your opinion, would you say that the components above are sufficient to capture the foundational knowledge, skills and professional behavior of midwifery ultrasound?	☐	☐

2.11 If your answer is **NO in question 2.10**, please recommend additional components or comments.

.

3. Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.

Statement 2: A midwife has the foundational knowledge, skills and professional behavior to perform an early and first trimester midwifery pregnancy ultrasound and evaluate findings

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
3.1	normal sonographic morphology for 5 to 10 weeks gestation	☐	☐	☐	☐
3.2	normal sonographic morphology for 11 to 14 gestation	☐	☐	☐	☐
3.3	criteria for a transvaginal early and first trimester ultrasound	☐	☐	☐	☐
3.4	ultrasound evaluation of ampullary tubal ectopic and non-tubal ectopic	☐	☐	☐	☐
3.5	subchorionic hematoma	☐	☐	☐	☐
3.6	sonographic features of molar pregnancy	☐	☐	☐	☐
3.7	ultrasound findings in the case of threatened abortion - fluid and funneling	☐	☐	☐	☐
3.8	association between thickened nuchal transparency and foetal chromosomal anomalies	☐	☐	☐	☐
3.9	selective foetal growth restriction	☐	☐	☐	☐
	A midwife has skills and professional behavior to:				
	Recognise the sonographic presentation of normal embryonic and foetal development with regard to:				
3.10	amnion	☐	☐	☐	☐
3.11	chrionicity	☐	☐	☐	☐
3.12	distinguish between normal and pathological ultrasound images for a transvaginal early pregnancy midwifery ultrasound	☐	☐	☐	☐
3.13	distinguish between normal pathological ultrasound images for a transvaginal first trimester ultrasound	☐	☐	☐	☐
3.14	use the principles of fetometry to estimate embryo / foetal age in the first trimester by means of transvaginal ultrasound fetometry	☐	☐	☐	☐
3.15	recognise adnexal masses and distinguish between physiological and pathological.	☐	☐	☐	☐

3. Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound. [Continue]

3.16 In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of early and trimester midwifery ultrasound?

Yes ☐ ☐ No

3.17 If your answer is **NO in question 3.16**, please recommend additional components or comments.

4. Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.

Statement 3: A midwife has the foundational knowledge, skills, and professional behavior to perform a second and third trimester midwifery ultrasound

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
	Basic foetal anatomy in the second and the third trimester with specific reference to normal ultrasound morphology of:				
4.1	normal sonographic morphology	☐	☐	☐	☐
4.2	the head (including central nervous system)	☐	☐	☐	☐
4.3	the face	☐	☐	☐	☐
4.4	the thorax (including the heart, lungs and diaphragm)	☐	☐	☐	☐
4.5	the spine	☐	☐	☐	☐
4.6	the abdomen (including the gastrointestinal tract, genitourinary tract)	☐	☐	☐	☐
4.7	the skeletal system	☐	☐	☐	☐
4.8	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	☐	☐	☐	☐
4.9	identification of preterm birth with specific reference to cervical assessment.	☐	☐	☐	☐
4.10	identification of preterm birth with specific reference to predisposing factors for foetal macrosomia and foetal growth restriction in third trimester	☐	☐	☐	☐
4.11	identification of preterm birth with specific reference to risks and indications for genetic amniocentesis	☐	☐	☐	☐
4.12	biophysical profile of the fetus	☐	☐	☐	☐
4.13	fetal well-being assessment with Doppler studies	☐	☐	☐	☐
4.14	spectral Doppler	☐	☐	☐	☐
4.15	pulsatility Index (PI)	☐	☐	☐	☐
4.16	colour Doppler	☐	☐	☐	☐
4.17	doppler recordings of velocity tracing in maternal arteries feeding the uterus as well as tracings of the arterial of the venous vessels in the umbilical cord	☐	☐	☐	☐
4.18	basic concepts related to foetal anomaly screening	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
4.19	examine the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	☐	☐	☐	☐
4.20	perform a pulsed and color Doppler ultrasound and evaluate the findings	☐	☐	☐	☐
4.21	recognise the range of compromised pregnancies and undertake the necessary observations using ultrasound techniques	☐	☐	☐	☐
4.22	perform a biophysical profile and evaluate the findings	☐	☐	☐	☐
4.23	appreciate the ethical issues associated with prenatal diagnostic procedures	☐	☐	☐	☐

		Yes	No
4.24	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of second and third trimester midwifery ultrasound?	☐	☐

4. **Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.** [Continue]

4.25 If your answer is **NO in question 4.24**, please indicate the recommended additional components or comments.

5. Competency FOUR: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an intrapartum ultrasound.

Statement 4: A midwife has the foundational knowledge, skills and professional behavior to perform an intrapartum ultrasound.

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has founational knowledge about:				
5.1	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour	☐	☐	☐	☐
5.2	normal measurements of the anatomy of the infrapubic plane	☐	☐	☐	☐
	A midwife has the skill and behavior to:				
5.3	perform a transvaginal (transperineal or translabial ultrasound to determine labour progress)	☐	☐	☐	☐
5.4	confirmation of a positive fetal heartbeat	☐	☐	☐	☐

		Yes	No
5.5	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills, and professional behavior of** an intrapartum midwifery ultrasound?	☐	☐

5.6 If your answer is **NO in question 5.5**, please recommend additional components or comments.

6. Competency FIVE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a postpartum midwifery ultrasound.

Statement 5: A midwife has the foundational knowledge, skills and professional behavior to perform a postpartum ultrasound

		Essential	Useful	Potential for inclusion	Not needed
	A midwife has foundational knowledge about:				
6.1	normal involution of the reproductive organs after childbirth	☐	☐	☐	☐
6.2	normal and potential pathological ultrasound appearance of uterus and adnexae, vaginal canal, perineal floor and anal sphincter	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
6.3	review the normal of the reproductive organs after childbirth	☐	☐	☐	☐
	Review the normal anatomy of the following:				
6.4	uterus and adnexae	☐	☐	☐	☐
6.5	vaginal canal	☐	☐	☐	☐
6.6	perineal floor muscles	☐	☐	☐	☐
6.7	intactness of anal sphincter	☐	☐	☐	☐
6.8	refer a person with a high risk profile or abnormal findings to a medial healthcare provider	☐	☐	☐	☐

		Yes	No
6.9	In your opinion, would you say that the components above are sufficient to capture the **foundational knowledge, skills and professional behavior** of a postpartum midwifery ultrasound?	☐	☐

6.10 If your answer is **NO in question 6.9,** please recommend additional components or comments.

7. Competency SIX: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound

Statement 6: A midwife has the foundational knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound

		Essential	Useful	Potential	Not need
	A midwife has foundational knowledge about:				
7.1	the normal structures of the uterus, ovaries and adnexa for normal non-pregnant findings	☐	☐	☐	☐
7.2	the normal structures of the pelvic floor	☐	☐	☐	☐
	A midwife has skill and professional behavior to:				
7.3	visualize the normal structure of the uterus, ovaries and adnexa with transabdominal ultrasound	☐	☐	☐	☐
7.4	visualize the normal structures of the basic pelvic floor structures with transabdominal ultrasound	☐	☐	☐	☐
7.5	examine the uterus, ovaries and adnexa for normal non-pregnant findings during the reproductive age	☐	☐	☐	☐
7.6	examine the basic pelvic floor structures for normal findings during the reproductive age	☐	☐	☐	☐

Please read the following expert statements (question 7.7 and 7.8) about gynaecological ultrasound as a competency for midwives.

7.7	Image interpretation for gynaecological scanning is not easy. It is a steep learning curve and transvaginal scanning is essential. Midwifery ultrasound should not include gynaecological ultrasound as a competency.	Strongly agree ☐	☐	☐	☐	Strongly disagree
7.8	A prerequisite for including gynaecological scanning for midwifery ultrasound should only be included if sufficient hours of clinical practice can be provided to achieve competency .	Strongly agree ☐	☐	☐	☐	Strongly disagree

8. Task shifting of midwifery ultrasound to the basic or specialist midwife.

The following motivations for basic or specialist midwives to perform ultrasound, based on the experts opinion in round one, are given. Indicate if you agree that the following statement:

8.1	The basic midwife's scope is wide enough (she has enough on her plate) and should primarily manage patients clinically.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.2	The basic midwife should have the basic competencies (level 1) and the specialist midwife should have more advanced skills.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.3	Midwives, irrespective of being a basic or specialist midwife, who has a keen interest in the field of ultrasound, should be allowed to prove themselves competent in midwifery ultrasound.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.4	Considering the shortages of sonographers and other appropriately qualified healthcare professionals, specialist midwives' roles should include midwifery ultrasound education and training as diagnostic ultrasound is a scarce skill in SA.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.5	The specialist midwife has the expertise to effectively integrate the use of midwifery ultrasound into practice.	Strongly agree ☐	☐	☐	☐	Strongly disagree
8.6	The current workload of a midwife (basic and/or specialist midwife) allows for midwifery ultrasound to be added as an additional competency.	Strongly agree ☐	☐	☐	☐	Strongly disagree

9. Level of midwifery ultrasound education and training (Level I, II, III)

The following motivations for the level of midwifery ultrasound practice, based on the experts opinion in round one, are given.

During round two, consensus where reached on the following statement, namely:

LEVEL 1, as this will ensure greater primary healthcare (PHC) access, primarily to basic sonographic services. Should the mother present with any high risk indicators or require further investigation through specialised evaluation, referral is needed.

Indicate if you agree with the following statements:

9.1	LEVEL 1, because ultrasound equipment is a scarce resource and level 2 and 3 needs advanced technology which is not available at PHC level.	Strongly agree ☐	☐	☐	☐	Strongly disagree
9.2	LEVEL 1 for a basic midwives and LEVEL 2 for a midwife specialist.	Strongly agree ☐	☐	☐	☐	Strongly disagree
9.3	LEVEL 1, with the ability to continue to level 2 or 3 for the midwife specialist working at secondary or tertiary	Strongly agree ☐	☐	☐	☐	Strongly disagree

10. Distribution of midwifery ultrasound as a potential addition to workload.

According to expert opinion in round two, the following statements are applicable to workload distribution of midwifery ultrasound.

Please indicate your opinion regarding to the following statements:

10.1	The benefit of midwifery ultrasound for the mother outweighs the addition to workload.	Strongly agree ☐	☐	☐	☐	Strongly disagree
10.2	Midwifery ultrasound should have a selective impact (only in specific circumstances such as high risk mothers and where a geographical need exists). The additional workload should be managed according to the specific circumstances.	Strongly agree ☐	☐	☐	☐	Strongly disagree

10. Distribution of midwifery ultrasound as a potential addition to workload. [Continue]

10.3	Midwifery ultrasound will replace other selective traditional skills such as palpation and fetal heart rate auscultation and consequently the additional workload will be equalised.	Strongly agree	☐	☐	☐	☐	Strongly disagree
10.4	The midwife should incorporate the competency of ultrasound in her/his daily duties. Competency in ultrasound will lead to time efficiency and should be part of the normal workflow. Midwifery ultrasound is an addition to a preset of competencies and should not be seen as a seperator of functions.	Strongly agree	☐	☐	☐	☐	Strongly disagree
10.5	The utilization of midwives with the competency of ultrasound in practice should be remunerated accordingly.	Strongly agree	☐	☐	☐	☐	Strongly disagree

END OF QUESTIONNAIRE

Round 1 = 91 Questions
n=18

Consensus reached: 27 elements (29.7%)
Incomplete questions: 0.07%

GREEN HIGHLIGHT: Consensus reached

CQN	OQR	Competency element	Mean	Std. Dev.	Essential		Useful		Potential for inclution		Not needed	
					1		2		3		4	
					n	%	n	%	n	%	n	%
Competency ONE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography.												
1	2,1	physics of ultrasound related to instrumentation	1,7	0,7	9	50%	6	33%	3	17%	0	0%
2	2,2	basic maintenance of ultrasound instrumentation	1,4	0,8	13	72%	2	11%	3	17%	0	0%
3	2,3	ultrasound safety	1,2	0,4	15	83%	3	17%	0	0%	0	0%
4	2,4	infection control	1,0	0,0	18	100%	0	0%	0	0%	0	0%
5	2,5	the principles of knobology	1,2	0,5	15	83%	2	11%	1	6%	0	0%
6	2,6	writing a complete ultrasound report	1,8	0,9	8	44%	7	39%	2	11%	1	6%
7	2,7	anatomy and physiology of the internal organs of the reproductive female system related to the productive age	1,7	1,2	13	72%	1	6%	1	6%	3	17%
8	2,8	apply physics of ultrasound and related instrumentation	2,0	1,0	7	39%	6	33%	3	17%	2	11%
9	2,9	apply basic maintenance of ultrasound machinery	1,6	0,9	11	61%	3	17%	2	11%	1	6%
10	2,10	apply the principles of knobology	1,4	0,7	13	72%	3	17%	2	11%	0	0%
11	- - -											
12	- - -											
13	2,11	write a complete ultrasound report	1,7	0,7	9	50%	6	33%	3	17%	0	0%

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					1		**2**		**3**		**4**	
					n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.												
14	3,1	normal sonographic morphology for 5 to 10 weeks gestation	1,9	1,0	8	44%	6	33%	2	11%	2	11%
15	3,2	normal sonographic morphology for 11 to 14 gestation	1,7	0,9	10	56%	6	33%	0	0%	2	11%
16	3,3	indications for an early and first-trimester ultrasound	1,3	0,7	14	78%	3	17%	0	0%	1	6%
17	3,4	criteria for a transabdominal early and first trimester ultrasound	1,4	0,8	14	78%	2	11%	1	6%	1	6%
18	3,5	criteria for a transvaginal early and first trimester ultrasound	1,7	0,9	10	56%	5	28%	2	11%	1	6%
19	3,6	normal and early embryonic development: singletons and twins	1,7	0,9	11	61%	3	17%	3	17%	1	6%
20	3,7	ultrasound evaluation of ampullary tubal ectopic and non-tubal ectopic	2,0	1,1	8	44%	4	22%	4	22%	2	11%
21	3,8	components of sonographic dating in trimester	1,1	0,3	16	89%	2	11%	0	0%	0	0%
22	3,9	subchorionic hematoma	1,9	0,8	7	39%	6	33%	5	28%	0	0%
23	3,10	criteria for definitive diagnosis and referral of embryonic/foetal death in first trimester	1,5	0,8	11	61%	6	33%	0	0%	1	6%
24	3,11	sonographic features of molar pregnancy	1,6	0,7	9	50%	7	39%	2	11%	0	0%
25	3,12	ultrasound findings in the case of threatened abortion - fluid and funneling	1,4	0,6	11	61%	6	33%	1	6%	0	0%
26	3,13	association between thickened nuchal transparency and foetal chromosomal anomalies	1,9	1,1	9	50%	5	28%	1	6%	3	17%
27	3,14	selective foetal growth restriction	1,7	1,0	11	61%	3	17%	2	11%	2	11%
28	3,15	single intrauterine demise	1,3	0,6	14	78%	3	17%	1	6%	0	0%
29	3,16	embryonic and foetal biometry	1,6	0,8	12	67%	2	11%	4	22%	0	0%

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CQN	OQR	Competency element	Mean	Std. Dev.	Essential		Useful		Potential for inclution		Not needed	
					1		2		3		4	
					n	%	n	%	n	%	n	%
Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.												
30	3,17	single and multiple pregnancy	1,4	0,7	13	72%	3	17%	2	11%	0	0%
31	3,18	gestational sac	1,5	0,8	11	61%	3	17%	3	17%	0	0%
32	3,19	yolk sac	2,1	1,0	7	39%	5	28%	4	22%	2	11%
33	3,20	amnion	2,0	0,9	7	39%	5	28%	5	28%	1	6%
34	3,21	chrionicity	1,9	1,0	8	44%	4	22%	5	28%	1	6%
35	3,22	evaluate embryo/fetus cardiac activity and documenting	1,4	0,8	14	78%	2	11%	1	6%	1	6%
36	3,23	determine the indication for an early or first trimester ultrasound	1,2	0,4	15	83%	3	17%	0	0%	0	0%
37	3,24	distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound	1,7	0,9	9	50%	6	33%	2	11%	1	6%
38	3,25	distinguish between normal and pathological ultrasound images for a transvaginal early pregnancy midwifery ultrasound	2,2	1,0	6	33%	5	28%	5	28%	2	11%
39	3,26	distinguish between normal pathological ultrasound images for a transabdominal first trimester midwifery ultrasound	1,6	0,6	8	44%	9	50%	1	6%	0	0%
40	3,27	distinguish between normal pathological ultrasound images for a transvaginal first trimester ultrasound	2,1	1,0	6	33%	6	33%	4	22%	2	11%
41	3,28	use the principles of fetometry to estimate embryo/foetal age in the first trimester by means of transabdominal ultrasound fetometry	1,6	0,9	12	67%	3	17%	2	11%	1	6%
42	3,29	use the principles of fetometry to estimate embryo / foetal age in the first trimester by means of transvaginal ultrasound fetometry	2,2	1,2	8	44%	2	11%	5	28%	3	17%
43	- - -											
44	3,30	refer persons with a high risk profile or abnormal findings to an appropriate healthcare professional	1,0	0,0	18	100%	0	0%	0	0%	0	0%

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					1		2		3		4	
					n	%	n	%	n	%	n	%
Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.												
45	4,1	the heart	2,0	1,1	8	44%	5	28%	2	11%	3	17%
46	4,2	normal sonographic morphology	1,7	0,7	9	50%	6	33%	3	17%	0	0%
47	4,3	face, neck, and thorax	1,8	0,9	8	44%	6	33%	3	17%	1	6%
48	- - -											
49	- - -											
50	- - -											
51	- - -											
52	4,4	abdomen	1,8	0,9	9	50%	5	28%	3	17%	1	6%
53	4,5	skeleton	1,7	0,9	10	56%	5	28%	2	11%	1	6%
54	4,6	components of foetal biometry in sonographic dating in second and third trimesters	1,3	0,6	14	78%	3	17%	1	6%	0	0%
55	4,7	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	1,4	0,8	13	72%	2	11%	3	17%	0	0%
56	4,8	identification of preterm birth with specific reference to cervical assessment.	2,1	1,1	7	39%	6	33%	2	11%	3	17%
57	4,9	identification of preterm birth with specific reference to predisposing factors for foetal macrosomia and foetal growth restriction in third trimester	2,0	0,9	6	33%	8	44%	2	11%	2	11%
58	4,1	identification of preterm birth with specific reference to risks and indications for genetic amniocentesis	2,1	0,9	5	28%	8	44%	2	11%	2	11%
59	4,11	presentation, position and attitude of the foetus in the third trimester	1,1	0,5	17	94%	0	0%	1	6%	0	0%
60	4,12	biophysical profile of the fetus	2,2	1,0	6	33%	5	28%	5	28%	2	11%

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					1		2		3		4	
					n	%	n	%	n	%	n	%
Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.												
61	4,13	indications for the referral to healthcare professionals	1,0	0,0	18	100%	0	0%	0	0%	0	0%
62	4,14	fetal well-being assessment with Doppler studies	2,2	1,0	5	28%	7	39%	4	22%	2	11%
63	4,15	spectral Doppler	2,6	0,8	1	6%	9	50%	5	28%	3	17%
64	4,16	pulsatility Index (PI)	2,4	0,8	2	11%	9	50%	4	22%	2	11%
65	4,17	colour Doppler	2,6	0,8	1	6%	9	50%	5	28%	3	17%
66	4,18	doppler recordings of velocity tracing in maternal arteries feeding the uterus as well as tracings of the arterial of the venous vessels in the umbilical cord	2,6	0,8	0	0%	10	56%	5	28%	3	17%
67	4,19	basic concepts related to foetal anomaly screening	1,8	0,9	9	50%	4	22%	3	17%	1	6%
68	4,20	measure the basic structures to estimate the age of the fetus	1,1	0,5	17	94%	0	0%	1	6%	0	0%
69	4,21	measure basic foetal morphology in the second and third trimester for the purpose of establishing normal foetal growth	1,4	0,9	15	83%	0	0%	2	11%	1	6%
70	4,22	review the basic fetal anatomy in the second and third trimester	1,7	1,1	12	67%	1	6%	3	17%	2	11%
71	4,23	examine the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	1,4	0,8	13	72%	2	11%	3	17%	0	0%
72	4,24	perform a pulsed and color Doppler ultrasound and evaluate the findings	2,6	1,0	2	11%	7	39%	4	22%	4	22%
73	4,25	recognise the range of compromised pregnancies and undertake the necessary observations using ultrasound techniques	1,9	1,1	8	44%	4	22%	3	17%	2	11%
74	4,26	perform a biophysical profile and evaluate the findings	2,4	1,0	4	22%	5	28%	6	33%	3	17%
75	4,27	appreciate the ethical issues associated with prenatal diagnostic procedures	1,4	0,7	13	72%	3	17%	2	11%	0	0%
76	4,28	referral of a person with a high risk profile or of abnormal findings to an appropriate healthcare professional	1,1	0,5	17	94%	0	0%	1	6%	0	0%

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CQN	OQR	Competency element	Mean	Std. Dev.	Essential 1		Useful 2		Potential for inclution 3		Not needed 4	
					n	%	n	%	n	%	n	%
Competency FOUR: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an intrapartum ultrasound.												
77	5,1	the presentation, lie, position and attitude of the fetus during labour	1,2	0,5	16	89%	1	6%	1	6%	0	0%
78	5,2	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour	1,3	0,7	14	78%	3	17%	0	0%	1	6%
79	5,3	normal measurements of the anatomical structures of the foetal skull during labour	1,8	1,1	11	61%	3	17%	1	6%	3	17%
80	5,4	normal measurements of the anatomy of the infrapubic plane	2,6	1,1	3	17%	6	33%	4	22%	5	28%
81	5,5	examine the position of placenta umbilical cord and amniotic fluid	1,3	0,7	14	78%	2	11%	2	11%	0	0%
82	5,6	review the presentation, lie, position and attitude of the fetus	1,2	0,5	16	89%	1	6%	1	6%	0	0%
83	5,7	perform a transvaginal (transperineal or translabial ultrasound to determine labour progress)	2,9	1,0	2	11%	5	28%	4	22%	7	39%
84	- - -											

CQN: Chronological question number **OQN: Original question number**

Round 1 = 91 Questions
n=18

Consensus reached: 27 elements (29.7%)
Incomplete questions: 0.07%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQR	Competency element	Mean	Std. Dev.	Essential		Useful		Potential for inclution		Not needed	
					1		2		3		4	
					n	%	n	%	n	%	n	%
Competency FIVE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a postpartum midwifery ultrasound.												
85	6,1	normal involution of the reproductive organs after childbirth	2,2	1,0	6	33%	5	28%	5	28%	2	11%
86	6,2	normal and potential pathological ultrasound appearance of uterus and adnexae, vaginal canal, perineal floor and anal sphincter	2,6	1,2	5	28%	1	6%	6	33%	5	28%
87	6,3	review the normal of the reproductive organs after childbirth	2,4	1,1	6	33%	1	6%	7	39%	3	17%
88	6,4	uterus and adnexae	2,4	1,2	6	33%	2	11%	6	33%	4	22%
89	6,5	vaginal canal	2,9	1,2	4	22%	1	6%	5	28%	8	44%
90	6,6	perineal floor muscles	3,0	1,2	4	22%	0	0%	6	33%	8	44%
91	6,7	intactness of anal sphincter	2,8	1,2	5	28%	0	0%	6	33%	7	39%
92	6,8	refer a person with a high risk profile or abnormal findings to a medial healthcare provider	1,7	1,0	11	61%	2	11%	4	22%	1	6%

CQN: Chronological question number **OQN: Original question number**

Round 1 = 91 Questions
n=18

Consensus reached: 27 elements (29.7%)
Incomplete questions: 0.07%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQR	Competency element	Mean	Std. Dev.	Essential		Useful		Potential for inclution		Not needed	
					1		2		3		4	
					n	%	n	%	n	%	n	%
Competency SIX: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound.												
93	7,1	the normal structures of the uterus, ovaries and adnexa for normal non-pregnant findings	2,1	1,0	7	39%	4	22%	6	33%	1	6%
94	7,2	the normal structures of the pelvic floor	2,6	1,2	5	28%	3	17%	4	22%	6	33%
95	7,3	visualize the normal structure of the uterus, ovaries and adnexa with transabdominal ultrasound	2,4	1,0	4	22%	5	28%	6	33%	3	17%
96	7,4	visualize the normal structures of the basic pelvic floor structures with transabdominal ultrasound	2,9	1,1	3	17%	3	17%	5	28%	7	39%
97	7,5	examine the uterus, ovaries and adnexa for normal non-pregnant findings during the reproductive age	2,4	1,0	4	22%	5	28%	6	33%	3	17%
98	7,6	examine the basic pelvic floor structures for normal findings during the reproductive age	2,9	1,0	2	11%	3	17%	6	33%	5	28%
99	7,7	refer a person with high risk profile or abnormal findings to an appropriate healthcare professional	1,6	0,7	9	50%	6	33%	2	11%	0	0%
100	- - -											
101	- - -											

CQN: Chronological question number **OQN: Original question number**

Round 1 = 91 Questions
n=18

Consensus reached: 27 elements (29.7%)
Incomplete questions: 0.07%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQR	Competency element	Mean	Std. Dev.	Essential		Useful		Potential for inclution		Not needed	
					1		2		3		4	
					n	%	n	%	n	%	n	%
Additional questions. Task shifting of midwifery ultrasound to the basic or specialist midwife.												
102	- - -											
103	- - -											
104	- - -											
105	- - -											
106	- - -											
107	- - -											
108	- - -											
109	- - -											
Additional questions. Level of midwifery ultrasound education and training (Level I, II, III).												
110	- - -											
111	- - -											
112	- - -											
113	- - -											

CQN: Chronological question number **OQN: Original question number**

Round 1 = 91 Questions
n=18

Consensus reached: 27 elements (29.7%)
Incomplete questions: 0.07%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQR	Competency element	Mean	Std. Dev.	Essential		Useful		Potential for inclution		Not needed	
					1		2		3		4	
					n	%	n	%	n	%	n	%
Additional questions. Distribution of midwifery ultrasound as a potential addition to workload.												
114	- - -											
115	- - -											
116	- - -											
117	- - -											
118	- - -											

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency ONE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography.										
1	2,1	physics of ultrasound related to instrumentation	10	59%	6	35%	1	6%	0	0%
2	2,2	basic maintenance of ultrasound instrumentation	11	65%	4	24%	1	6%	1	6%
3	- - -									
4	- - -									
5	- - -									
6	2,3	writing a complete ultrasound report	10	59%	6	35%	1	6%	0	0%
7	2,4	anatomy and physiology of embryology, fetal anatomy and physiology and the internal organs of the reproductive female system related to the reproductive age.	11	65%	4	24%	1	6%	1	6%
8	2,5	apply physics of ultrasound and related instrumentation	9	53%	5	29%	2	12%	1	6%
9	2,6	apply basic maintenance of ultrasound machinery	10	59%	6	35%	0	0%	1	6%
10	2,7	apply the principles of knobology	12	71%	4	24%	1	6%	0	0%
11	- - -									
12	- - -									
13	2,8	write a complete ultrasound report	11	65%	5	29%	0	0%	1	6%

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.										
14	3,1	normal sonographic morphology for 5 to 10 weeks gestation	10	59%	5	29%	1	6%	1	6%
15	3,2	normal sonographic morphology for 11 to 14 gestation	10	59%	5	29%	1	6%	1	6%
16	- - -									
17	- - -									
18	3,3	criteria for a transvaginal early and first trimester ultrasound	9	53%	5	29%	1	6%	2	12%
19	- - -									
20	3,4	ultrasound evaluation of ampullary tubal ectopic and non-tubal ectopic	7	41%	8	47%	1	6%	1	6%
21	- - -									
22	3,5	subchorionic hematoma	5	29%	7	41%	4	24%	1	6%
23	3,6	criteria for definitive diagnosis and referral of embryonic/foetal death in first trimester	12	71%	4	24%	0	0%	1	6%
24	3,7	sonographic features of molar pregnancy	8	47%	8	47%	0	0%	1	6%
25	3,8	ultrasound findings in the case of threatened abortion - fluid and funneling	10	59%	5	29%	1	6%	1	6%
26	3,9	association between thickened nuchal transparency and foetal chromosomal anomalies	7	41%	6	35%	2	12%	2	12%
27	3,10	selective foetal growth restriction	8	47%	4	24%	3	18%	2	12%
28	- - -									
29	3,11	embryonic and foetal biometry	12	71%	2	12%	2	12%	1	6%

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.										
30	3,12	single and multiple pregnancy	16	94%	1	6%	0	0%	0	0%
31	3,13	gestational sac	12	71%	5	29%	0	0%	0	0%
32	3,14	yolk sac	12	71%	3	18%	1	6%	0	0%
33	3,15	amnion	11	65%	5	29%	1	6%	0	0%
34	3,16	chrionicity	11	65%	4	24%	1	6%	0	0%
35	- - -									
36	- - -									
37	3,17	distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound	13	76%	3	18%	0	0%	1	6%
38	3,18	distinguish between normal and pathological ultrasound images for a transvaginal early pregnancy midwifery ultrasound	9	53%	5	29%	0	0%	3	18%
39	3,19	distinguish between normal pathological ultrasound images for a transabdominal first trimester midwifery ultrasound	12	71%	3	18%	1	6%	1	6%
40	3,20	distinguish between normal pathological ultrasound images for a transvaginal first trimester ultrasound	6	35%	6	35%	2	12%	3	18%
41	3,21	use the principles of fetometry to estimate embryo/foetal age in the first trimester by means of transabdominal ultrasound fetometry	12	71%	2	12%	2	12%	1	6%
42	3,22	use the principles of fetometry to estimate embryo / foetal age in the first trimester by means of transvaginal ultrasound fetometry	7	41%	4	24%	4	24%	2	12%
43	- - -									
44	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.										
45	4,1	the heart	10	59%	4	24%	1	6%	2	12%
46	4,2	normal sonographic morphology	11	65%	5	29%	0	0%	1	6%
47	4,3	face, neck, and thorax	7	41%	7	41%	1	6%	2	12%
48	- - -									
49	- - -									
50	- - -									
51	- - -									
52	4,4	abdomen	9	53%	5	29%	1	6%	2	12%
53	4,5	skeleton	9	53%	6	35%	0	0%	2	12%
54	- - -									
55	4,6	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	10	59%	5	29%	1	6%	1	6%
56	4,7	identification of preterm birth with specific reference to cervical assessment.	7	41%	4	24%	5	29%	1	6%
57	4,8	identification of preterm birth with specific reference to predisposing factors for foetal macrosomia and foetal growth restriction in third trimester	8	47%	5	29%	2	12%	2	12%
58	4,9	identification of preterm birth with specific reference to risks and indications for genetic amniocentesis	7	41%	4	24%	4	24%	2	12%
59	- - -									
60	4,10	biophysical profile of the fetus	4	24%	6	35%	3	18%	4	24%

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.										
61	- - -									
62	4,11	fetal well-being assessment with Doppler studies	3	18%	8	47%	4	24%	2	12%
63	4,12	spectral Doppler	0	0%	8	47%	5	29%	4	24%
64	4,13	pulsatility Index (PI)	0	0%	10	59%	5	29%	2	12%
65	4,14	colour Doppler	1	6%	9	53%	5	29%	2	12%
66	4,15	doppler recordings of velocity tracing in maternal arteries feeding the uterus as well as tracings of the arterial of the venous vessels in the umbilical cord	0	0%	10	59%	4	24%	3	18%
67	4,16	basic concepts related to foetal anomaly screening	9	53%	5	29%	1	6%	1	6%
68	- - -									
69	- - -									
70	4,17	review the basic fetal anatomy in the second and third trimester	13	76%	4	24%	0	0%	0	0%
71	4,18	examine the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	10	59%	7	41%	0	0%	0	0%
72	4,19	perform a pulsed and color Doppler ultrasound and evaluate the findings	2	12%	8	47%	3	18%	3	18%
73	4,20	recognise the range of compromised pregnancies and undertake the necessary observations using ultrasound techniques	4	24%	5	29%	4	24%	4	24%
74	4,21	perform a biophysical profile and evaluate the findings	3	18%	6	35%	3	18%	5	29%
75	4,22	appreciate the ethical issues associated with prenatal diagnostic procedures	10	59%	4	24%	2	12%	0	0%
76	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency FOUR: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an intrapartum ultrasound.										
77	- - -									
78	5,1	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour	11	65%	5	29%	0	0%	1	6%
79	- - -									
80	5,2	normal measurements of the anatomy of the infrapubic plane	2	12%	7	41%	2	12%	6	35%
81	5,3	examine the position of placenta umbilical cord and amniotic fluid	16	94%	1	6%	0	0%	0	0%
82	5,4	review the presentation, lie, position and attitude of the fetus	16	94%	1	6%	0	0%	0	0%
83	5,5	perform a transvaginal (transperineal or translabial ultrasound to determine labour progress)	1	6%	6	35%	2	12%	8	47%
84	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency FIVE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a postpartum midwifery ultrasound.										
85	6,1	normal involution of the reproductive organs after childbirth	8	47%	6	35%	2	12%	1	6%
86	6,2	normal and potential pathological ultrasound appearance of uterus and adnexae, vaginal canal, perineal floor and anal sphincter	4	24%	6	35%	4	24%	3	18%
87	6,3	review the normal of the reproductive organs after childbirth	4	24%	7	41%	3	18%	3	18%
88	6,4	uterus and adnexae	7	41%	5	29%	2	12%	3	18%
89	6,5	vaginal canal	3	18%	5	29%	3	18%	5	29%
90	6,6	perineal floor muscles	4	24%	3	18%	4	24%	6	35%
91	6,7	intactness of anal sphincter	3	18%	4	24%	4	24%	6	35%
92	6,8	refer a person with a high risk profile or abnormal findings to a medial healthcare provider	11	65%	2	12%	3	18%	1	6%

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency SIX: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound.										
93	7,1	the normal structures of the uterus, ovaries and adnexa for normal non-pregnant findings	9	53%	4	24%	3	18%	1	6%
94	7,2	the normal structures of the pelvic floor	6	35%	5	29%	1	6%	4	24%
95	7,3	visualize the normal structure of the uterus, ovaries and adnexa with transabdominal ultrasound	7	41%	6	35%	3	18%	1	6%
96	7,4	visualize the normal structures of the basic pelvic floor structures with transabdominal ultrasound	3	18%	7	41%	3	18%	4	24%
97	7,5	examine the uterus, ovaries and adnexa for normal non-pregnant findings during the reproductive age	4	24%	6	35%	4	24%	2	12%
98	7,6	examine the basic pelvic floor structures for normal findings during the reproductive age	3	18%	6	35%	2	12%	6	35%
99	7,7	refer a person with high risk profile or abnormal findings to an appropriate healthcare professional	12	71%	3	18%	2	12%	0	0%
100	- - -									
101	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

CQN.	OQN	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Additional questions.										
Task shifting of midwifery ultrasound to the basic or specialist midwife.										
102	8,1	The basic midwife's scope is wide enough (she has enough on her plate) and should primarily manage patients clinically.	5	29%	4	24%	5	29%	3	18%
103	8,2	The basic midwife working at primary health care level, especially rural areas, is sometimes the only person who performs an ultrasound due to the shortage of appropriately qualified healthcare professions and should be able to do a basic obstetric ultrasound.	13	76%	3	18%	1	6%	0	0%
104	8,3	The basic midwife should have the basic competencies (level 1) and the specialist midwife should have more advanced skills.	10	59%	3	18%	1	6%	3	18%
105	8,4	Midwives, irrespective of being a basic or specialist midwife, who has a keen interest in the field of ultrasound, should be allowed to prove themselves competent in midwifery ultrasound.	9	53%	6	35%	1	6%	1	6%
106	8,5	Considering the shortages of sonographers and other appropriately qualified healthcare professionals, specialist midwives' roles should include midwifery ultrasound education and training as diagnostic ultrasound is a scarce skill in SA.	4	24%	1	6%	0	0%	1	6%
107	8,6	The specialist midwife has the expertise to effectively integrate the use of midwifery ultrasound into practice.	6	35%	10	59%	0	0%	0	0%
108	8,7	The specialist midwife should be allowed to add midwifery ultrasound as an additional skill set after their training as a specialist midwife.	15	88%	1	6%	1	6%	0	0%
109	8,8	The current workload of a midwife (basic and/or specialist midwife) allows for midwifery ultrasound to be added as an additional competency.	7	41%	5	29%	2	12%	3	18%

CQN: Chronological question number **OQN: Original question number**

Round 2=84 Questions
n=17

Consensus reached: 16 elements (19%)
Incomplete questions: 1.47%

GREEN HIGHLIGHT: Consensus reached

Additional questions.										
Level of midwifery ultrasound education and training (Level I, II, III).										
110	9,1	Should the mother present with any high risk indicators or require further investigation through specialised evaluation, referral is needed.	15	88%	2	12%	0	0%	0	0%
111	9,2	LEVEL 1, because ultrasound equipment is a scarce resource and level 2 and 3 needs advanced technology which is not available at PHC level.	11	65%	4	24%	2	12%	0	0%
112	9,3	LEVEL 1 for a basic midwives and LEVEL 2 for a midwife specialist.	7	41%	6	35%	2	12%	2	12%
113	9,4	LEVEL 1, with the ability to continue to level 2 or 3 for the midwife specialist working at secondary or tertiary	6	35%	6	35%	3	18%	2	12%
Additional questions.										
Distribution of midwifery ultrasound as a potential addition to workload.										
114	- - -									
115	- - -									
116	- - -									
117	- - -									
118	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency ONE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to safely and effectively do a midwifery ultrasound based on the general principles of sonography.										
1	2,1	physics of ultrasound related to instrumentation	8	57%	3	21%	2	14%	1	7%
2	2,2	basic maintenance of ultrasound instrumentation	9	64%	3	21%	1	7%	1	7%
3	- - -									
4	- - -									
5	- - -									
6	2,3	writing a complete ultrasound report	7	50%	4	29%	2	14%	1	7%
7	2,4	anatomy and physiology of embryology, fetal anatomy and physiology and the internal organs of the reproductive female system related to the reproductive age.	8	57%	3	21%	0	0%	2	14%
8	2,5	apply physics of ultrasound and related instrumentation	5	36%	6	43%	1	7%	2	14%
9	2,6	apply basic maintenance of ultrasound machinery	7	50%	5	36%	0	0%	1	7%
10	- - -									
11	2,7	apply appropriate midwifery ultrasound techniques and/or protocols for image formation.	8	57%	5	36%	1	7%	0	0%
12	2,8	identify the normal maternal and fetal anatomy, physiology and embryology.	10	71%	4	29%	0	0%	0	0%
13	2,9	write a complete ultrasound report	7	50%	5	36%	1	7%	1	7%

CQN: Chronological question number **OQN: Original question number**

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.										
14	3,1	normal sonographic morphology for 5 to 10 weeks gestation	7	50%	5	36%	1	7%	1	7%
15	3,2	normal sonographic morphology for 11 to 14 gestation	10	71%	2	14%	1	7%	1	7%
16	- - -									
17	- - -									
18	3,3	criteria for a transvaginal early and first trimester ultrasound	8	57%	4	29%	1	7%	1	7%
19	- - -									
20	3,4	ultrasound evaluation of ampullary tubal ectopic and non-tubal ectopic	3	21%	7	50%	2	14%	2	14%
21	- - -									
22	3,5	subchorionic hematoma	4	29%	7	50%	1	7%	2	14%
23	- - -									
24	3,6	sonographic features of molar pregnancy	5	36%	6	43%	2	14%	1	7%
25	3,7	ultrasound findings in the case of threatened abortion - fluid and funneling	5	36%	7	50%	1	7%	0	0%
26	3,8	association between thickened nuchal transparency and foetal chromosomal anomalies	7	50%	3	21%	2	14%	1	7%
27	3,9	selective foetal growth restriction	5	36%	5	36%	3	21%	1	7%
28	- - -									
29	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency TWO: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an early and first trimester midwifery ultrasound.										
30	- - -									
31	- - -									
32	- - -									
33	3,10	amnion	7	50%	6	43%	1	7%	0	0%
34	3,11	chrionicity	7	50%	6	43%	1	7%	0	0%
35	- - -									
36	- - -									
37	- - -									
38	3,12	distinguish between normal and pathological ultrasound images for a transvaginal early pregnancy midwifery ultrasound	8	57%	4	29%	1	7%	1	7%
39	- - -									
40	3,13	distinguish between normal pathological ultrasound images for a transvaginal first trimester ultrasound	7	50%	5	36%	1	7%	1	7%
41	- - -									
42	3,14	use the principles of fetometry to estimate embryo / foetal age in the first trimester by means of transvaginal ultrasound fetometry	7	50%	5	36%	0	0%	2	14%
43	3,15	recognise adnexal masses and distinguish between physiological and pathological.	4	29%	8	57%	1	7%	1	7%
44	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.										
45	- - -									
46	4,1	normal sonographic morphology	12	86%	2	14%	0	0%	0	0%
47	- - -									
48	4,2	the head (including central nervous system)	9	64%	3	21%	1	7%	1	7%
49	4,3	the face	6	43%	5	36%	1	7%	2	14%
50	4,4	the thorax (including the heart, lungs and diaphragm)	7	50%	4	29%	2	14%	1	7%
51	4,5	the spine	8	57%	4	29%	1	7%	1	7%
52	4,6	the abdomen (including the gastrointestinal tract, genitourinary tract)	8	57%	4	29%	1	7%	1	7%
53	4,7	the skeletal system	7	50%	5	36%	0	0%	1	7%
54	- - -									
55	4,8	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	10	71%	3	21%	0	0%	1	7%
56	4,9	identification of preterm birth with specific reference to cervical assessment.	7	50%	4	29%	0	0%	3	21%
57	4,10	identification of preterm birth with specific reference to predisposing factors for foetal macrosomia and foetal growth restriction in third trimester	8	57%	3	21%	1	7%	2	14%
58	4,11	identification of preterm birth with specific reference to risks and indications for genetic amniocentesis	5	36%	5	36%	1	7%	3	21%
59	- - -									
60	4,12	biophysical profile of the fetus	3	21%	5	36%	2	14%	4	29%

CQN: Chronological question number **OQN: Original question number**

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency THREE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a second and third trimester ultrasound.										
61	- - -									
62	4,13	fetal well-being assessment with Doppler studies	4	29%	7	50%	2	14%	1	7%
63	4,14	spectral Doppler	2	14%	6	43%	2	14%	4	29%
64	4,15	pulsatility Index (PI)	3	21%	6	43%	3	21%	2	14%
65	4,16	colour Doppler	2	14%	6	43%	3	21%	3	21%
66	4,17	doppler recordings of velocity tracing in maternal arteries feeding the uterus as well as tracings of the arterial of the venous vessels in the umbilical cord	2	14%	6	43%	4	29%	2	14%
67	4,18	basic concepts related to foetal anomaly screening	7	50%	5	36%	1	7%	1	7%
68	- - -									
69	- - -									
70	- - -									
71	4,19	examine the placenta, umbilical cord and amniotic fluid and adnexa during foetal examination in the second and third trimester	9	64%	4	29%	0	0%	1	7%
72	4,20	perform a pulsed and color Doppler ultrasound and evaluate the findings	1	7%	8	57%	3	21%	2	14%
73	4,21	recognise the range of compromised pregnancies and undertake the necessary observations using ultrasound techniques	6	43%	3	21%	4	29%	1	7%
74	4,22	perform a biophysical profile and evaluate the findings	3	21%	4	29%	3	21%	4	29%
75	4,23	appreciate the ethical issues associated with prenatal diagnostic procedures	10	71%	4	29%	0	0%	0	0%
76	- - -									

CQN: Chronological question number **OQN: Original question number**

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency FOUR: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform an intrapartum ultrasound.										
77	- - -									
78	5,1	normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour	9	64%	4	29%	0	0%	1	7%
79	- - -									
80	5,2	normal measurements of the anatomy of the infrapubic plane	2	14%	6	43%	1	7%	5	36%
81	- - -									
82	- - -									
83	5,3	perform a transvaginal (transperineal or translabial ultrasound to determine labour progress)	1	7%	5	36%	3	21%	5	36%
84	5,4	confirmation of a positive fetal heartbeat	12	86%	1	7%	0	0%	1	7%

CQN: Chronological question number OQN: Original question number

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency FIVE: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a postpartum midwifery ultrasound.										
85	6,1	normal involution of the reproductive organs after childbirth	10	71%	3	21%	0	0%	1	7%
86	6,2	normal and potential pathological ultrasound appearance of uterus and adnexae, vaginal canal, perineal floor and anal sphincter	5	36%	5	36%	0	0%	3	21%
87	6,3	review the normal of the reproductive organs after childbirth	5	36%	4	29%	1	7%	3	21%
88	6,4	uterus and adnexae	7	50%	3	21%	1	7%	3	21%
89	6,5	vaginal canal	5	36%	3	21%	1	7%	5	36%
90	6,6	perineal floor muscles	3	21%	4	29%	2	14%	5	36%
91	6,7	intactness of anal sphincter	3	21%	3	21%	3	21%	5	36%
92	6,8	refer a person with a high risk profile or abnormal findings to a medial healthcare provider	11	79%	2	14%	0	0%	1	7%

CQN: Chronological question number OQN: Original question number

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Competency SIX: Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behavior to perform a basic gynaecological midwifery ultrasound.										
93	7,1	the normal structures of the uterus, ovaries and adnexa for normal non-pregnant findings	4	29%	6	43%	1	7%	2	14%
94	7,2	the normal structures of the pelvic floor	2	14%	4	29%	3	21%	4	29%
95	7,3	visualize the normal structure of the uterus, ovaries and adnexa with transabdominal ultrasound	4	29%	5	36%	2	14%	2	14%
96	7,4	visualize the normal structures of the basic pelvic floor structures with transabdominal ultrasound	1	7%	5	36%	2	14%	5	36%
97	7,5	examine the uterus, ovaries and adnexa for normal non-pregnant findings during the reproductive age	3	21%	5	36%	2	14%	2	14%
98	7,6	examine the basic pelvic floor structures for normal findings during the reproductive age	1	7%	4	29%	2	14%	5	36%
99	- - -									
100	7,7	Image interpretation for gynaecological scanning is not easy. It is a steep learning curve and transvaginal scanning is essential. Midwifery ultrasound should not include gynaecological ultrasound as a competency.	9	64%	3	21%	1	7%	1	7%
101	7,8	A prerequisite for including gynaecological scanning for midwifery ultrasound should only be included if sufficient hours of clinical practice can be provided to achieve competency .	12	86%	2	14%	0	0%	0	0%

CQN: Chronological question number OQN: Original question number

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

GQR	QNR	Competency element	Essential		Useful		Potential for inclution		Not needed	
			1		2		3		4	
			n	%	n	%	n	%	n	%
Additional questions.										
Task shifting of midwifery ultrasound to the basic or specialist midwife.										
102	8,1	The basic midwife's scope is wide enough (she has enough on her plate) and should primarily manage patients clinically.	5	36%	0	0%	8	57%	1	7%
103	- - -									
104	8,2	The basic midwife should have the basic competencies (level 1) and the specialist midwife should have more advanced skills.	6	43%	7	50%	0	0%	0	0%
105	8,3	Midwives, irrespective of being a basic or specialist midwife, who has a keen interest in the field of ultrasound, should be allowed to prove themselves competent in midwifery ultrasound.	4	29%	7	50%	2	14%	0	0%
106	8,4	Considering the shortages of sonographers and other appropriately qualified healthcare professionals, specialist midwives' roles should include midwifery ultrasound education and training as diagnostic ultrasound is a scarce skill in SA.	2	14%	4	29%	1	7%	0	0%
107	8,5	The specialist midwife has the expertise to effectively integrate the use of midwifery ultrasound into practice.	4	29%	8	57%	1	7%	1	7%
108	- - -									
109	8,6	The current workload of a midwife (basic and/or specialist midwife) allows for midwifery ultrasound to be added as an additional competency.	3	21%	7	50%	1	7%	3	21%

CQN: Chronological question number **OQN: Original question number**

Round 3=81 questions
n=14

Consensus reached: 9 elements (11,1%)
Incomplete questions: 2,1%

GREEN HIGHLIGHT: Consensus reached

Additional questions.										
Level of midwifery ultrasound education and training (Level I, II, III).										
110	- - -									
111	9,1	LEVEL 1, because ultrasound equipment is a scarce resource and level 2 and 3 needs advanced technology which is not available at PHC level.	7	50%	4	29%	3	21%	0	0%
112	9,2	LEVEL 1 for a basic midwives and LEVEL 2 for a midwife specialist.	3	21%	8	57%	2	14%	1	7%
113	9,3	LEVEL 1, with the ability to continue to level 2 or 3 for the midwife specialist working at secondary or tertiary	5	36%	6	43%	2	14%	1	7%
			Essential		**Useful**		**Potential for inclution**		**Not needed**	
			1		**2**		**3**		**4**	
GQR	**QNR**	**Competency element**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Additional questions.										
Distribution of midwifery ultrasound as a potential addition to workload.										
114	10,1	The benefit of midwifery ultrasound for the mother outweighs the addition to workload.	6	43%	6	43%	2	14%	0	0%
115	10,2	Midwifery ultrasound should have a selective impact (only in specific circumstances such as high risk mothers and where a geographical need exists). The additional workload should be managed according to the specific circumstances.	3	21%	8	57%	3	21%	0	0%
116	10,3	Midwifery ultrasound will replace other selective traditional skills such as palpation and fetal heart rate auscultation and consequently the additional workload will be equalised.	1	7%	5	36%	1	7%	7	50%
117	10,4	The midwife should incorporate the competency of ultrasound in her/his daily duties. Competency in ultrasound will lead to time efficiency and should be part of the normal workflow. Midwifery ultrasound is an addition to a preset of competencies and should not be seen as a seperator of functions.	6	43%	5	36%	2	14%	1	7%
118	10,5	The utilization of midwives with the competency of ultrasound in practice should be remunerated accordingly.	5	36%	6	43%	3	21%	0	0%

CQN: Chronological question number **OQN: Original question number**

Addendum D: Data from open-ended questions, Round 1

Domain-specific open-ended questions	**CQN, Competency**
Competency # 1, Round 1:	
knowledge about embryology, fetal anatomy and physiology	CQN 7 Competency #1
Indication for or clinical integration with imaging .... is important	CQN 11 Competency #1
Embryology should be included	CQN 7 Competency #1

Additional questions **Task shifting, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,1. In your opinion, should the basic midwife or the midwife specialist be competent in midwifery ultrasound? Please motivate your answer.		
It is essential to be included **into the specialist midwife curriculum, as they are specialised in midwifery** - **including the ability to identify and refer abnormalities detectable by ultrasound only.**	**CQN 107** **Specialist midwife** **Expert**	**CQN 110** **Identity normal refer abnormal**
ONLY the midwife specialist. **The basic midwife should not be delegated or trained in this skill set. Their scope is wide enough** to not be consider for this delegation. However I do think this should be an **additional skill set for midwife specialists. So the ones that are trained can up graded and the ones training can be included. As the after accessing of this skill set is not easily available currently.**	**CQN 102** **Not Basic midwife** **CQN 108** **Specialist midwife as an additional skill** **CQN 107** **Specialist Midwife**	
Ectopic pregnancy and high suspicion index for extra-uterine pregnancy **(identification of high risk factors)**		**CQN 110** **Identity normal refer abnormal**
However it will also be useful to **equip the basic midwife to be competent in basic ultrasonography** as they are allowed by their scope of practice to practice independent, indicating that they also need to be able **to identify and refer for abnormal findings detectable by ultrasound only.**	**CQN 104**	**CQN 110** **Identity normal refer abnormal**

Additional questions **Task shifting, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,1. In your opinion, should the basic midwife or the midwife specialist be competent in midwifery ultrasound? Please motivate your answer.		
The basic midwife has enough on her plate.	**CQN 102** **Not basic midwife** **CQN 107** **Specialist Midwife**	
Considering the **shortages of sonographers and other appropriately qualified healthcare professionals to enable the required legislated access to sonographic services, capacity building of additional healthcare professionals may be beneficial.**	**CQN 103** **Shortage of U/S**	
Not necessarily. It might be a bonus for a **specific midwife who has an interest** in it and who is technically proficient, **but midwives should primarily manage patients clinically**. If they are not proficient in ultrasound, it is entirely acceptable that they refer for ultrasound examinations to other professionals when a clinical indication arises.	**CQN 102** **Midwives should primarily manage patients clinically** **CQN 105** **Midwives with a keen interest** **U/S competent**	
Yes. If a midwife performs scans **needs to know what he/she is doing.**	**CQN 105** **U/S competent**	

Additional questions **Task shifting, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,1. In your opinion, should the basic midwife or the midwife specialist be competent in midwifery ultrasound? Please motivate your answer.		
YES, I think **midwives working at a primary health care level should be able to do the basic obstetric ultrasound**	**CQN 103** **Basic midwife** **Basic U/S** **Primary healthcare**	
Yes, this fits in well as part of an antenatal visit. **With the lack of sonographers in the country, midwifery ultrasound skills are essential.**	**CQN 103** **Primary healthcare** **Shortage of U/S** **Basic midwife**	
A midwife should have **basic knowledge regarding gestational age dating, lie and possibly basic anatomy**	**CQN 104**	
Yes, the **basic/specialist midwife should be competent in midwifery ultrasound**. Obstetric ultrasound screening should **be offered to all pregnant women preferably at PHC** level. **Diagnostic ultrasound is a scarce skill in SA. The number of qualified health care professionals offering obstetric ultrasound services is grossly inadequate for the needs of the country.** Midwives are best positioned to offer the service if they are appropriately trained. However, ultrasound competency has a steep learning curve requiring many hours of clinical practice. Should ultrasound be included in the curriculum of the midwife, it will have an impact on the length of the course. **Ultrasound examinations can be time-consuming e.g. 2nd-trimester fetal anomaly scan can take 20-30 minutes. Due consideration should be given to the workload of the midwife. Can the midwife in the field absorb this additional workload?**	**CQN 103** **Primary healthcare** **CQN 105** **U/S competent** **CQN 106** **CQN 109**	

Additional questions **Levels of midwifery U/S, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,2: In your opinion, should midwifery ultrasound be classified according to level one, two or three obstetric and gynaecological ultrasound? Please motivate your answer.		
I think level 1 because **sonar equipment is a scarce resource and level 2 and 3 needs advanced technology and skills.**		**CQN 110** **Level 1** **Identity normal refer abnormal** **CQN 111** **Scarce resource, Level 2 and 3 not at primary healthcare**
I believe **level 1 for a basic midwife**. To have knowledge and skills to assist in the detection of abnormalities and further timeous referral. **A specialist midwife should be at level 2 to be able to do more advanced ultrasound examinations. They should have a more advanced skill set than that of a basic midwife**. As per my previous answer: I believe that a basic midwife should have some basic competencies in ultrasound, such as a basic introductory course. To assist with timeous detection of abnormalities and referral to the appropriate healthcare professional. **A specialist midwife can then do a more advanced course on ultrasound with more advanced ultrasound competencies. Enabling them to diagnose, treat and refer appropriately.**	**CQN 108** **Specialist midwife as an additional skill**	**CQN 110** **Identity normal refer abnormal** **CQN 112** **Level 1 basic midwife and Level 2 specialists midwife**

Additional questions **Levels of midwifery U/S, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,2: In your opinion, should midwifery ultrasound be classified according to level one, two or three obstetric and gynaecological ultrasound? Please motivate your answer.		
Level 1, as it does not need more sophisticated ultrasound equipment.		**CQN 111** **Scarce resource, Level 2 and 3 not at primary healthcare**
Yes, it can be classified as such. I do feel though that midwives should definitely still refer clients to a more trained professional if there are concerns. **So they would have to send clients to either sonographers or obstetricians if there are concerns about the client and the foetus.**		**CQN 110** **Identity normal refer abnormal**
Level 1 - and referral if any abnormalities are detected.		**CQN 110** **Identity normal refer abnormal**
Midwives should at least be able to perform **level 1 Basic scanning as a means to incorporate technology to enhance their already acquired skills.** It may be useful to specify that Midwives may use ultrasound in **a non-specialised clinical setting** for Midwifery and Gynaecological. I would also encourage midwives to learn and use the **Doppler technique, especially for umbilical flow.**	**CQN 105** **U/S competence**	**CQN 110** **Level 1 (Doppler)** **Primary healthcare**
For a **basis midwife at least level I ultrasound training and for a specialist midwife even level II ultrasound training.**		**CQN 112**

Additional questions **Levels of midwifery U/S, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,2: In your opinion, should midwifery ultrasound be classified according to level one, two or three obstetric and gynaecological ultrasound? Please motivate your answer.		
Level1. The mobile ultrasounds of Dept of Health issued to midwives, **do not have the ability of the specialised machines in bigger centra**. **The midwife can do a basic ultrasound and refer to a specialist when abnormalities are detected.**		**CQN 110** **Level 1** **Primary healthcare** **Identify normal** **Refer abnormal** **CQN 111** **Scarce resource, Level 2 and 3 not at primary healthcare**
Level 1 only. Midwives should provide safe antenatal care in low-risk women and identify abnormalities in time.		**CQN 110** **Level 1** **Primary healthcare** **Identify normal** **Refer abnormal**
Level I only.		**CQN 110** **Level 1**

Additional questions **Levels of midwifery U/S, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,2: In your opinion, should midwifery ultrasound be classified according to level one, two or three obstetric and gynaecological ultrasound? Please motivate your answer.		
To maintain clear role clarification and not encroaching on other healthcare professionals' roles within the wider healthcare system in South Africa, **specialist midwives should receive education and training corresponding to level I midwifery ultrasound.** **This will ensure greater PHC access, primarily, to basic sonographic services. Should the patient present with any high risk indicators or require further investigation through specialised evaluation, the midwife would be in a position to refer the patient to specialist sonographers and other obstetrics and gynaecology professionals.**	**CQN 108** **Specialist midwife as skill**	**CQN 110** **Level 1** **Primary healthcare** **Identify normal** **Refer abnormal**
Level I.		**CQN 110** **Level 1**
Level 1 obstetric ultrasound could be included in the curriculum of the basic midwife. This would require basic ultrasound training. This service can thus be offered at PHC level as a screening programme. **Level 2 (or 3) obstetric ultrasound should be included in the curriculum of the midwife specialist. This would require advanced ultrasound training. The service can thus be offered at secondary and tertiary level.** Careful consideration must be given to gynaecological ultrasound. I would recommend a normal gynaecological scan and early pregnancy complications. Gyn pathological appearances on ultrasound can be tricky.		**CQN 112** **Level 1** **Basic midwife** **Level 2 or 3 for the specialist midwife at secondary or tertiary level**
Level 1 should be essential.		**CQN 110** **Level 1**

Additional questions **Levels of midwifery U/S, Round 1**	**Thematic allocation**	
	Task shifting	**Level of U/S**
OQN 8,2: In your opinion, should midwifery ultrasound be classified according to level one, two or three obstetric and gynaecological ultrasound? Please motivate your answer.		
I think ultrasound should be a basic understanding and practice and not become a speciality.		**CQN 110** **Level 1**
Level 1. Training for level 2 and 3 will be much longer, and others can do these.		**CQN 110** **Level 1**
This will depend on the midwife's area of responsibility. If assigned to perform level II and III that level of competence needs to reach.	**CQN 105**	**CQN 112** **Level 1 basic midwife** **Level 2 and 3** **Specialist midwife**

Addendum D: Data from open-ended questions, Round 2

Domain-specific open-ended questions	**CQN**
Competency # 1, Round 2	
Apply appropriate ultrasound techniques /protocols for image formation. Identify normal maternal and fetal anatomy, physiology, embryology.	CQN 11
Competency # 2, Round 2	
recognise adnexal masses and distinguish between physiological and pathological masses	CQN 43
Competency # 3, Round 2	
CNS seems excluded from the list of organs to assess are absolutely essential!	CQN 48
If the aim is to train midwives to be competent to do a 2nd trimester level 2 scan, then the following should be included when assessing fetal anatomy: head, neck and spine thorax including heart lungs and diaphragm gastro-intestinal tract genito-urinary tract skeletal system. Basic Doppler ultrasound maybe useful for complications e.g. IUGR however these patients would be referred for specialist management / next level of care where detailed Doppler studies would be done. Doppler ultrasound should never be done routinely or as a screening programme due to possible biological effects	CQN 48 CQN 50 CQN 51 CQN 52 CQN 53
Competency # 4, Round 2	
Include confirmation of a positive fetal heart beat	CQN 84

Domain-specific open-ended questions	CQN, Competency
Competency # 5, Round 2	
The above is a gynaecological scan and requires quite a lot of practice. These skills should only be included if sufficient hours of ultrasound practice can be provided for the necessary level of competency.	CQN 101
Competency # 6, Round 2	
Image interpretation for gynaecological scanning is not easy. It is a steep learning curve. Transvaginal scanning is essential. Should there be sufficient hours for ultrasound practice to achieve competency, then this skill may be included.	CQN 101

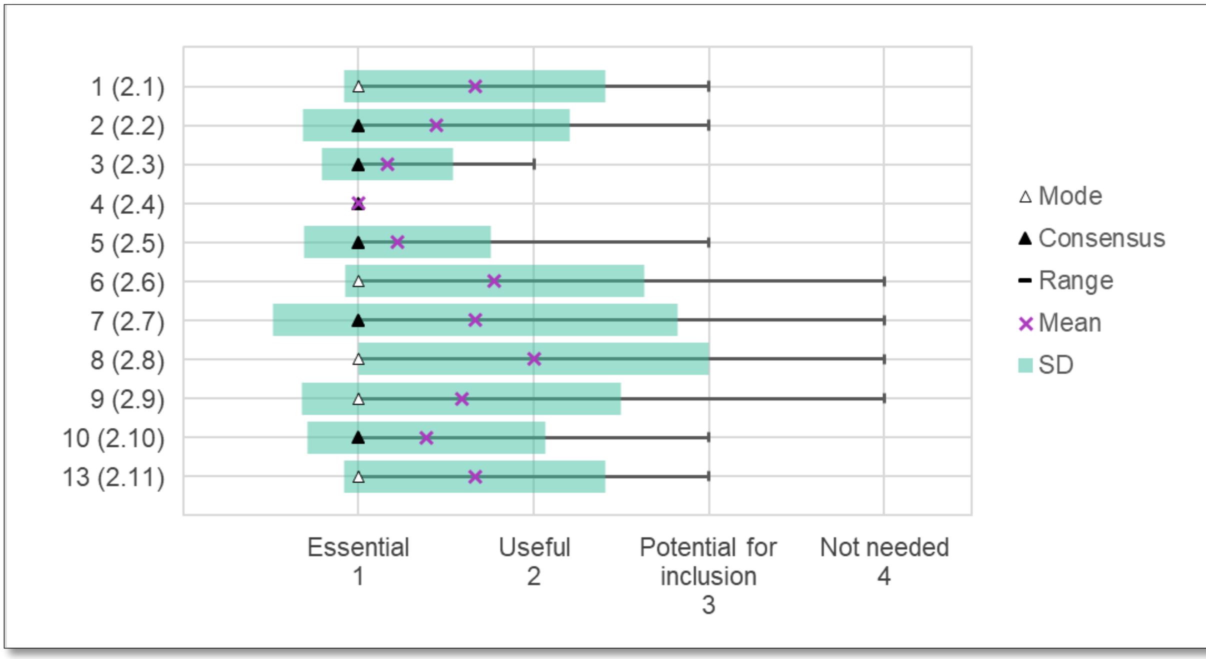
Additional questions **Workload distribution of midwifery U/S, Round 2**	**Thematic allocation**				
	Remuneration	**Daily duties**	**Benefit vs workload**	**Replaced traditional skills**	**Use selectively for highest impact**
OQN 8.8: In your opinion, how would you propose the midwife in the field should absorb this additional workload?					
A competent midwife who performs ultrasound, will not take up that much time - 15 - 20 minutes, and the result of the ultrasound findings **will contribute to the management of the patient. Planning is essential.**		**CQN 114**	**CQN 114**		
I believe the specialist midwife working in primary health care or district facilities should learn basic U/S to differentiate normal from potential abnormal pathology and refer timeously					**CQN 115**
It is not that much extra work when clinically checking a client for her routine checkup. The ultrasound **replaces listening to the heart with doppler and having to palpate to figure out lie of baby as well as measuring fundal height. And anyways you get a more accurate look at the progress of the pregnancy. In my opinion a consultation does not take me longer just because I am doing an ultrasound as well**		**CQN 117**		**CQN116**	
Not all patients need ultrasound. **A midwife should do an ultrasound after she identified high risk factors during a normal physical assessment of the mother and foetus including history taking.**		**CQN 117**			

Additional questions **Workload distribution of midwifery U/S,** **Round 2**	**Thematic allocation**				
	Remuneration	**Daily duties**	**Benefit vs workload**	**Replaced traditional skills**	**Selective for highest impact**
OQN 8.8: In your opinion, how would you propose the midwife in the field should absorb this additional workload?					
If you look at issues of workload you may think this is addition to the work but interms of Job satisfaction then you may think again as you will be having a direction in your management There will be improved outcomes which may be not affecting Midwifery profession as we are carrying more workload on unresolved issues timeously **This can be part of the routine in the clinical management of any patient not as added workload The benefits outweighs the rest of all**		**CQN 117**	**CQN 114**		
it requires far too much training time to become really competent in even a basic ultrasound and one loses the skill quickly if it is not practiced regularly. It is not feasible to make this a compulsory part of midwife training as it will not be possible to fit it into the current curriculum. It is far better to focus on in-depth training in the clinical skills for all midwives. **I would support ultrasound training to be offered as a separate module** (perhaps as an 'elective'?) for those midwives who have an interest and aptitude for this technology and who will indeed put this skill into practice after their qualification, i.e. **those who wish to work in rural areas or specialist midwives**. **Midwives in a hospital setting where obstetric doctors are working will rarely use this skill and hence it not worthwhile to spend a significant time into the skills training for this - some theoretrica knowledge however is still required for al midwives.**					**CQN 115**

Additional questions **Workload distribution of midwifery U/S,** **Round 2**	**Thematic allocation**				
	Remuneration	**Daily duties**	**Benefit vs workload**	**Replaced traditional skills**	**Selective for highest impact**
OQN 8.8: In your opinion, how would you propose the midwife in the field should absorb this additional workload?					
In group practice some more proficient in ultrasound spending more time on ultrasound		**CQN 117**			
Sometimes the lack of resources e.g a functional sonar machine poses a bigger problem than task allocation to midwifes					
If most midwives are competent to perform ultrasound, **it is not additional workload in my opinion as it would be part of patient management just as other equipment** or **technologies are used. instead of using hands (imagination), ultrasound can provide visualising** Ultrasound may be listed as one of equipment needed to manage gynaecological and obstetric patients		**CQN 117**		**CQN 117**	
Basic Midwives should only do basic ultrasounds **which can be done at booking and should not take much longer than the normal booking.** If more specialised scans required, midwives should 'specialise' in this, i.e. be given specific time for this purpose.		**CQN 117**			
I strongly suggest this only be offered as a post training add on only to the Specialist Midwife. Only after been found competent should this be included in her skill set. **The workload addition needs to be taken in on allocation and geographical need as well as remuneration for the midwife**	**CQN 118**				
Should be part of patient examination/evaluation		**CQN 117**			
For a specialist midwife to be trained in all aspects of OBGYN ultrasound he/she should do an additional course after training as a specialist midwife. Limited ultrasound examinations e.g. Level 1 Obstetric Scan, may be integrated in midwifery training. There are 2 big challenges: 1. Achieving competency in ultrasound requires many hours of practice. This must be taken into account if one includes it in any of the curricula 2. **Ultrasound services will add to the midwife's workload. An examination can take 10 min or as long as 30 min. Health care facilities should motivate for extra midwifery posts.**					**CQN 115**

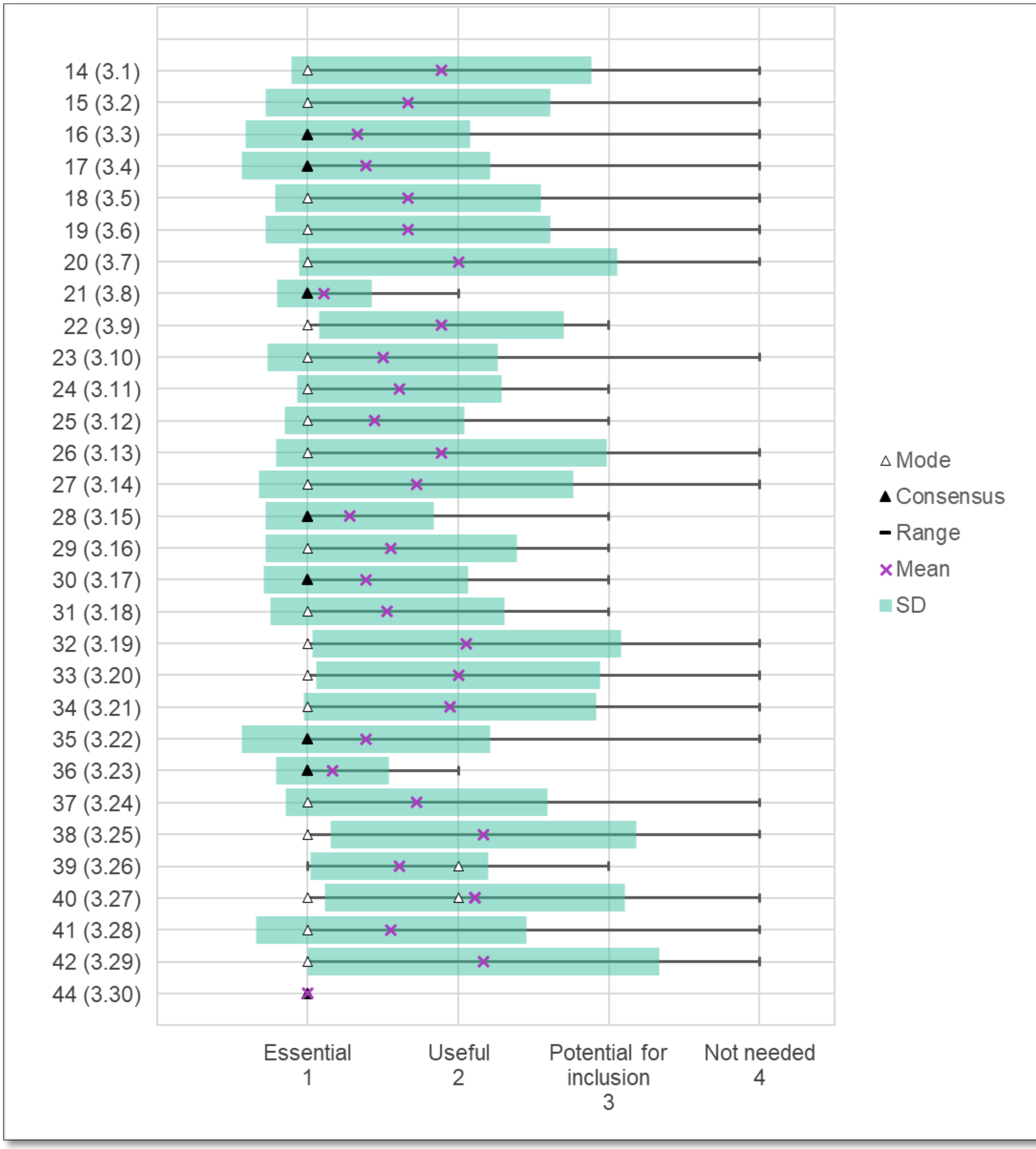
Addendum D: Descriptive statistics, Round 1

Competency #1



Round 1 Competency #1

Competency #2



Round 1, Competency #2

Competency #3

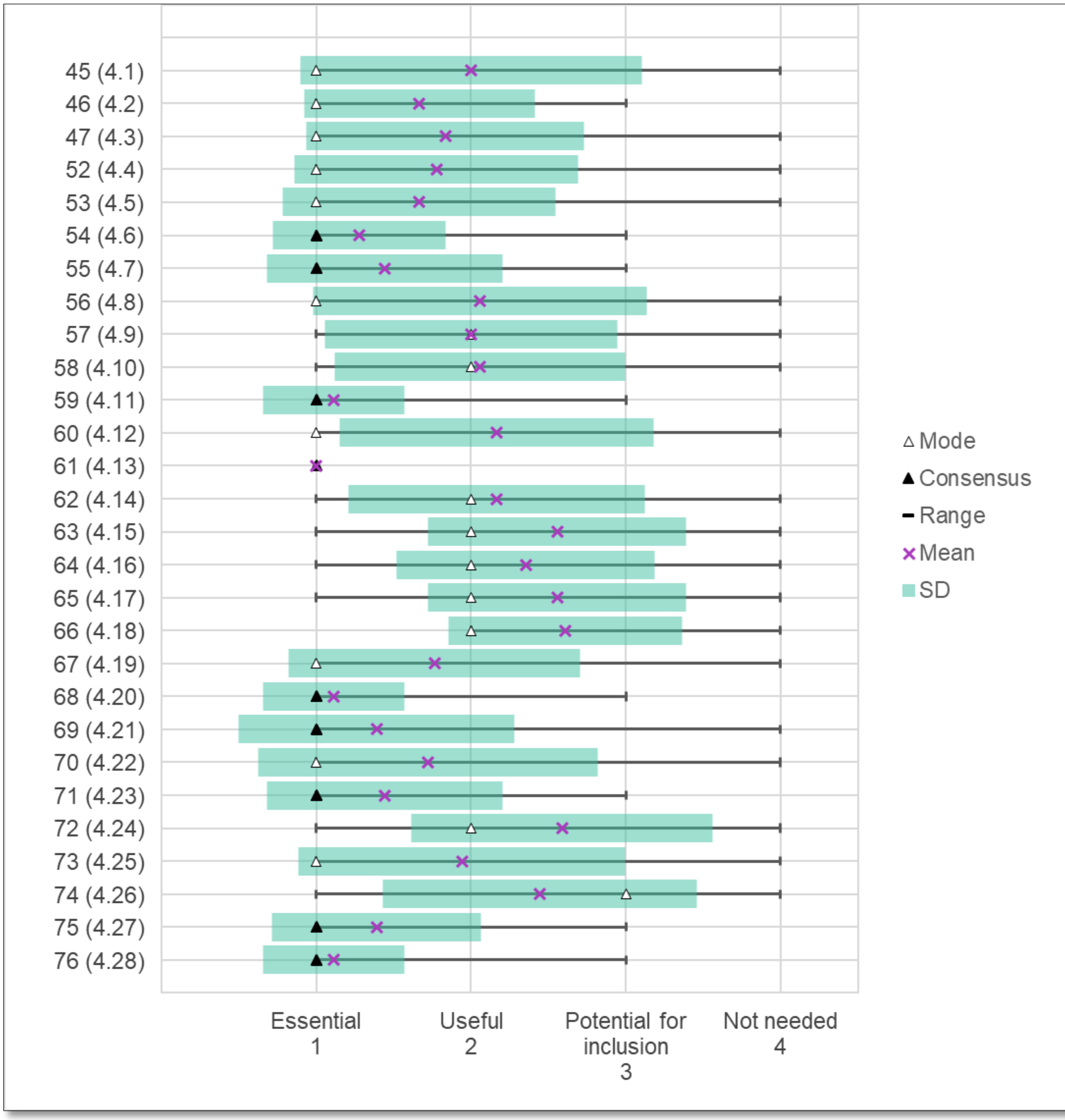


Figure 1 Round 1, Competency #3

Competency #4

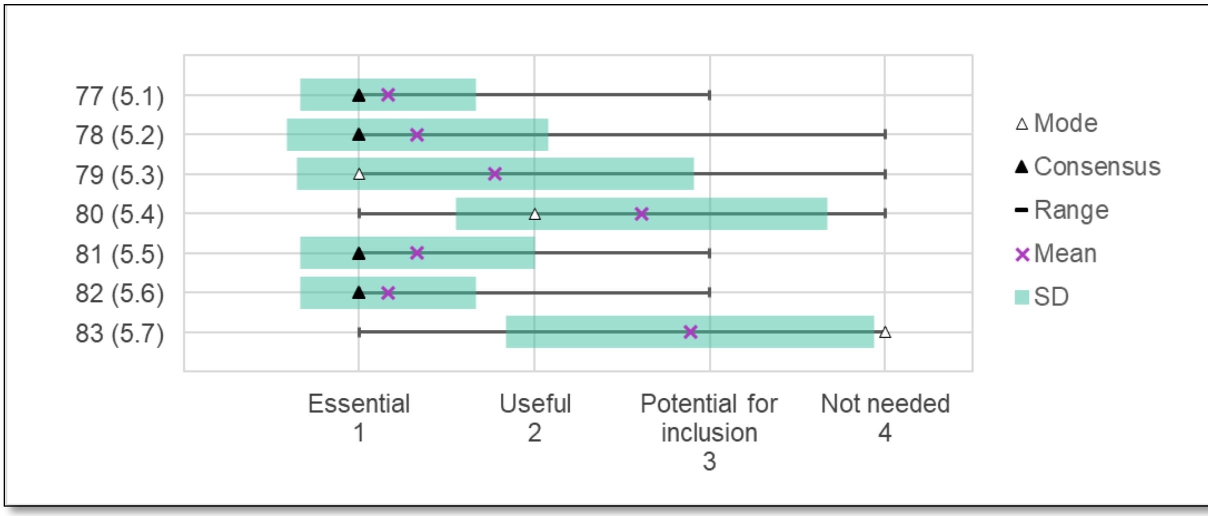


Figure 2 Round 1, Competency #4

Competency #5

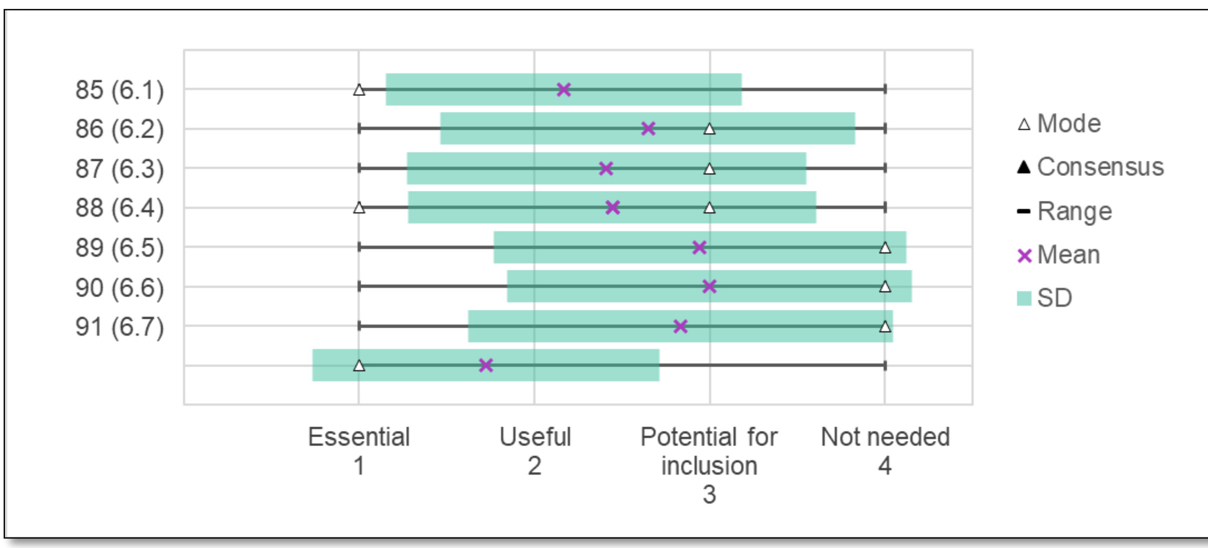


Figure 3 Round 1, Competency #5

Competency #6

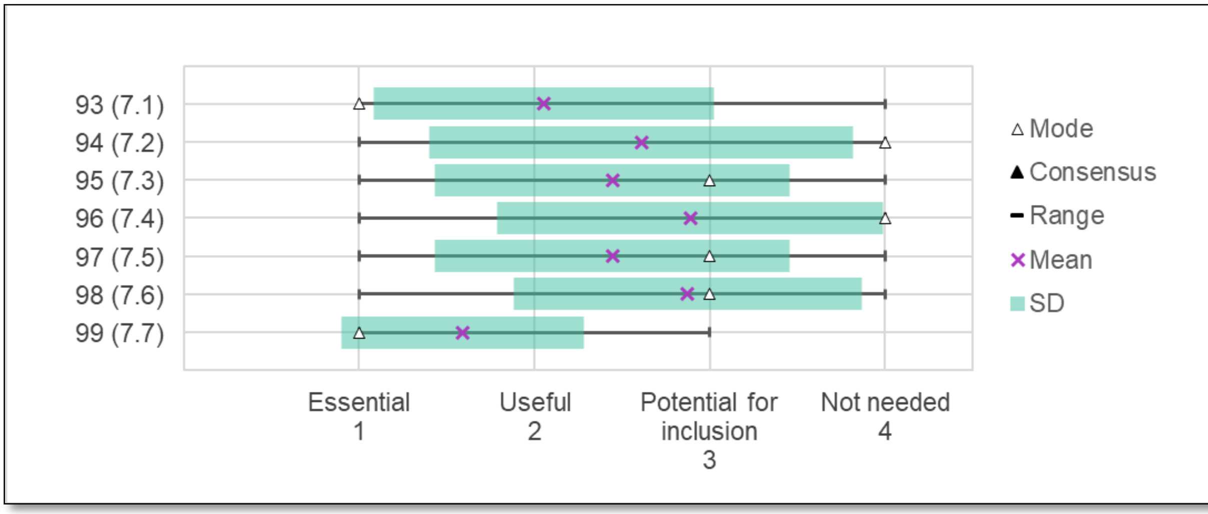
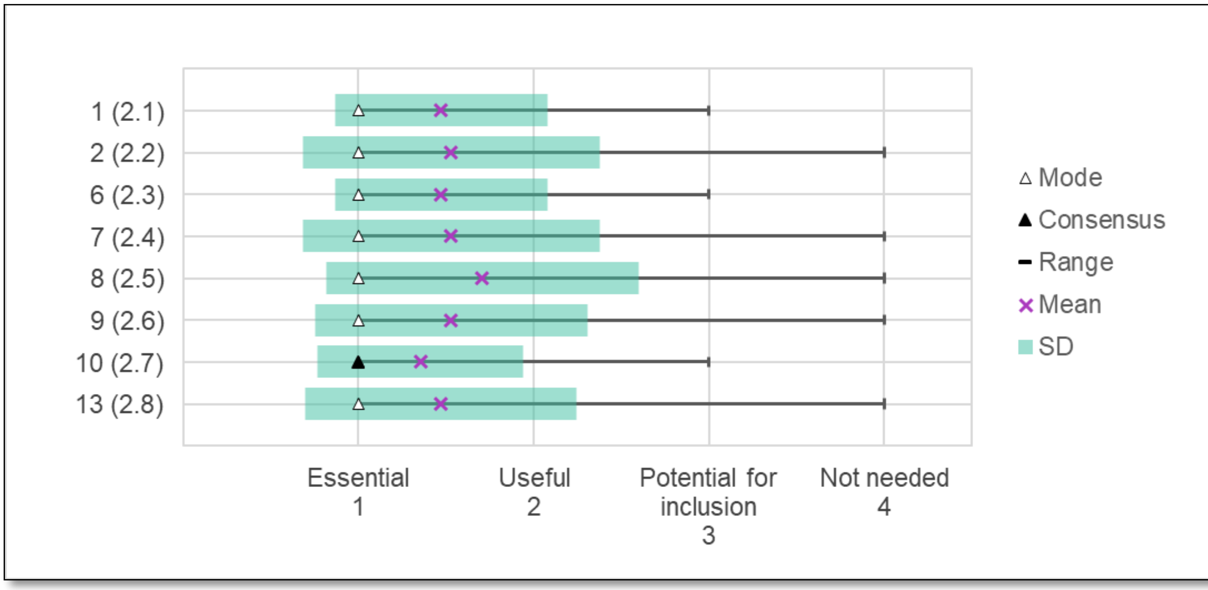


Figure 4 Round 1, Competency #6

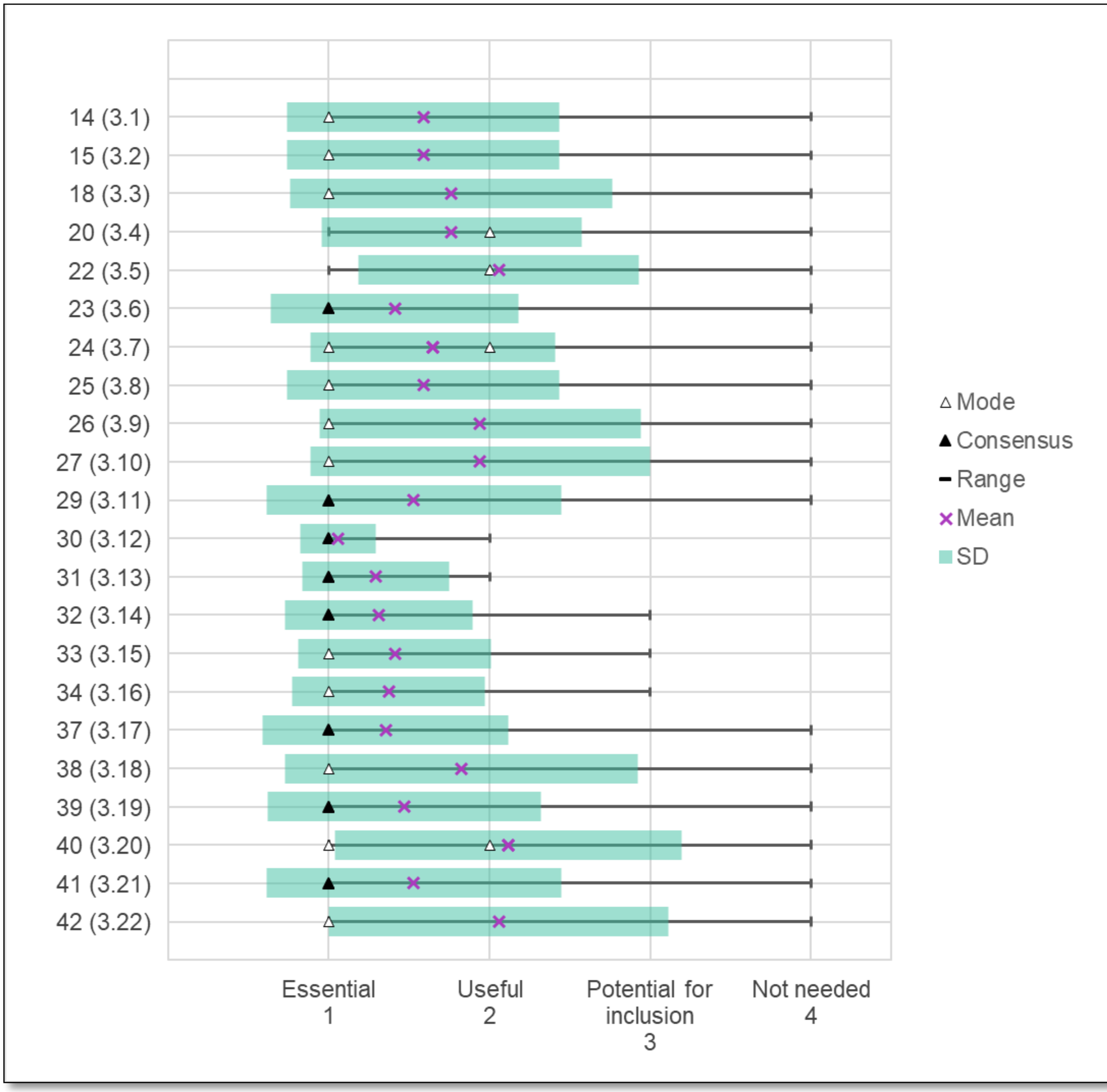
Descriptive statistics, Round 2

Competency #1



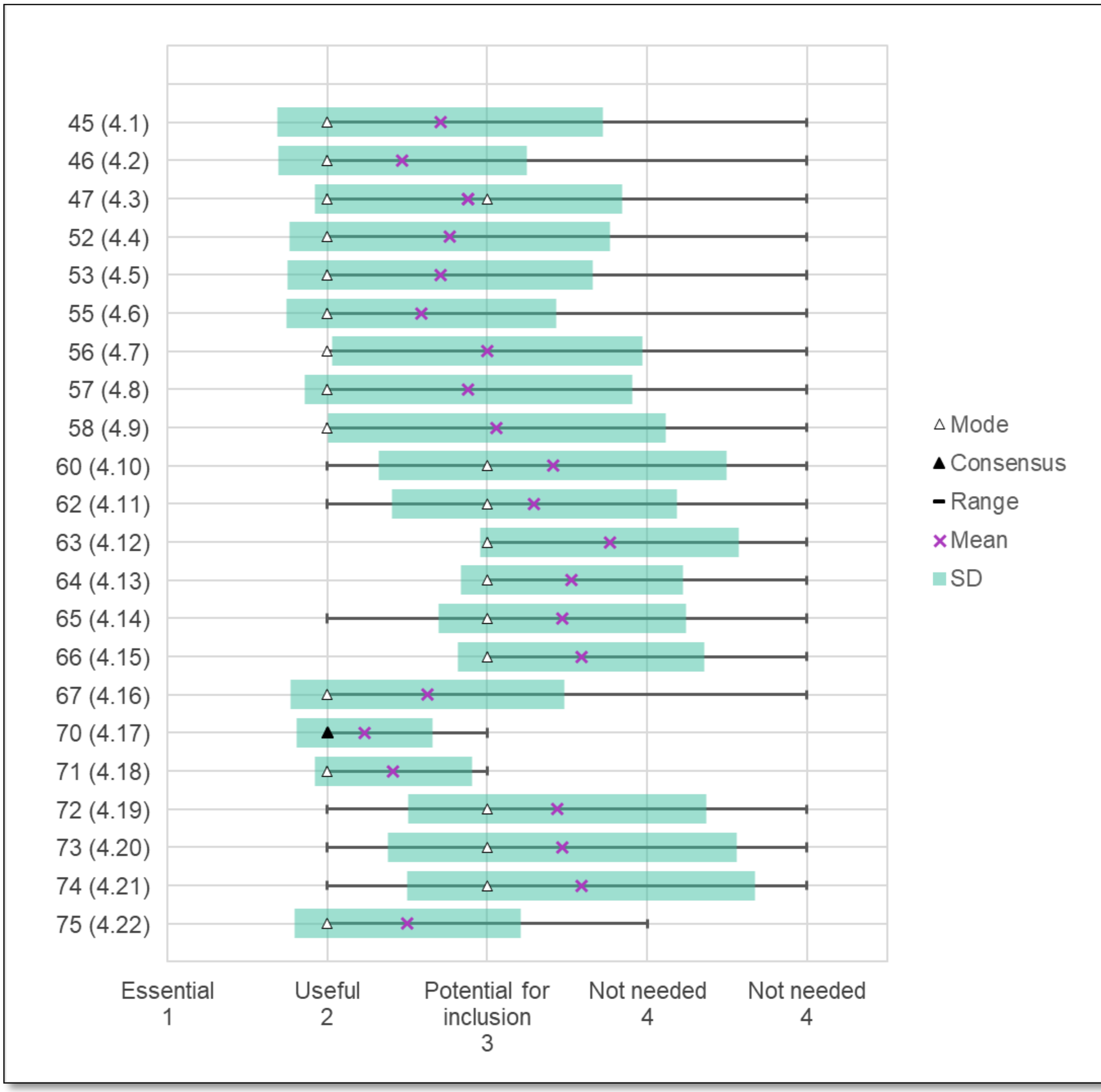
Round 2 Competency #1

Competency #2



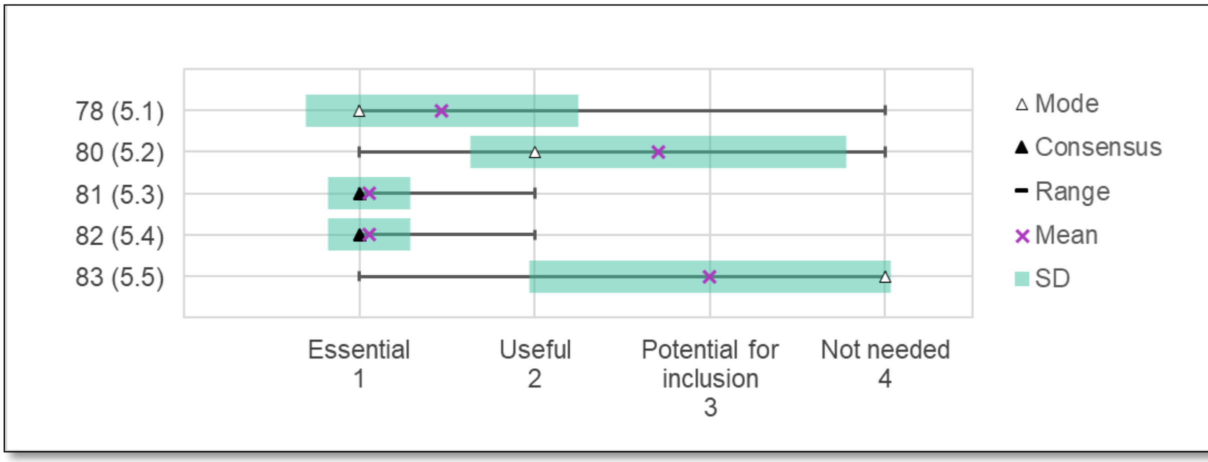
Round 2, Competency #2

Competency #3



Round 2, Competency #3

Competency #4



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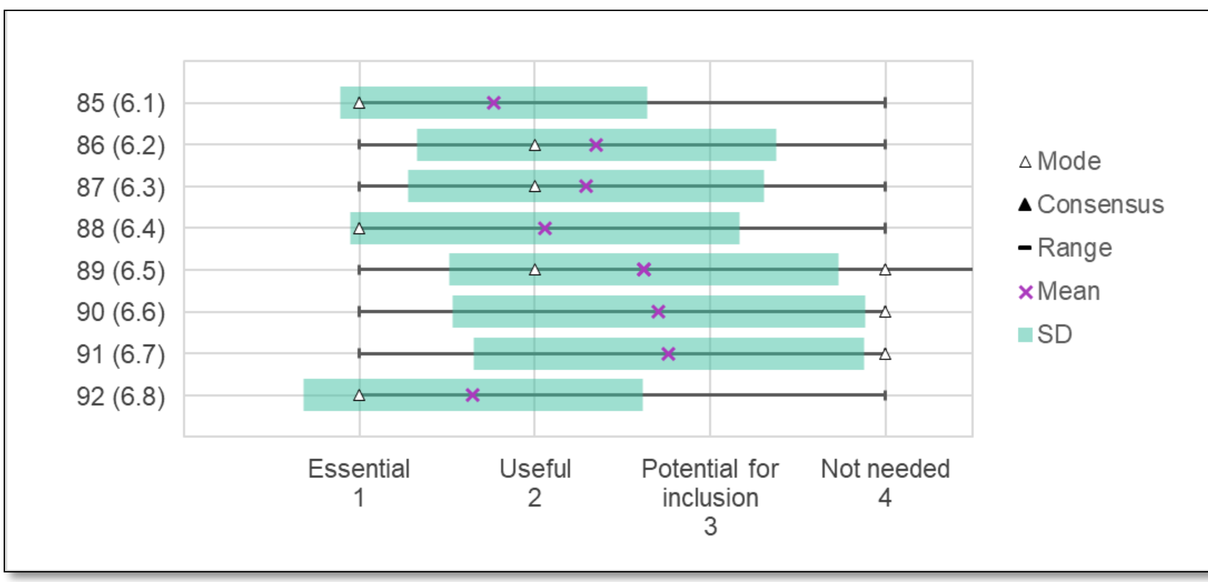
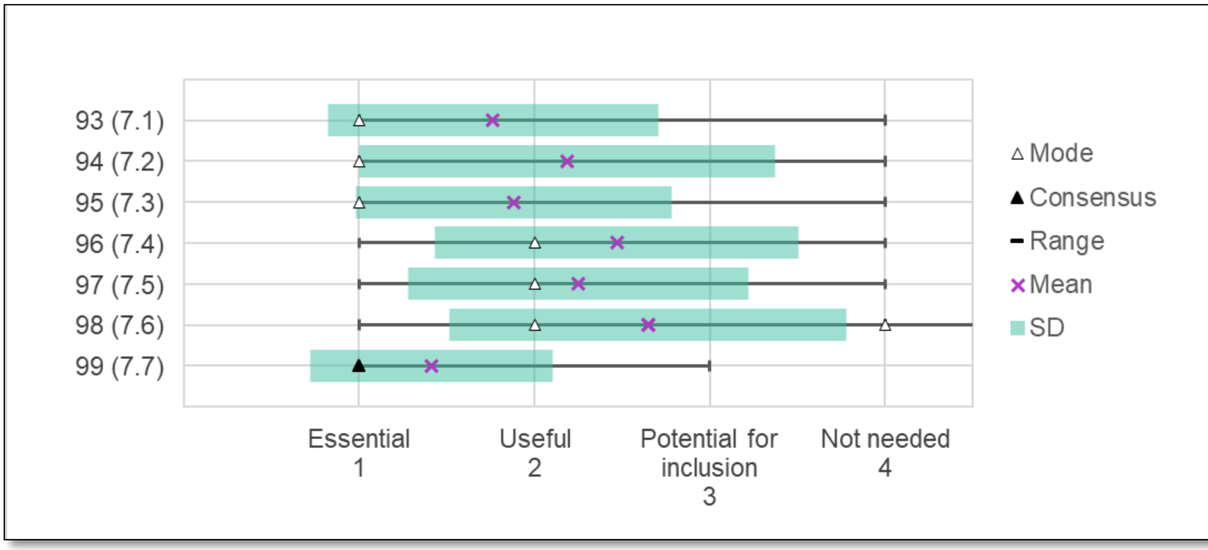


Round 2, Competency #5

Competency #6



Round 2, Competency #6

Descriptive statistics, Round 3

Competency #1

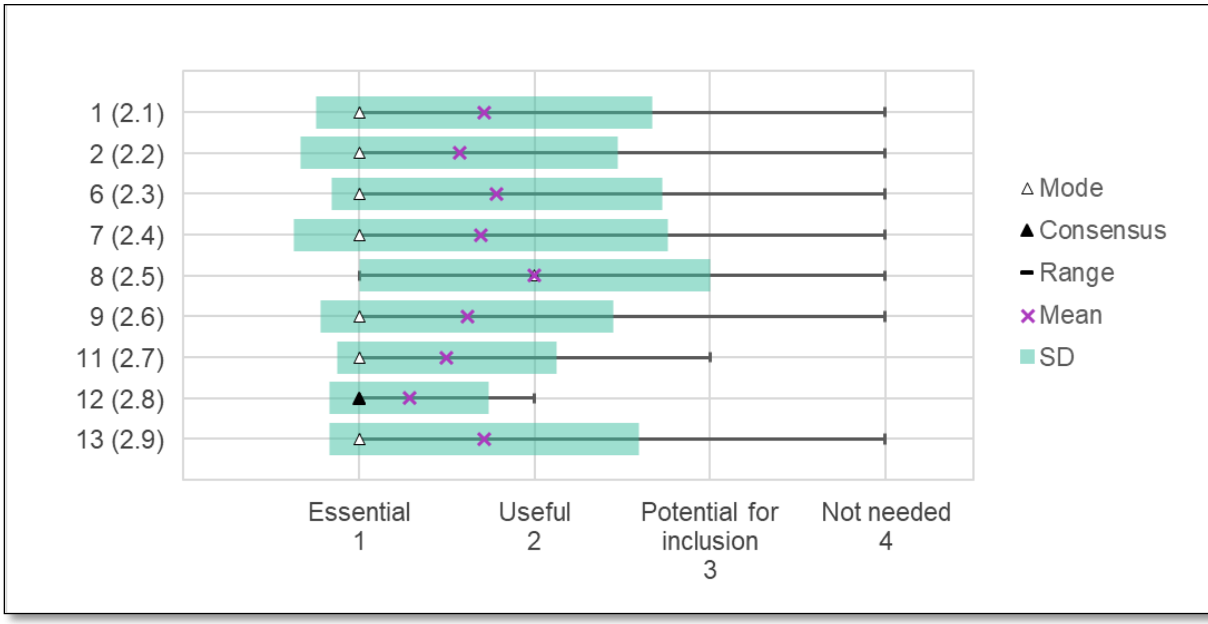


Figure 1 Round 3 Competency #1

Competency #2

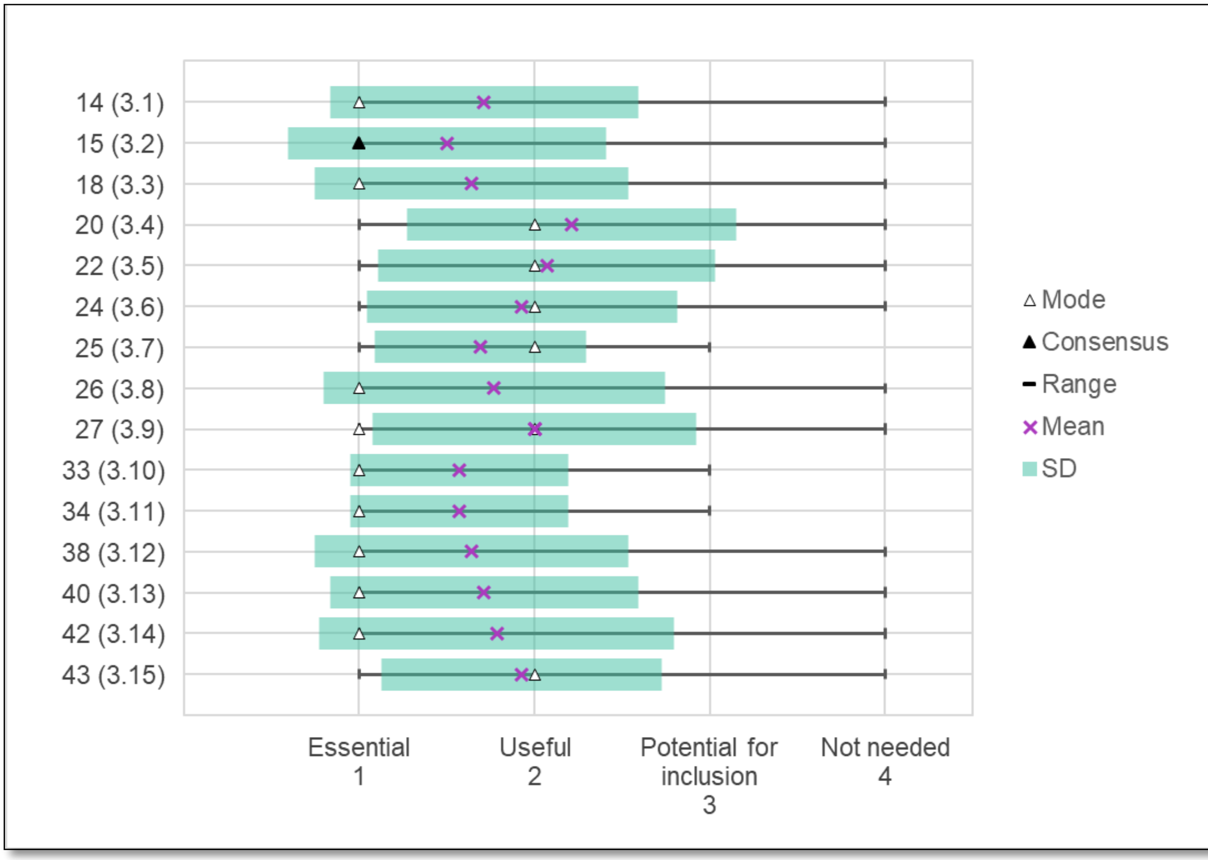


Figure 2 Round 3, Competency #2

Competency #3

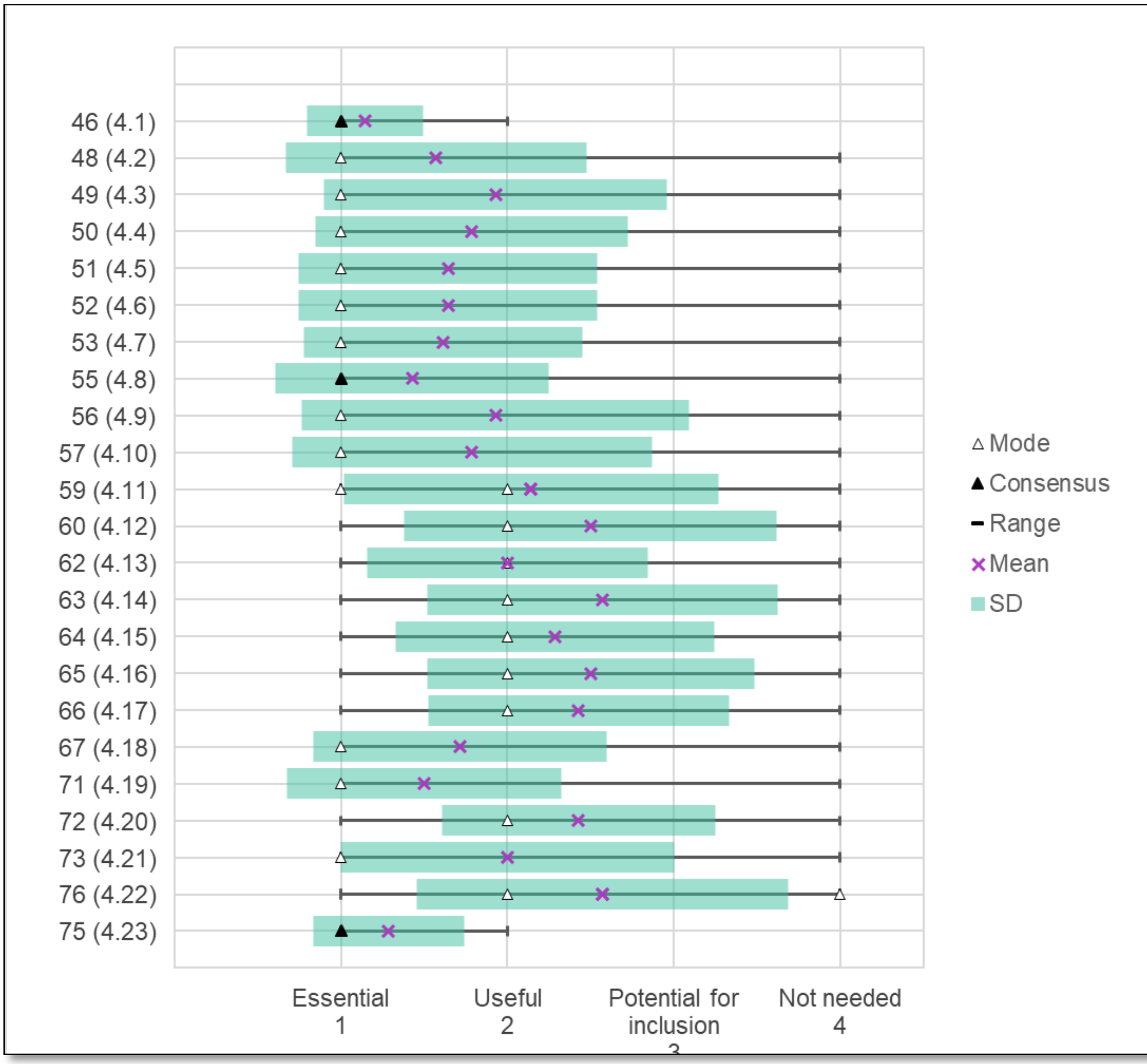


Figure 3 Round 3, Competency #3

Competency #4

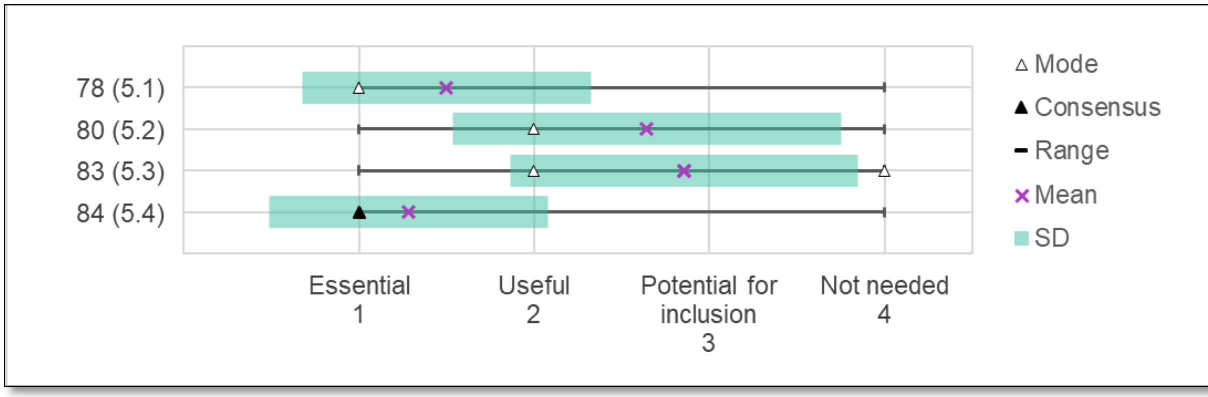


Figure 4 Round 3, Competency #4

Competency #5

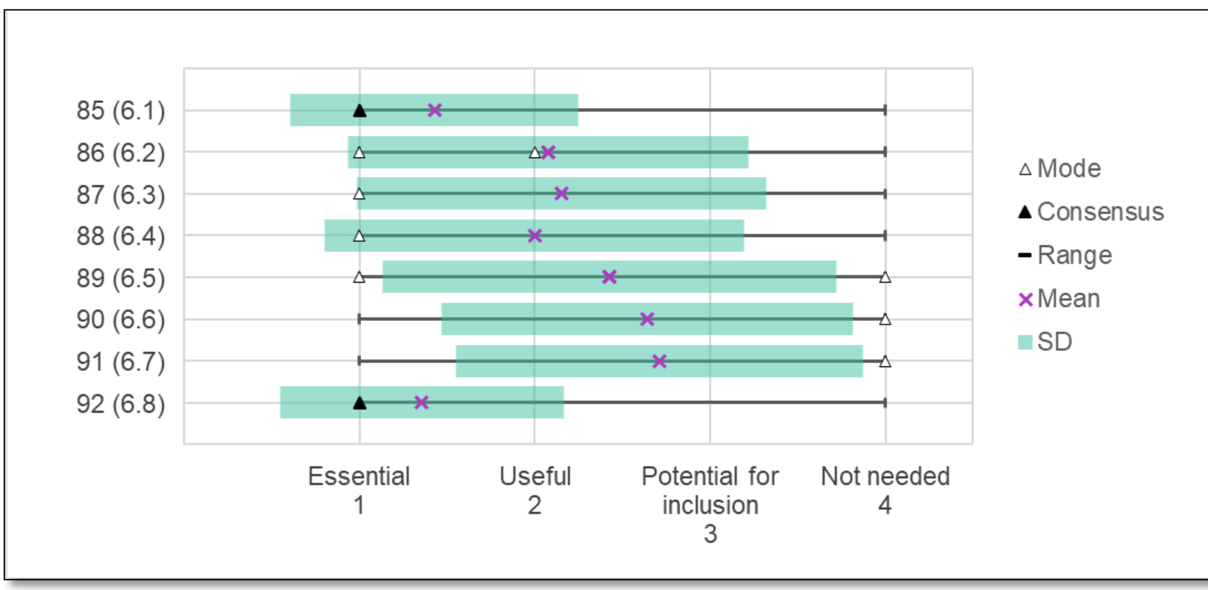


Figure 5 Round 3, Competency #5

Competency #6

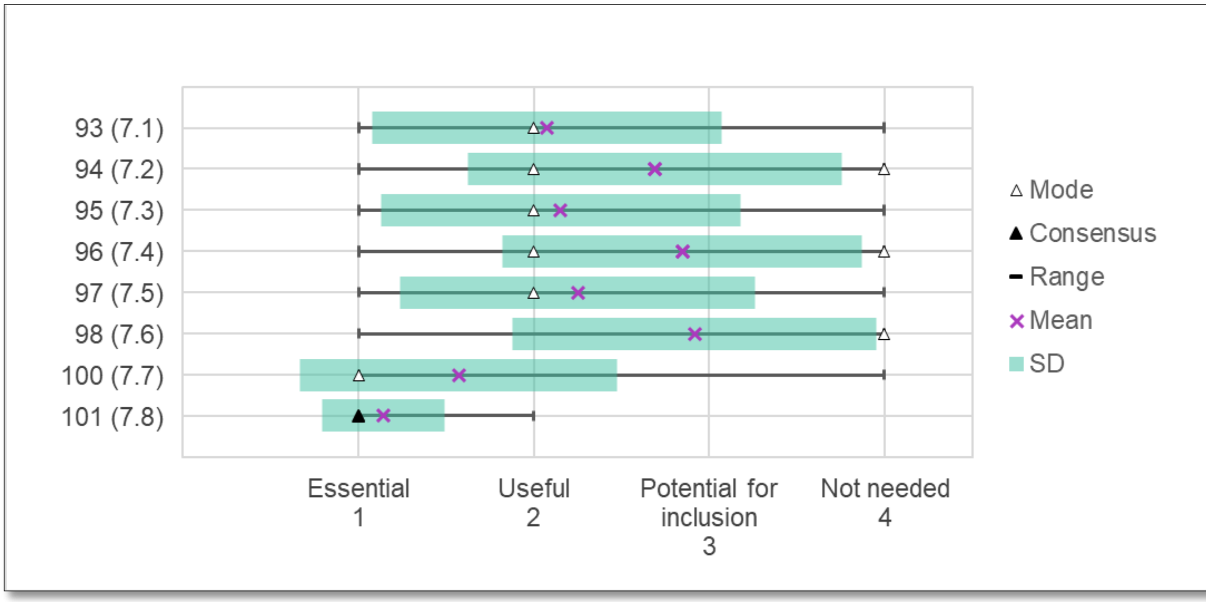
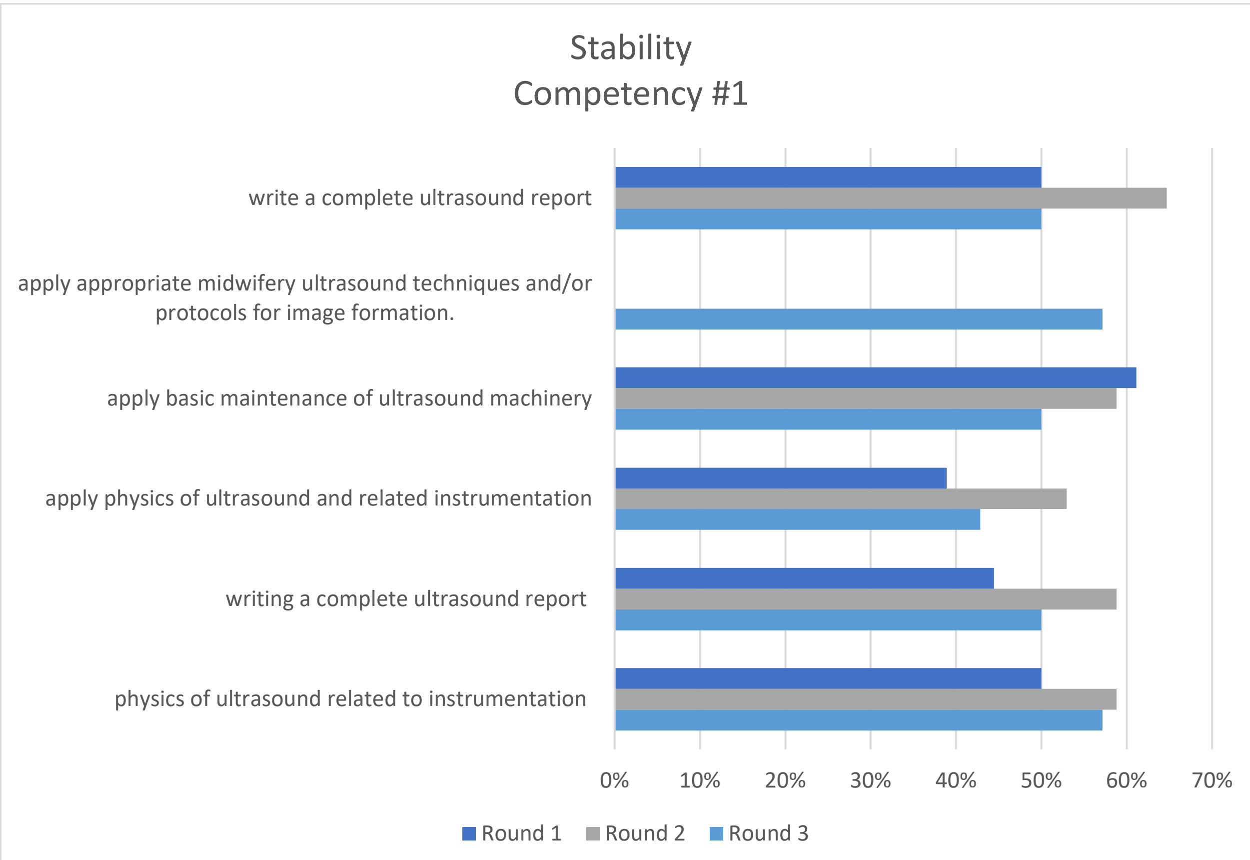


Figure 6 Round 3, Competency #6

Addendum D:

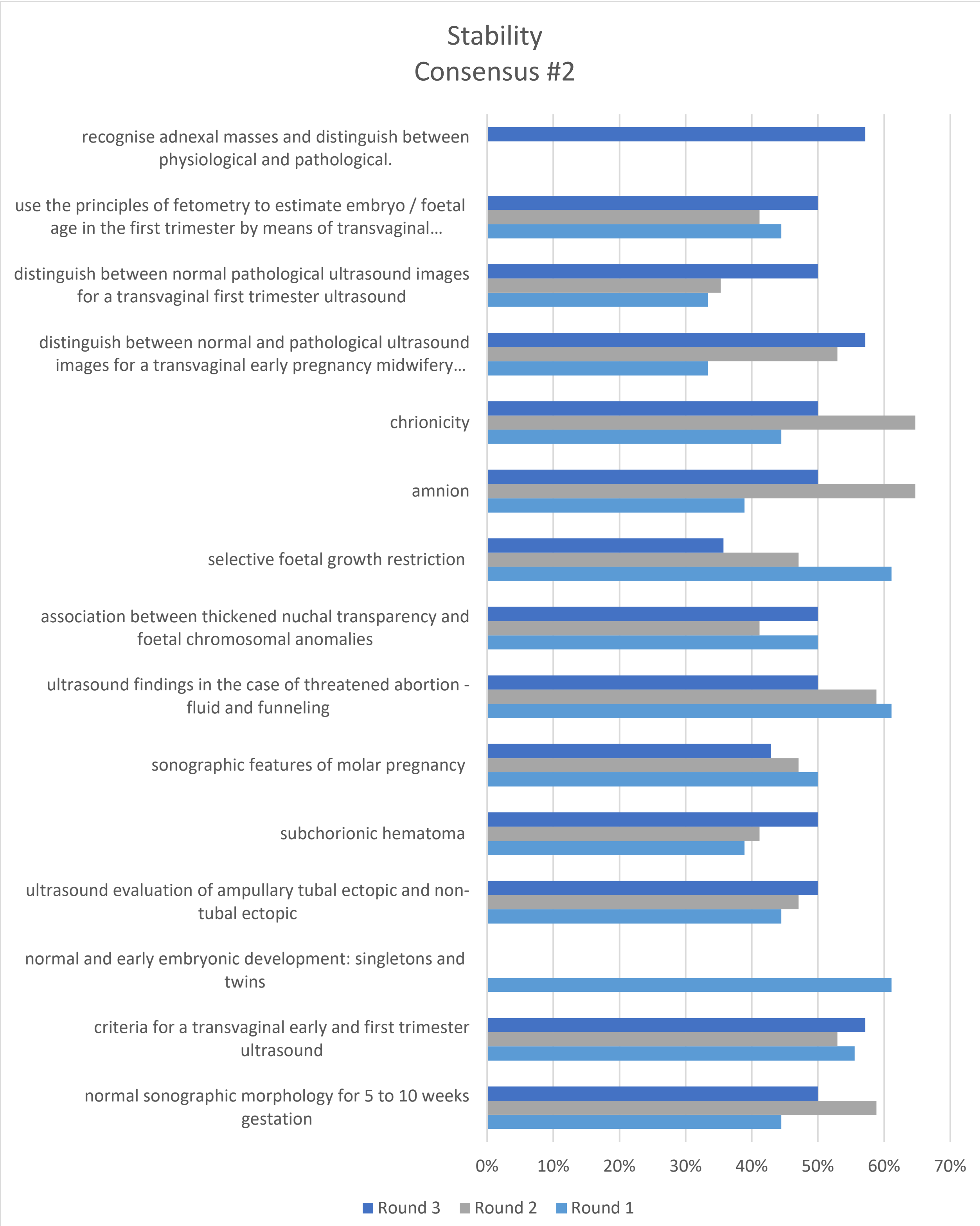
Stability declared in Round 3 on non-consensus statements

Competency #1



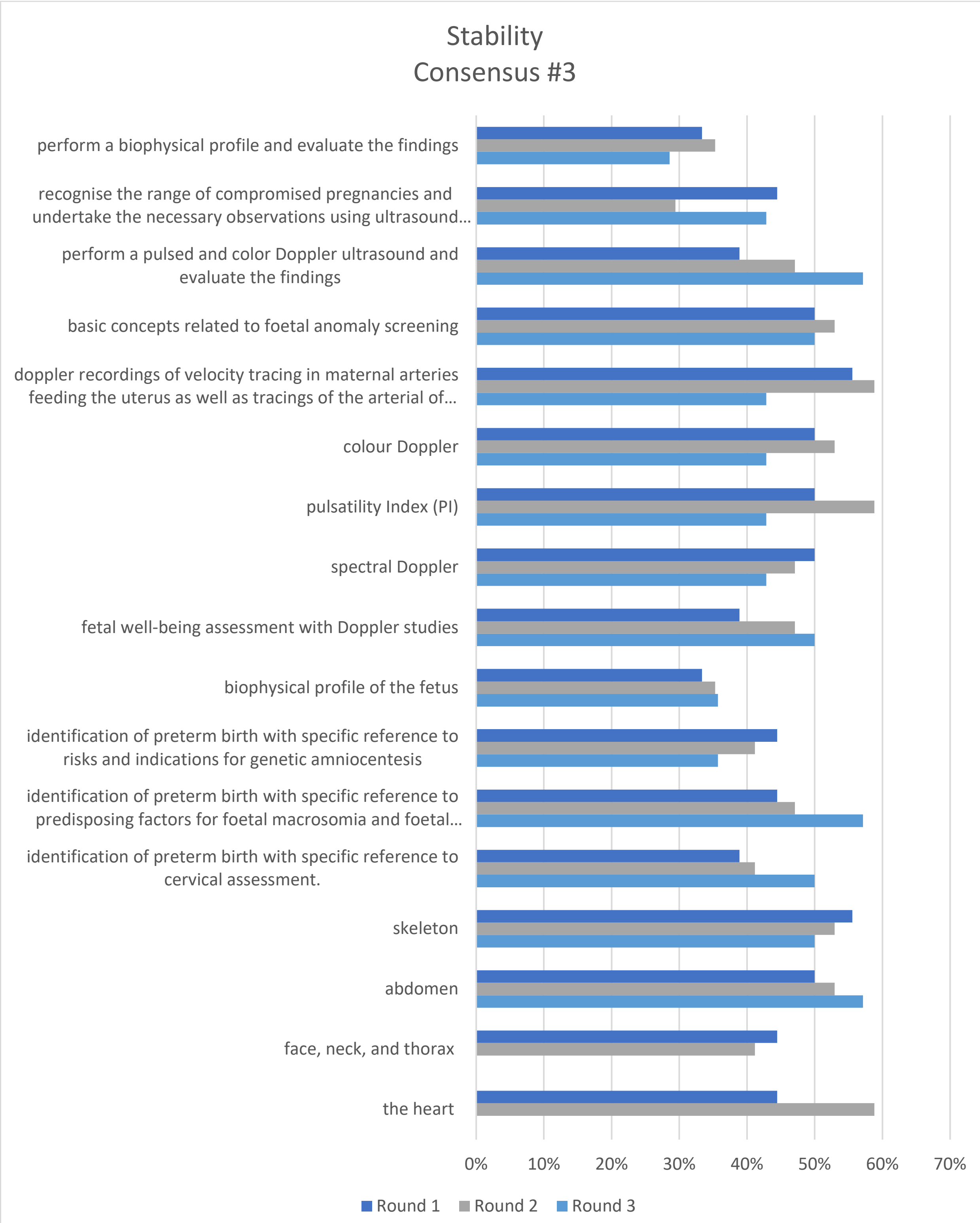
Stability, Competency #1

Competency #2



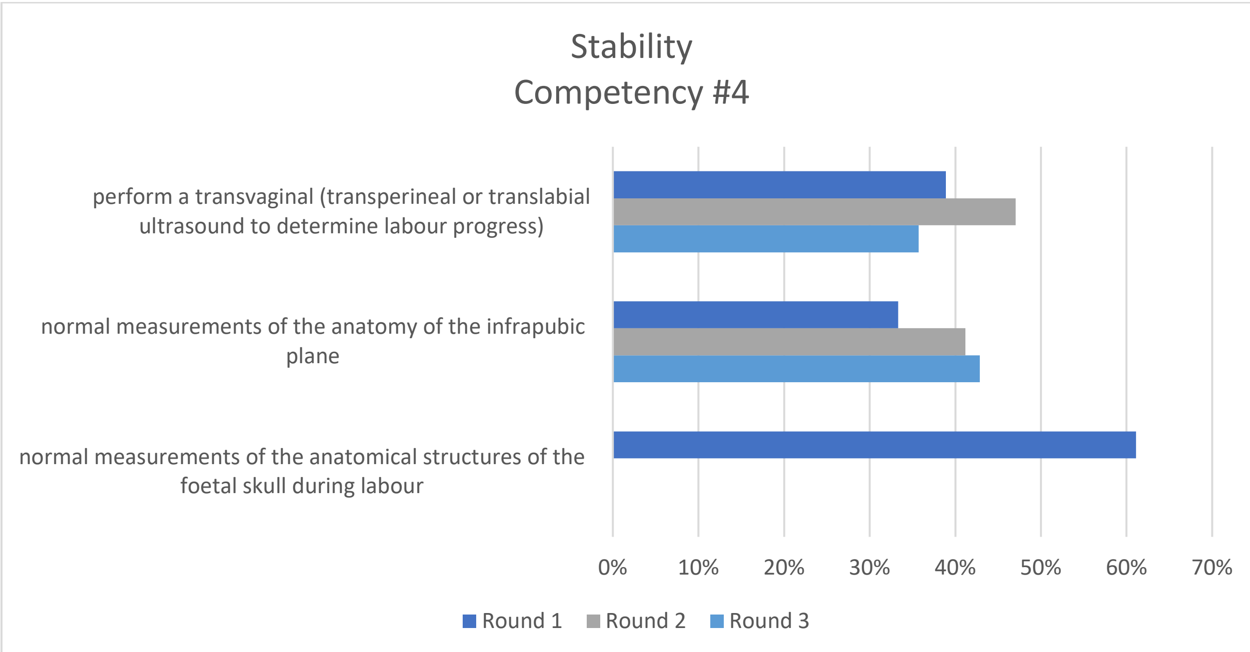
Stability, Competency #2

Competency #3



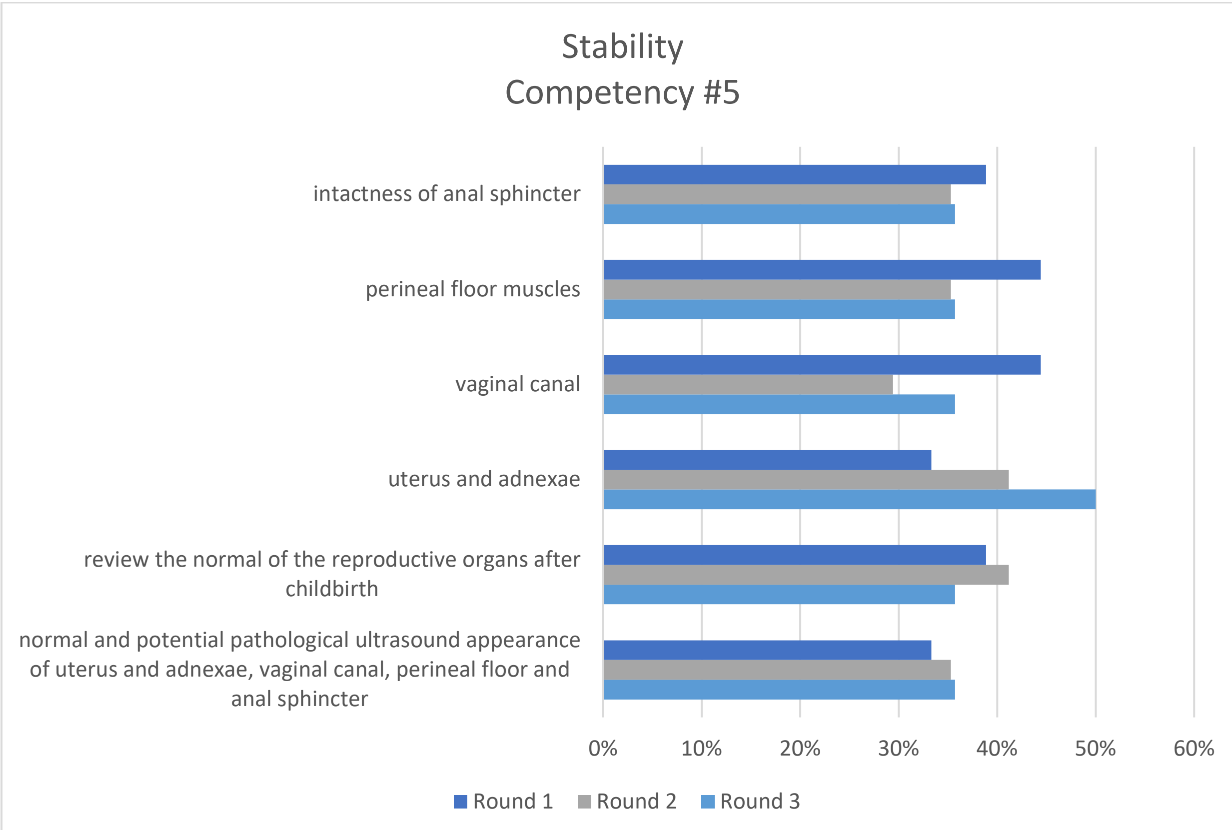
Stability, Competency #3

Competency #4



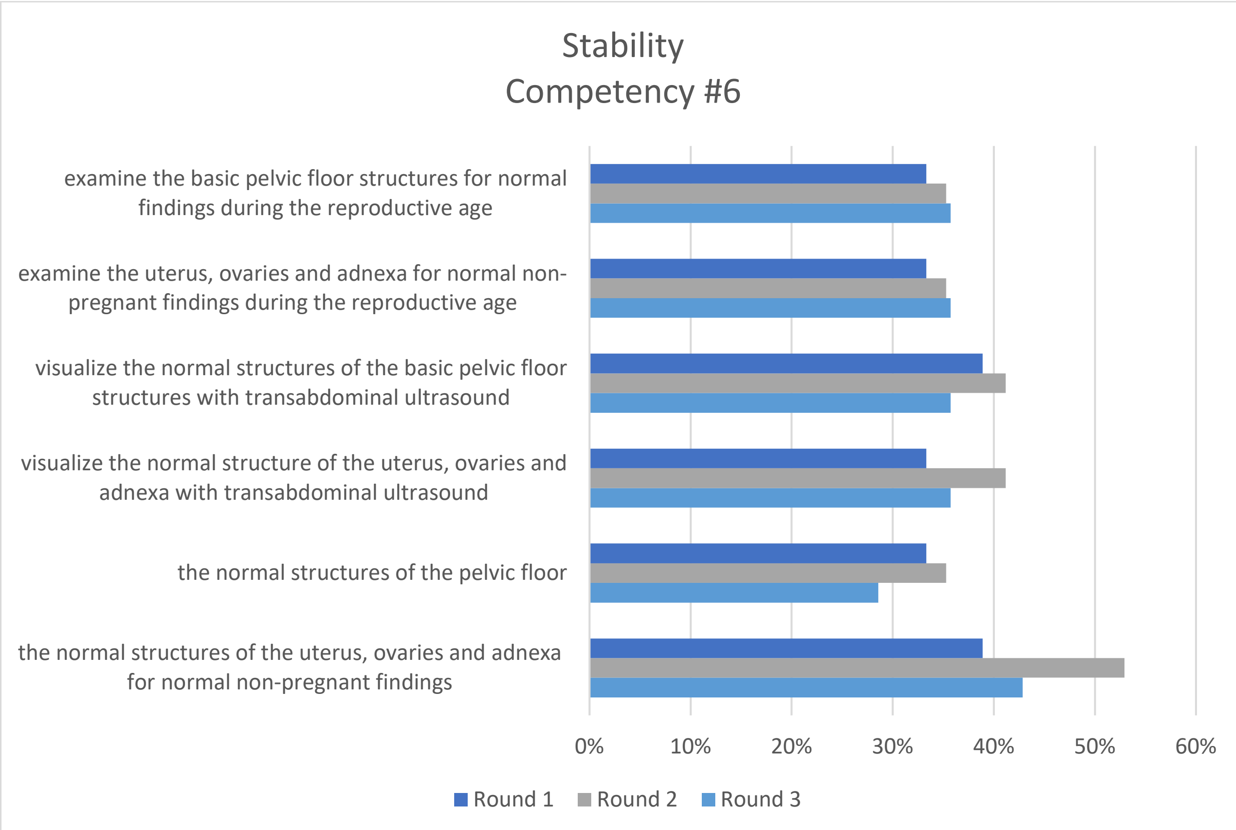
Stability, Competency #4

Competency #5



Stability Competency #5

Competency #6



Stability, Competency #6

To whom it may concern

This is to state that the Master's thesis study *Competencies for midwifery ultrasound education and practice in South Africa by Charné Eloise Human* has been language edited by me, according to the tenets of academic discourse.

Annamarie du Preez

0837641864

B.Bibl.; B.A. Hons. (English)
28-11-2020

Addendum H: Comparison of ISUOG recommendations for basic U/S and Intrapartum training guidelines with expert consensus of competencies for midwifery U/S education and practice in South Africa.

ISOUG Education Committee recommendations for basic training in obstetric and gynaecological US (ISUOG, 2014,1113-116)	Inclusion elements *Essential or useful*	Exclusion elements *Potential for inclusion or not needed*	Consensus reached	Not included in research
	CQN	CQN	Tick if applicable	
Basic Physical Principles				
Acoustics	1		✓	
Effects on tissues of pulsed- and continuous-wave US beams	1 3		✓ ✓	
Safety: ALARA principles	3		✓	
Transducer technology	1		✓	
2D gray-scale U/S and signal processing (grey-scale, time gain compensation, gain dynamic range and focus, acoustic output)	1 5 10		✓ ✓ ✓	
U/S artefacts				✓
Doppler U/S	1		✓	
3D or volume U/S	1		✓	

ISOUG Education Committee recommendations for basic training in obstetric and gynaecological US (ISUOG, 2014,1113-116)	**Inclusion elements** ***Essential or useful***	**Exclusion elements** ***Potential for inclusion or not needed***	**Consensus reached**	**Not included in research**
	CQN	**CQN**	**Tick if applicable**	
Theoretical teaching of the basics of diagnostic U/S				
Patient information required to obtain informed consent for an ultrasound examination	5 10		✓ ✓	
Statistical tests that can be used to describe the performance of screening and diagnostic tests.				✓
Sonographic biometry (linear, circumference, area and volume) (Knobology)	5 10		✓ ✓	
Image recording, storage and analysis	5 10		✓ ✓	
Medico-legal aspects of ultrasound	15		✓	
Quality control processes (qualitative or quantitative)				✓

ISOUG Education Committee recommendations for basic training in obstetric and gynaecological US (ISUOG, 2014,1113-116)	Inclusion elements *Essential or useful*	Exclusion elements *Potential for inclusion or not needed*	Consensus reached	Not included in research
	CQN	CQN	Tick if applicable	
First-trimester U/S				
Ultrasound features of normal early pregnancy: description of the intrauterine gestational sac, yolk sac and embryo.	31 32 14		✓ ✓ ✓	
Fetal viability and criteria used to diagnose definitive non-viability (miscarriage).	23		✓	
Tubal and non-tubal ectopic pregnancy and the principle of a pregnancy of unknown location (PUL).	20		✓	
Interpretation serum human chorionic gonadotropin (hCG) levels and progesterone in the event of a PUL.				✓
Ultrasound features of molar pregnancy	24		✓	
Early pregnancy biometry, e.g. crown-rump length (CRL) and mean gestational sac diameter (MSD) for (fetal age and size assessment).	29		✓	
Chorionicity and amnionicity in (singleton) and multiple pregnancies.	30 33 34		✓ ✓ ✓	
Gross fetal malformations that can be recognized during the first trimester.	37 39		✓ ✓	
Association between thickened nuchal translucency and fetal chromosomal anomalies (at the end of the first trimester).	26		✓	

ISOUG Education Committee recommendations for basic training in obstetric and gynaecological US (ISUOG, 2014,1113-116)	**Inclusion elements** *Essential or useful*	**Exclusion elements** *Potential for inclusion or not needed*	**Consensus reached**	**Not included in research**
	CQN	**CQN**	**Tick if applicable**	
Second and third-trimester U/S				
Determination of fetal position	59		✓	
Assessment of fetal wellbeing, including fetal movements	35		✓	
Amniotic fluid volume estimation and conditions associated with abnormal amniotic fluid volume	55 71		✓ ✓	
Placental assessment, including related to the internal cervical os	55 71		✓ ✓	
Standard fetal biometry (biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur diaphysis length (FL) and estimated fetal weight calculation.	54 68		✓ ✓	
Fetal growth and typical causes of abnormal fetal growth.	57 69		✓ ✓	
Fetal head (intact cranium, head shape, midline falx, cerebral ventricles, cavum septum pellucidum, cerebellum, cisterna magna) and typical anomalies.	48		✓	
Fetal face (orbits, nose and mouth in different planes) and typical anomalies	49		✓	

ISOUG Education Committee recommendations for basic training in obstetric and gynaecological US (ISUOG, 2014,1113-116)	**Inclusion elements** ***Essential or useful***	**Exclusion elements** ***Potential for inclusion or not needed***	**Consensus reached**	**Not included in research**
	CQN	**CQN**	**Tick if applicable**	
Second and third-trimester U/S				
Fetal thorax (lung morphology and relationship to heart size) and typical anomalies	50		✓	
Fetal heart (situs, four-chamber view, outflow tracts, three-vessel view) and typical anomalies.	48 (50)		✓	
Fetal abdomen (stomach, liver with the umbilical vein, kidneys and urinary bladder, diaphragm, bowel, abdominal wall and cord insertion) and typical anomalies.	52		✓	
Fetal spine in longitudinal and transverse planes and typical anomalies.	51		✓	
Fetal limbs (arms, hands, legs, feet) and typical anomalies.	53		✓	
Umbilical and uterine artery Doppler.	62		✓	

ISOUG Practice Guidelines: Intrapartum U/S (2018:128-139)	**Inclusion elements** ***Essential or useful***	**Exclusion elements** ***Potential for inclusion or not needed***	**Consensus reached**	**Not included in research**
	CQN	**CQN**	**Tick if applicable**	
Intrapartum: General findings				
Indications for IP U/S				✓
Fetal viability and heart rate	84		✓	
Presentation of fetus	77 82		✓ ✓	
Position of the fetus (anterior or posterior)	77 82		✓	
Placental position	78 81		✓ ✓	
The second stage of labour				
Assessment of fetal head position and fetal head station per transperineal U/S		83	✓	
Assessment measures (progression, station, position) (Progression)		83	✓	
• The angle of progression (AOP)		79 80 83	✓ ✓ ✓	

ISOUG Practice Guidelines: Intrapartum U/S (2018:128-139)	**Inclusion elements** *Essential or useful*	**Exclusion elements** *Potential for inclusion or not needed*	**Consensus reached**	**Not included in research**
	CQN	**CQN**	**Tick if applicable**	
The second stage of labour				
• Progression distance (PD)		79 80 83	✓ ✓ ✓	
• Head-symphysis distance (HSD)		79 80 83	✓ ✓ ✓	
• Head-perineum distance (HPD)		79 80 83	✓ ✓ ✓	
• Midline angel (MLA)		79 80 83	✓ ✓ ✓	

ISOUG Education Committee recommendations for basic training in obstetric and gynaecological US (ISUOG, 2014,1113-116)	**Inclusion elements** *Essential or useful*	**Exclusion elements** *Potential for inclusion or not needed*	**Consensus reached**	**Not included in research**
	CQN	**CQN**	**Tick if applicable**	
Gynaecological U/S				
Age-related differences in normal female pelvic anatomy (adolescent, reproductive age, postmenopausal). (age-related not included)	93		✓	
How to describe endometrial pathology (global and focal) including a knowledge of international endometrial tumor analysis (IETA) terminology.				✓
How to describe and recognize common adnexal pathology, including knowledge of international ovarian tumor analysis (IOTA) terminology and rules.				✓
How to understand when to refer women with abnormal uterine and ovarian pathology for further specialist opinion.				✓
How to recognize the presence of peritoneal fluid and its potential sources.				✓
The appearance of intrauterine contraceptive devices (IUDs) and their correct placement.				✓

ISOUG Education Committee recommendations for basic training in obstetric and gynaecological US (ISUOG, 2014,1113-116)	Inclusion elements *Essential or useful*	Exclusion elements *Potential for inclusion or not needed*	Consensus reached	Not included in research
	CQN	CQN	Tick if applicable	
General skills				
Awareness of consent and what information to give to a patient to obtain consent.				✓
Awareness of latex sensitivity/allergy and the cleaning/disinfection of transducers.	4		✓	
How to enter patient-identification data into the ultrasound machine.	5 10		✓	
Understanding ultrasound systems, the various transducers used and techniques required to optimize images.	5 10		✓ ✓	
Experience in selecting and manipulating the various transducers to achieve optimal views.	5 10		✓ ✓	
Interpretation of the resultant ultrasound images.	Continuously		✓	
Experience in measuring distances and areas and recording these.	5 10		✓ ✓	
Experience in storing a set of standard images and sending measurements and images to an associated database where available.				✓
Structured reporting of the ultrasound examination.	6 13		✓ ✓	
Counselling the patient before, during and after an ultrasound examination.	75		✓	

(appreciate the ethical issues associated with prenatal diagnostic procedures)				
Knowing when supervision or a second opinion for confirmation of findings is required.	Continuously		✓	
Being aware of referral routes to second-and third-level centres for additional investigations when these are not immediately available.	Continuously		✓	

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72**Table of** content

 List of Acronyms
Acronyms Description Fourth Industrial Revolution 4IR HPCSA Health Practitioners Council in South Africa ICM International Confederation of Midwives IP U/S Intrapartum ultrasound

103**ISUOG International Society** in **Ultrasound in Obstetrics and Gynaecology**

SA South Africa SA DoH South Africa,

96**Department of Health** SANC **South African** Nursing **Council** SASUOG **South African**

Society of Ultrasound in Obstetrics and Gynaecology SB Stillbirth/s SBR Stillbirth rate SDG Sustainable developmental goals

6**SOMSA Society of Midwives of South Africa** SORSA Society **of**

Radiographers of South Africa U/S Ultrasound WHO World Health Organization

91**Concept clarification The following concepts are** relevant **to this** research study, **and**

are listed in alphabetical order. The concept clarification and operationalisation ensures a clear interpretation of each concept listed. The chosen concepts are based on the research topic and components found within the field of midwifery in order to reduce ambiguity. Advanced Midwife/ Midwife Specialist: An Advanced Midwife refers to a Registered Midwife who has completed a Postgraduate Diploma in Advanced Midwifery and Neonatology and

24**is registered with the South African Nursing Council (SANC) (Regulation**

368, SANC, 2014(a):1) or a Clinical Master's Degree. On 15 March 2014, the then Health Minister Aaron Motswaledi announced that the Advanced Midwife would onwards be referred to as "Midwife Specialist" (SANC, 2014[a]:1). A midwife specialist is

40**a specialist clinician with a broad autonomous practice managing a specific caseload. The**

2**midwife specialist may function as first entry-point and needs the knowledge and expertise to be able** to **accurately assess, diagnose and manage the patient population in the speciality area.**

The midwife specialist makes medical diagnoses and prescribes treatment, which requires capacity

49**in diagnostic testing and treatment beyond the normal practice of the nurse/midwife. In South Africa,** the midwife specialist **may** practice **as** an independent midwife **practitioner,** although **not** being **exclusive to this category**

42**(Duma, Dippenaar, Bhengu, Oosthuizen, Middleton, Phillips, Naude & Uys, 2012:**

np). Midwifery Ultrasound (U/S) Competence:

81**According to the International Confederation of Midwives (ICM)** (2013:19) **the** act **of**

being competent refers to a multilayered concept that includes

37**the combination of knowledge, psychomotor, communication, and decision-making skills that enable an individual to perform a specific task**

(Fullerton, Butler, Aman & Reid, 2011:e416; ICM, 2013:19;). Competence is assessed, demonstrated or observed according to

25**a defined level of proficiency (ICM,**

2013:19). In this study, midwifery U/S competence

94**refers to the combination of knowledge, psychomotor, communication and decision-making skills that enable** a midwife **to perform specific**

midwifery U/S tasks to

161**a defined level of proficiency. Midwifery** U/S **Competency:** Competency **is** defined as **the** specific minimum set **of**

characteristics/concepts related to the combination of knowledge, skill and professional behaviour that underpins the performance of tasks associated with competence (Fullerton et al., 2011:6; ICM, 2013:19). The ICM

7**competencies are presented in a framework** consisting **of four categories**

(ICM, 2018:2). In this study, midwifery U/S competencies refer to six categories, called domains, which include the specific minimum set of characteristics/concepts that underpin the performance of midwifery U/S competence. The set of characteristics/concepts for each of the six midwifery U/S domains are founded on the combination of knowledge, specific skills and professional behaviour required for competence. Consensus: Consensus is achieved when at least two-thirds of respondents agree on the issue at hand (Audige, Schwyzer, & Durchloz et al., 2019:2063).

5**A consensus level is set (e.g. 70%) and once the pre-determined percentage of the expert panel has come to** an **agreement on the importance or position of the statement, it is said to have reached consensus**

(Keeney, Hasson & McKenna, 2011:5). In

100**this study and** in **the** context **of** using **the Delphi technique,**

consensus refers to the decision reached by the majority agreement of expert opinion in the field of midwifery U/S education and practice. Midwife: The ICM defines a midwife as "a person who has completed a midwifery education programme that is based on ICM Essential Competencies for Basic Midwifery Practice and the framework of the ICM Global Standards for Midwifery Education and is recognised in the country where it is located; who has acquired the requisite qualifications to be registered and/or legally licensed to practise midwifery and use the title 'midwife'; and who demonstrates competency in the practice of midwifery "(ICM, 2017:online). In the South African context, the midwife has completed a four-year Diploma or Baccalaureus Degree (SANC Regulation 425, 1985:online) in General Nursing, Community, Psychiatry and Midwifery. A diploma in midwifery

88**(Regulation 425)** as **a one-year post-basic** qualification **in midwifery**

is needed for a general nurse (SANC Regulation 368, 2014[b]) to be qualified as a midwife. Perinatal: The World Health Organization

60**(WHO) states that the perinatal period** begins **at 22 completed weeks** (154 days) **of gestation and ends after seven completed days after birth**

(WHO, 2019[a]:online). In this study, the perinatal period commences at 28 weeks of gestation (viability as defined

76**by the Department of Health** (SA DoH) in **South Africa** (2016:92) **and** ends at seven completed days after birth. Stillbirth: A stillbirth refers to the

101**death of a fetus** ≥28 **weeks of gestation** and **/or**

≥1000 g birth weight

141**(Lawn, Blencowe, Pattinson, Cousens, Kumar, Ibiebele, Gardosi, Day & Stanton, 2011:** 1451). **Stillbirth**

rate: The number of stillbirths per every 1 000 live births (WHO, 2016 [6]:online). Task shifting: The WHO

133**defines task shifting as** the **process of delegation,** through which **tasks are moved to less** specialised **health**

professionals. Task shifting is a viable and valuable solution to improve healthcare coverage by using human resources more efficiently. In turn, the accessibility of healthcare is enhanced (WHO, 2008:online). In this study, the definition as given will be used in the context of U/S screening of a person seeking reproductive health. Ultrasound: In this study, ultrasound (U/S) refers to the diagnostic use of U/S for reproductive health to form a two-dimensional image used for evaluating normality. Diagnostic U/S

21**is a sophisticated electronic technology, which utilises pulses of high-frequency sound to produce an image.** The **diagnostic** U/S **examination**

as benchmarked

151**by the International Society of Ultrasound in Obstetrics and Gynaecology**

(ISUOG) can be used

48**in a variety of specific circumstances during pregnancy, such as after clinical complications, or where there are concerns about fetal growth (Whitworth, Bricker, Neilson & Dowswell,**

2015:1). The childbearer may also use U/S (two-, three- or four-dimensional image) for picturing and bonding. Abstract Background: The benefits of U/S for the childbearing family has been widely documented, and lately, the childbearers' preference of intrapartum U/S above vaginal examination for progression of labour has emerged. Accessibility of U/S during the childbearing period

96**in low-** to **-middle income countries** such as **South Africa is**

inadequate. Midwives, as the most appropriate skilled birth attendant are best positioned to perform U/S during pregnancy, intrapartum and the postpartum period. The use of midwifery U/S is recognised internationally by the ICM and nationally by SOMSA. However, in South Africa, midwifery U/S education and training is unaccredited and unregulated by SANC and the South African Qualification Authority (SAQA). Aim: The study aimed to describe the consensus reached by expert opinion on the competencies for midwifery U/S education and practice for South Africa. Design: A quantitative descriptive research design with a modified e-Delphi technique was implemented. A heterogeneous group of U/S experts representing midwives, sonographers, and obstetricians and gynaecologists in South Africa contributed to consensus on 118 elements of six competency domains of midwifery U/S education and practice. Results: Expert consensus was reached on midwifery U/S competencies for education and practice in South Africa to include 52 elements pertaining to pregnancy, intrapartum and postpartum midwifery U/S. Conclusion: With the exclusion of gynaecological U/S competence, the South African midwifery U/S competency elements are comparable to the ISUOG's basic U/S training. It was clear that the experts were in agreement on the essential elements needed for midwifery U/S. The experts indicated that the basic midwife at the primary healthcare level would be best suited to implement midwifery U/S

152**during pregnancy, labour and the postpartum period.** Intrapartum U/S **in the** hands **of** midwives will change intrapartum care to be congruent with what mothers want. The

7**ICM's Philosophy and Model of Midwifery Care**

guides midwifery U/S within the Fourth Industrial Revolution (4IR) to stay true to the core principles of the profession.

2**Chapter 1 Overview of the study 1.1 Introduction The**

10**International Confederation of Midwives (ICM) defines a midwife as a person who has successfully completed a midwifery education programme that is duly recognised in the country where it is located.** The education programme **is based on the ICM'** s **Essential Competencies for Basic Midwifery Practice, and the framework of the ICM Global Standards for Midwifery Education.** The midwife, **who has acquired the requisite qualifications and**

demonstrates competency in the practice of midwifery, who is

140**registered and legally licensed to practise midwifery,** may **use the title 'midwife'**

(ICM, 2017:1). The practice of the midwifery profession is guided by the ICM's

6**philosophy and model of midwifery care (ICM, 2014:1),**

which states that a midwife works in partnership with women while advocating and protecting the normal physiological process of positive pregnancy and childbirth experience (WHO, 2018:2). Midwifery care should exemplify

123**respect for human dignity, compassion and promotion of human rights for all persons.** The **midwifery**

care rendered is holistic and continuous in nature, emancipatory, and allows the partnership of care to be culturally sensitive and diverse (ICM, 2014:1-2). A midwifery-led continuity model of care benefits mothers and newborns, amongst others, by improving the pregnancy and birth experience (ICM, 2014:1; Sandall, Soltani, Gates, Sheena & Devane, 2016:2). According to the WHO (2018[b]:2) and the ICM (2014:1), a midwife can provide nearly all the

110**essential care needed for women and newborns, and**

is therefore regarded as a skilled birth attendant (SBA) to achieve the Sustainable Developmental Goal (SDG) target 3.1. According to SDG target 3.1.1, the aim

35**is to reduce the global maternal mortality ratio to less than 70 per 100 000 live births by 2030**

(WHO, 2018[b]:online). Unfortunately, South Africa's current rate of 134 per 100 000 live births is still a far cry away from achieving this important milestone, according to the Saving Mothers report (SA. DoH, 2017[b]:ii). 19 Globally, the stillbirth rate (SBR)

24**is an** essential **indicator of the quality of** healthcare **rendered**

to childbearing women (WHO, 2016[c]:2). Despite South Africa reporting a slight decline in the SBR from 2002 – 2016, the SBR remains alarmingly high at 21/1000. These high numbers do not reflect the WHO target of 12/1000 births (WHO, 2020:9). In the South African context, the

38**Saving Babies 2014-2016 Triennial Report on perinatal mortality**

(SA. DoH, 2017) states that unexplained intrauterine death for babies >1000g was the major cause for loss of life (24.4%) during that period. This statistic was a significant concern because 43% of unexplained stillbirths weighed above 2500g and occurred in women with uncomplicated pregnancies (Allanson, Muller & Pattinson, 2015:1; SA. DoH, 2017:24). Loss of life is always traumatic, but losing a child during an uncomplicated pregnancy without any explanation contributes to a lifetime of psychological grief. An option in preventing the tragic loss of life and related emotional distress is using U/S as a valuable diagnostic tool to identify the possible causes for the prevention of stillbirths and pregnancy complications (Ahman, Edvardsson, Kidantoc, et al., 2018:241). Nkosi, Makin, Hlongwane and Pattinson (2019:350) strengthened this notion by indicating that monitoring low- risk pregnancies between 28 – 32 weeks by means Doppler flow, which is a component of the U/S, showed an increase in the identification of

54**small for gestational age (SGA) babies who are at risk**

for perinatal complications. An early U/S is beneficial for several reasons. Not only could the procedure be used

89**to determine gestational age,** but also to **detect multiple pregnancies and fetal**

anomalies. Furthermore, early U/S for gestational dating can reduce the

135**induction of labour for post-term pregnancy, and improve** women's overall **pregnancy experience (WHO,**

2018[a]:online). A new pathway for intrapartum U/S emerged during the last few years that showed the positive maternal experience of trans-perineal U/S versus vaginal examination (Waife, Whitehead, Venables & Dassah, 2019:4). Currently in South Africa midwives contribute to 68% of the total births as SBAs (Statistics South Africa, 2020:15) and they are therefore ideally positioned to implement a technologically appropriate, non-invasive approach of surveillance during the continuum of childbirth (ICM, 2014:2). Congruent with the ICM philosophy and model of care, appropriate use of technology in a partnership with childbearing families increases a positive pregnancy and birth experience. According to the ICM, it is therefore, essential for midwives to be competent in performing a safe and effective U/S. As the governing body of the midwifery profession in this country, the SANC regulates the midwife and midwife specialist education and practice. However, the midwife specialist is regarded as a specialist clinician that should be competent

124**in diagnostic testing beyond the** standard **practice of the nurse/midwife in South Africa**

(Duma et al., 2012:5). Despite the SANC not capturing U/S competency in its regulations, the ICM includes U/S in 'The Essential Competencies of the Basic Midwife' (ICM, 2013:8; ICM, 2018:online). The competency describes that the midwife should "evaluate fetal growth, placental location, and amniotic fluid volume, using U/S visualisation and measurement" (ICM, 2013:8). The latest update

13**of the ICM Essential Competencies for Midwifery Practice**

(ICM, 2019:13) which also recognises the consideration of a country's contextual needs, yet again states the importance of midwifery U/S screening (Fullerton et al., 2019:415-416). On an international level, various low- to middle-income countries have shown an effective implementation of midwifery U/S education and training programmes (Nathan, Swanson & Goldenberg, 2014:210). However, in South Africa, the variations of the learning programmes over different provinces create disparities in education standards, and to date there is no regulation or control of the quality of the training output. This absence of regulation is a key concern not only for the medico-legal risks involved in a non-regulated programme, but also for the lack of quality assurance of midwifery U/S education (SOMSA, 2017). Midwives who were educated as part of midwifery U/S programmes in South Africa are deemed qualified to continue practicing U/S within the public setting. However, the absence of regulation and accreditation in confirming the quality of U/S education raises concerns for education and practice. In addition, midwives working independently or in the private healthcare setting is not deemed appropriately qualified to continue the practice of U/S, as in the public setting. The fact that different options of unaccredited midwifery U/S training programmes for South Africa are still available validates the need for education programmes that should comply with the competencies set by the ICM. Concerns regarding the education and practice of midwifery U/S were further highlighted during an annual congress of the

> 33**Society of Midwives of South Africa (SOMSA) in August 2017.** During **the**

congress, a workgroup collectively decided that accredited U/S education for the midwife specialist should be established and regulated (SOMSA, 2017). Due to the level of experience and scope of practice, the midwife specialist was identified as the appropriate category of the profession to be the ideal practitioners of midwifery U/S (SOMSA, 2017). Regardless of current midwifery U/S programmes that fulfil a need for education and practice in South Africa, neither SANC nor the SAQA have approved the inclusion of midwifery U/S. The role-players in the field of U/S, in the current climate determined by the high burden of disease in South Africa, should consider the following: 1) The impact of midwifery U/S competencies on a positive pregnancy and childbirth experience, including the maternal and perinatal mortality rate; 2) Consensus on midwifery competencies could guide the regulation and accreditation of U/S education and practice for the benefit of quality and equity in midwifery U/S education; and 3) Task shifting to enhance the accessibility of quality midwifery care, including midwifery U/S. The midwife is ideally positioned as a vital SBA

> 33**to contribute to the** SDG **of** decreasing perinatal **mortality and morbidity.**

Implementing a diagnostic tool such as midwifery U/S can be useful to not only decrease the perinatal mortality and morbidity, but also to contribute to a positive pregnancy and birth experience for the childbearing family (WHO, 2016[b]:online). 1.2 Problem statement The midwife, as an SBA, is recognised by the ICM

> 127**as the professional of choice for childbearing women in all** parts **of the world**

(WHO, 2016[d]:5; ICM, 2017:1). Despite the WHO, ICM and SOMSA recognising midwifery U/S as an essential competency, midwifery U/S education and practice is not regulated nor accredited by SANC or SAQA in South Africa. Furthermore, the impact of the high SBR as part of the perinatal statistics in South Africa is an indicator of poor quality of healthcare. Midwifery U/S can increase the opportunity for targeted intervention to decrease the perinatal mortality and morbidity rate. However, the WHO emphasises that looking at perinatal survival alone has become unacceptable and that the new focus is on

> 70**a positive pregnancy and childbirth experience**

(WHO, 2016[b]:1). 22 The midwife is ideally positioned to contribute to reducing the SBR while enhancing

> 70**a positive pregnancy and childbirth experience**

by implementing a diagnostic tool such as midwifery U/S. Despite the absence of regulation and accreditation of midwifery U/S education, various unaccredited midwifery U/S programmes exist. Consequently, the unregulated education and practice of midwifery U/S contributes to midwives not being

> 86**able to practice to the full** capacity **of their**

profession as autonomous midwives. In addition, the situation creates ambiguity around midwifery U/S practice. There is no approved set of midwifery U/S competencies in South Africa to guide education and practice. Reaching consensus could guide the regulation and accreditation of midwifery education programmes. Competencies for midwifery U/S can be instrumental in the quality assurance of midwifery U/S education and practice. Hence, consensus on competencies for midwifery U/S education and practice is crucial. 1.3 Research question What is the consensus on competencies for midwifery U/S education and practice in

> 63**South Africa? 1.4** The aim **of the study This study** aimed to determine **the**

consensus on competencies for midwifery U/S education and practice in South Africa. 1.5 Objectives 1.1.1. Identify from literature competencies for midwifery U/S education and practice. 1.1.2. Compile a list of competencies for midwifery U/S education and practice in the continuum of female reproductive health.

1.1.3. Describe the competencies for midwifery U/S education and practice as validated by expert opinion. 1.6 Demarcation Midwifery U/S is positioned within the domain of midwifery education and practice. The competencies of midwifery U/S inform both regulation and accreditation of education and practice. The study did not aim to justify the use of midwifery U/S, but described midwifery U/S competencies through expert consensus within the Midwifery

6**Philosophy and Model of Care (ICM, 2014:1-**

2). 1.7

61**Conceptual framework Polit and Beck** (2012:129) describe **a conceptual framework as**

the overarching conceptual foundation of a study. The implication is that the first thought patterns of a study are conceived from a specific model or framework. A depiction of the

115**conceptual framework** for **this research is** given **in Figure 1.1. Figure 1.1 Conceptual framework** for **the**

aim of the study (designed by the researcher). The foundation of all midwifery interventions is guided by the

7**ICM's** midwifery **philosophy and model of care.** As stated **in**

Section 1.1, the midwifery philosophy states that midwifery care is a partnership between a midwife and the childbearing family. It promotes non-intervention while protecting the normal physiological process of childbirth (ICM, 2017:2). The ICM's definition of the midwife stems from its midwifery philosophy and model of care. The definition states that the title of a midwife is given to someone that completed their midwifery education,

42**based on the essential competencies for** a **basic** midwife, demonstrated competency, **and**

is able to practice autonomously (ICM, 2017:1). As approved by SOMSA (2016:1), the midwife should ideally comply with the definition of a midwife, not only within the country in which he/she practices the profession, but also with international recognition. The ICM Essential Competencies for basic midwifery should form the basis of midwifery education and training. Midwifery U/S, as recognised by the ICM (ICM, 2018:13), can increase the quality of antenatal care and is directly measurable against the SBR. South Africa has a very high SBR of >21/1000 births that continues to place a high burden of disease on the community. Through task shifting in South Africa, midwifery U/S could decrease the SBR. Expansion of the midwifery functions could contribute to the partnership between the mother and midwife. Incorporating U/S in midwifery practice through task shifting and expansion of midwifery care will increase the quality of care and a positive birth experience. As various unaccredited, unregulated midwifery U/S training programmes existed at the time in South Africa, the regulation and quality of education were highlighted by the SOMSA workgroup as a concern (SOMSA, 2017:1-13). To ensure that midwives can develop and maintain U/S competence and be able to practice independently as an autonomous practitioner, consensus on midwifery U/S competencies are vital for the process of further education and ultimately SAQA accreditation. By using the Delphi technique, expert opinion led to consensus of the recommended competencies for midwifery U/S education and practice in South Africa. 1.8 Paradigmatic perspective The researcher was guided by a postpositivist worldview that recognises knowledge as truth (Taylor & Francis, 2013:18). The researcher who holds a postpositivist paradigmatic approach stands objective toward the outcome of the aim of the research (Mertens, 2015:59). The postpositivist researcher accepts knowledge that is created by using traditional research methods 26 as truth (Creswell & Creswell, 2018:37). Observational deductions are made from data gathered during the course of the research (Creswell & Creswell, 2018:37). Multi-dimensional factors, also referred to as variables, interact with the outcomes and may influence the data (Taylor & Francis, 2013:18). Therefore the postpositivist researcher applies measures to control the possible influence of variables on the outcome (Henning, Van Rensburg & Smit, 2005:3). 1.9

30**Research design** A **research design is** defined as **the** structure **of the study that**

should

33**ensure that the reliability and validity of the** findings are **not**

affected by uncontrolled factors (Grove & Gray, 2019:41, 218, 696). For this study, a quantitative, descriptive research design was implemented.

67**Quantitative research is a formal and systematic process in which numerical data** is **used to obtain information to describe variables,**

as well as the relationships and interactions between the variables (Burns & Grove, 2009:22). However, the aim of this study was not experimental in nature (Grove & Gray, 2019:258), and did not attempt to describe relationships or interactions between variables. As the research aimed to describe the consensus of expert opinion on competencies for midwifery U/S education and practice in South Africa, a quantitative descriptive research design was applied as further discussed in detail in Section 3.2. In contrast with quantitative research, qualitative research aims to make meaning out of participants' lives, or their lived experiences (Maree, 2020:50). As this study focused on consensus of the competencies for midwifery U/S screening and not on the experts' experiences, a qualitative research design would not have been able to serve the aim of the study. 1.10 Research technique The research technique refers to the method applied to support the aim of the study within the research design (Polit & Beck, 2012:257). Where there is little knowledge about the subject, or a lack of evidence-based practice in health sciences, a consensus method is invaluable (Hohmann, Cote & Brand, 2018:3272). Two of the techniques that are useful in reaching

53**consensus are the** the **nominal group** technique **and the Delphi technique**

(Hohmann, Cote et al, 2018:3278). Due to the vast geographical distribution of experts on the study topic in South Africa, a face-to-face nominal group technique would not have sufficed. Therefore the Delphi technique was applied to reach consensus on expert opinion within a quantitative descriptive design, where little prior knowledge in the area of study exists (Avella, 2016:2). Various types of Delphi techniques have evolved over the years, such as the classic or modified e-Delphi. In this study, the modified e-Delphi, which uses an online questionnaire was beneficial because of the ease and low cost implication of online data distribution and collection of a geographically dispersed group of experts. To purposefully establish an expert group for consensus could have been interpreted as a disadvantage of the Delphi technique due to possible selection bias (Millar, Thorstensen, Tomkins, Mepham & Kaiser, 2017:61). However, the researcher used inclusion criteria for the selection of an expert and therefore preserved the reliability, as elaborated on in Section 3.3. To determine consensus for this study, the Biostatistics Department of the University of the Free State set the level of aggregate at 70%. The consensus level of 70% was supported by literature stating that a minimum of two-thirds of the responses for any particular statement should be set for the two highest levels of the Likert scale of the survey instrument (Du Plessis & Human, 2007:22). The development of the questionnaire was meticulously referenced to ensure transparency and inclusivity in the development process, and was

64**further discussed in Section 3.3.1.** 1.11 **Population and Sampling The**

32**population is defined as a group of individuals or elements** which form **the focus of the research (Grove & Gray,**

2019:293). The total population of this study included obstetricians and gynaecologists, sonographers, general practitioners and midwives as healthcare workers with U/S experience during the child birthing period. From the total population,

71**a target population is defined as the entire set of individuals or elements who meet the** inclusion **criteria (Grove & Gray,**

2019:293; Polit & Beck, 2012:274). However, at this stage, it is important to clarify that the population of a Delphi technique does not pursue representation of the population, but rather expert opinion (Avella, 2016:306). Therefore, the inclusion criteria defined experts of this study, as discussed in detail in Section 3.4. Inclusivity of U/S experts in South Africa require the target population to be divided into two groups, as illustrated in Table 1.1.The

9**accessible population is referred to as the** target **population** to which **the** researcher had reasonable access (Asiamah, Mensah & Oteng-Abayie, 2017:1612; Grove & Gray, 2019:294), 28 Table 1.1 Overview of the population as related to the research aim Research aim To determine the consensus on competencies for midwifery U/S education and practice in South Africa. Total population Health care professionals with U/S experience Target population Experts in both of the following categories of expertise ‣ Subjective knowledge ‣ Mandated knowledge • Inclusion criteria Group A: Midwives • Accredited by a regulatory body • Member of the executive committee of professional association or professional body • Peer identification Group B: Traditional U/S healthcare professionals • Accredited by a regulatory body • Member of the executive committee of professional association or professional body • Peer identification Accessible population Group A: Midwives • Clinical experts • SOMSA executive members • Independent midwives registered on Sensitive Midwifery Independent Midwifery Practitioners registry Group B: Traditional U/S healthcare professionals • Clinical experts • SASOUG executive members • SORSA executive members • NCCEMD members Group A included experts in midwifery U/S. The midwives were identified based on clinical experience in midwifery U/S or their involvement as executive committee members representing midwifery. The aim was to have 50% of the accessible population representing midwives with clinical experience in U/S. Group B represented traditional U/S healthcare professionals such as obstetricians and gynaecologists, and sonographers within the related field of U/S, inclusive of education or the policy environment. The accessible population in Group B included executive members of the management committees of the various professional bodies who had experience in U/S, or field-specific education. The researcher aimed to have equal representation of both groups of the accessible population in the sample group. The classification of the two main classes of sampling methods is probability and non-probability/purposive sampling (Grove & Gray, 2019:303). Probability sampling is the random selection from the population to ensure that all individuals have the same opportunity to be selected (Maree, 2020:214). As this study focused on expert consensus, which did not allow for a random selection sampling method, probability sampling was not applicable. Therefore, the researcher used, purposive sampling in selecting the experts. A purposive sampling method is useful where the population has specific characteristics that relate to the purpose of the research, or where there is a small number of potential participants available to answer the research question (Grove & Gray, 2019:310). Since

17**the purpose of this study was to** glean **the** opinions **of selected**

experts within the professional healthcare groups, stratified purposive sampling was used (Polit & Beck. 2012, 279). The combination of sampling strategies to form stratified purposive sampling allowed the researcher to identify the sample based on specified criteria for each subgroup and strata from which to identify the sample (Mertens, 2015:399). Although Maree (2020:219) cautions against using non-probability sampling, mainly because of the difficulty to generalise findings to a larger population, generalisation was not the purpose of the study, while expert opinion was. The researcher implemented stratified purposive sampling to identify a sample of information-rich individuals (Mertens, 2015:397). A sample of a heterogeneous group of experts allowed for contextualisation of the global issue of midwifery U/S with minimal bias (Polit & Beck, 2012:276). 1.12 Recruitment of participants The researcher contacted the potential participants via email. Experts was selected because of their active involvement and expertise in the field of U/S. An internet search of the identified experts of the various committees (refer to Table 1.1) assisted in providing the researcher with their email addresses, as this information is in the public domain. In cases where committee members or clinical midwives were not accessible via the public domain were contacted by first requesting the secretary or the president of the different committees to forward the applicable information about the study to the selected experts. If certain strata are were under-represented, the researcher asked the expert members and committee members to suggest experts that would be interested in participating. An email containing the aim of the study, inclusion criteria and stratum which the participant would represent were sent to the sample population. The estimated timeframe of the study and the expected time occupancy per questionnaire was described in the email. The Participants who replied and indicated

108**their willingness to participate in the study received**

an automated individual password with the Evasys® link that included the information 30 letter, informed consent and the first-round questionnaire (Addendum B). Evasys® is an online automation software programme used by the University of the Free State for

146**surveys and research projects, course and training evaluations, exams and assessments.**

1.13 Pilot survey To ensure a well-structured questionnaire, with questions that were clear and unbiased, the first- round questionnaire was sent to three individuals who met the same criteria as the prospective survey population. The three individuals that agreed to participate in the pilot survey received an automated individual password with the Evasys® link that included informed consent and the first- round questionnaire (Addendum B). The pilot participants completed the questionnaire and gave feedback on three questions that were posed to them, as described in Section 3.5.2. This process indicated the time required for completion of the questionnaire, identified possible technical issues with the questionnaire, as well as certain content-specific concepts that needed clarity. As changes had to be made to the first-round questionnaire after the pilot survey, the data of the three individuals were not included in the final analysis (Louw, 2009:20). 1.14 Data collection Three iterative rounds, each using a questionnaire, were used to seek consensus on the competencies of midwifery U/S education and practice (Du Plessis & Human, 2007:15). The development of the structured first-round questionnaire was guided by a literature search of the research topic and is described in Chapter 2 (Hasson & Keeney, 2011:1697). Subsequent questionnaires were adjusted based on data from preceding rounds. The data collection

143**process is depicted in Figure 1.2. Figure 1.2** Data collection process **The**

modified e-Delphi consists of three rounds. Round 1 started with an email to the experts that contained a web-link to Evasys® with an individual auto-generated password. The Evasys® password enabled the experts to access the information letter, informed consent and the first- round questionnaire. After the first round, the researcher retrieved the data for statistical analyses. The consensus statement was removed and reported on in Chapter 4. However, the qualitative data were combined to form new questions. The non-consensus statements and the new questions collectively formed the second-round questionnaire. The researcher gave controlled feedback to the experts. The steps were repeated for Rounds 2 and 3. However, in Round 3, the researcher reported on consensus and the qualitative data without forming a new questionnaire. 1.15 Data analysis Data analysis is defined as coming to a meaningful conclusion by using different techniques of statistical analysis to manage numerical data (Grove & Gray, 2019:378; Sharif, 2015:4). The quantitative data analysis included descriptive statistics and reported on the experts' collective opinion (Sharif, 2015:4). Both the quantitative and qualitative data collected by Evasys® was retrieved in a RAW CSV Excel® file. The raw data from Evasys® is received in an already-coded format, and therefore the researcher could not identify responses linked to specific experts. An independent academic researcher from the University of the Free State with extensive statistical expertise assisted the researcher in organising the data from each round. Inferences were made based on the biostatistician's recommendation of using 70% as the set level for consensus. According to Giannarou and Zervas, (2014:67), data analysis for consensus with a Delphi technique should report on the frequency distribution, the mean and the coefficient of variation, as discussed in Chapter 4. Consensus was determined for each of the elements and each of the four levels on the Likert scale. The elements that reached consensus at 70% were removed from the questionnaire for further analysis in Chapter 4. However, non-consensus statements were reiterated in the subsequent rounds until consensus was reached, or until the end of round 3. The qualitative data was thematically analysed by the researcher for relationships and patterns, similarities and differences (Sharif, 2015:4). The data was converted to closed-ended questions, verified with the study leaders and added to the subsequent round's questionnaire (Sharif, 2015:4). The process of data analysis is further described in Section 3.7. Although it was not the

92**aim of** the **study to report** on **the** differences **of** consensus between **groups**

A and B, the researcher reported any meaningful statistical relationships of the analysed data in Chapter 4. 1.16 Methodological rigour Methodological

57**rigour is defined as the soundness or precision of a study in terms of planning, data collection, analysis and reporting** (Marquard, **2017:**

online). The traditional indicators for methodological rigour in quantitative studies are reliability and validity. The perceived lack of methodological rigour of the Delphi technique permeates most literature on the subject. However, Avella (2016:318) pointed out that the criticism of earlier researchers such as Sackman (in Avella, 2016:318) has been repeatedly contextualised. The researcher discussed in detail measures applied to demonstrate the

27**reliability and validity of the research** n **Section 3.**

7. 1.17 Ethical considerations The

102**Health Sciences Research Ethics Committee of the University of the Free State approved the study: UFS-**

HSD2020/0022/2104 (see Addendum A). In addition, approval was obtained by the

52**Head of the School of Nursing,** where this study **was** conducted. **The researcher**

selected the

69**Belmont Report** (The **National Commission for the Protection of Human** Services **of Biomedical and Behavioural Research, 1979:** online) as **a** basic point **of** departure in ensuring **ethical** conduct throughout the **research**

process. The Belmont Report identifies three broad ethical principles which are often used in health sciences studies. These principles are

27**a) Respect** of **persons, b) Beneficence, and c) Justice.**

73**A detailed description of** the principles and **how these were applied in this study is provided in Chapter 3. 1.** 18 Limitations of **the**

study Using a descriptive study design could be considered as a low level of research by critics. However, use of the research design was the most applicable to reach the aim of the study, as discussed in Section 5.4. Another limitation was a gap in the knowledge that was identified by the researcher. The competence of gynaecological U/S and the integration with midwifery U/S was underrepresented in the first round questionnaire. Lastly, the researcher reflected in Chapter 5 on the descriptors of the Likert scale used in the questionnaires. The third level descriptor could have a stronger inclination towards a positive sentiment. However, as the data analysis indicated in Chapter 4, no correlation was found between the responses and a stronger interpretation of the level descriptor. 1.19

9**Value of the study The value of** this **research** is **in the** establishment **of**

expert-recommended competencies for midwifery U/S in South Africa. This list of midwifery competencies is the first of its kind in South Africa and could be used in future to inform midwifery education and practice. The knowledge gained from the research may lead to curricular development, which in turn can allow measurable and regulated competencies for midwifery U/S. National implementation will ensure equal competence by all midwifery U/S training programmes. Although the generalisation of the consensus is specific to the South African midwifery context, consensus reached during this study could potentially be utilised in comparative studies in other countries. 1.20 The layout of the dissertation Table 1.2 Layout of the dissertation

18**CHAPTER 1 Overview of the study CHAPTER 2 Literature review CHAPTER 3 Research methodology CHAPTER 4 Research findings CHAPTER 5 Conclusions**

51**An overview of the** study **was provided in Chapter**

1, as indicated in Table 1.2. The second chapter described the literature reviewed for the proposed competencies for midwifery U/S education and practice in South Africa, and for which consensus was pursued. A description of the methodology, including the research design, research technique, the questionnaire development, data collection, data analysis, ethical considerations, methodological rigour, and limitations follow in Chapter 3. The research findings are described in Chapter 4. In the last chapter, Chapter 5, a conclusion with recommendations are given. 1.21 Concluding remarks The researcher aimed to address the problem of unaccredited and unregulated education and practice of midwifery U/S in South Africa by implementing a modified e-Delphi research method to reach consensus on competencies never before described. Six midwifery U/S competencies

1**were developed based on national and international** literature about **the** skill, knowledge **and** professional behaviour needed for midwifery U/S. The researcher set out to gather experts from all groups of applicable U/S healthcare professionals to contribute to consensus on midwifery competencies for education and practice

39**in South Africa. Chapter 2 Literature review 2.1 Introduction This**

quotation from Ian Donald identifies the important aspect that the safe, effective and respectful use of any technological diagnostic tool, such as the ultrasound should be considered before implementation. In Chapter 2 the researcher considers the interest of the childbearing family in the context of the history of ultrasound, maternal and child health in South Africa, and the crucial fundamental components related to midwifery U/S education and practice

144**as illustrated in Figure 2.1. Figure 2.1 Outline of**

fundamentals related to midwifery U/S The historical footprint of the U/S sheds some light on the progress of U/S during the last eight decades, and how it has developed to benefit the childbearing family. With the application of any technological technique such as the U/S, the balance between clinical usefulness and the cost related to the burden of disease lies somewhere between over-medicalisation and

97**poor quality of care** (Miller, Abalos, Chamillard **et al., 2016:** 2176). Therefore, **the**

context of ultrasound in South Africa needs to be balanced against the benefit of U/S for the childbearing family. As the midwife is the professional of choice to render care during the profound period of childbirth (ICM, 2014:2), recognition should be given to the midwife's contribution to quality care during pregnancy and childbirth. As midwifery care is influenced by a competency approach, the competencies for midwifery ultrasound should be examined concerning how midwifery ultrasound has been positioned globally. A formal literature search was conducted by an experienced librarian

8**at the University of the Free State,** using **the**

Boolean search string depicted in Figure 2.2. Figure 2.2 The literature search process The literature search was supplemented with a continuous exploration of literature on midwifery U/S, U/S related topics, U/S education, and U/S competencies using Science Direct, Cochrane Library, Pubmed and Google Scholar. U/S contributes to new terminology which does not form part of the midwifery field. For ease of reference, the researcher included certain terms that the reader may find useful

111**(Table 2.1). Table 2.1 U/S**

terminology descriptions applicable to the study. U/S terminology Description Knobology Includes the basic U/S characteristics with reference to: •

1**Ultrasound transducers: principles of sound generation; compare transducer characteristics and applications. • Sound penetration and** bio-effect **with consideration related to acoustic power output. • Effect of frequency on resolution and penetration. • Effect of depth settings on field of view and image size. • Gain settings for optimal image brightness with minimum power output. • Focal zone depths to achieve best resolution of structures of interest. • Image persistence settings to reduce background noise. • Inputting patient information into ultrasound system before starting**

Level 1 U/S Complete ultrasound examination that includes early and first trimester U/S, second and third trimester U/S, gynaecological U/S. Level 2 U/S Specialised examinations (also called survey or targeted examinations) with detailed anatomy screening when anomalies are suspected. Includes biophysical profile Fetal morphology Refers to the U/S screening of anatomical structures to identify congenital anomalies Biophysical profile A specialised component of U/S that includes the evaluation of fetal breathing, movement, and tone. It also includes an evaluation of the amniotic fluid volume. AOP The

4**AOP is the angle between the axis of the symphysis and the line drawn from the under border of the symphysis tangential to the fetal skull**

SHD The

> 4**SHD is the distance between the under border of the symphysis to the fetal skull measured perpendicular to the axis of the symphysis**

Biometry Sonographic biometry (linear, circumference, area and volume) Fetometry (measurement during first -trimester) Includes standard measures of

> 120**bi-parietal diameter [BPD], head circumference [HC], abdominal circumference [AC], and-** femur **length [FL]).** Adapted **from**

Abuhamad, Minton, Benson, Chudleigh, Crites, Doubilet, Driggers, Lee, Mann, Perez, Rose, Simpson, Tabor and Benacerraf (2018:31, 41), Van Adrichem, Faes, Kinget and Jacquemyn, (2018:252), Callen and Norton (2017:5,18), ISUOG (2014:114), Ukweh, Ugbem, Okeke and Ekpo (2019:109). 2.2 History of Ultrasound The diagnostic application of U/S in obstetrics and gynaecology has been in use for the last 80 years. Although U/S was initially developed in the early 1800s, it was the discovery of the piezo- electric effect, described by the Pierre and Jacques Curie, which led to the generation and the reception of U/S in megahertz that could be employed in echo sounding devices (Woo, 2008:1). The piezo-electric

> 139**effect refers to the ability** of **certain materials to create an electrical charge**

when under mechanical pressure. The application of the piezo-electric effect is still applicable today in the single plate crystal U/S transducers/probe (Murugandoss, Coyle & Datta, 2018:42). As electrical current passes through the crystal, it produces a U/S wave at frequencies higher than 20kHz. However, for the obstetrical U/S, a bandwidth of 1-15 kHz is considered safe for diagnostic use (Murugandoss et al., 2018:42)., as prolonged or higher use can lead to tissue heating and cavitation (Goodchild & Cheschelr, 2014:139) on which the author will elaborate elaborated on in Section 2.3.2. During World War I, the development of the underwater sonar detection system led to underwater navigation by submarines. Alexander Belm described the underwater echo-sounding device in 1912, the same year that the Titanic sank. In 1914, Reginald Fessenden became the first person to design and build a working sonar machine for the detection of underwater icebergs (Woo, 2008:1). It is the same underwater echo principle that was instrumental in creating the U/S image. In medical ultrasound terms, the B-mode or the brightness mode refers to the cross-sectional image that is created due to the pulse-echo effect. The pulse-echo impact refers to the electrical current that is created when the sound wave bounces back in the form of an echo and reaches the piezo-crystal. The electrical current produced in the piezo-crystal by the echo is stored in the U/S machine as a single line of information (Murugandoss et al., 2018:42). During the following decades, the use of U/S technology for its diagnostic ability exploded, and a deep-seated scientific bed of knowledge was created in the field of obstetrics and gynaecology. Dr Ian Donald is heralded as the father of obstetric and gynaecological U/S. In 1958, the iconic paper 'Investigation of abdominal masses by pulsed U/S', was published. This pioneered the measurement of fetal images and set the scene for future U/S developments. During 1959, Dr Donald described the use of U/S to measure the fetal head (Campbell, 2015:215; Woo, 2008:10), developed the full bladder technique for visualisation and was the first to describe the hydatiform mole. Dr H. Robinson further developed a detailed biometry chart in 1973, as we still know it today. Other development such as placentography, described as the visualisation of the placenta with a radiopaque medium, was instrumental in identifying the placental location for the diagnosis of antepartum haemorrhage in placenta praevia. The collaboration between Dr B. Sunden and Dr I. Donald gave way to Dr Sunden's published thesis that was the earliest and most comprehensive publication in obstetrics and gynaecology at the time. One of the critical scientific findings in Dr Sunden's thesis was that he detected no harmful effects of the U/S on pregnant rats (Woo, 2008:2-12). Dr Kratochwil used the transvaginal probe for the early identification of a fetal heartbeat and dating of pregnancy, which led to a major change in pregnancy and childbirth management (Woo, 2008:2-12). The development of U/S changed the way we view the child birthing family, including the partner as a crucial member. It is now recommended and accepted that every pregnancy should have a minimum of one U/S (SA DoH, 2015:155; WHO, 2018(b):1). Although Lars Grennert and Per Persson demonstrated the value of routine screening in 1978 (Campbell, 2013:218), the question remains how often during pregnancy the U/S should be utilised for diagnostic purposes.

> 55**Little is** however **known about the general frequency of antenatal** U/S **exposure in low-risk women.**

According to Ranji and Dykes (2012:26), a mean of 6.9 U/S examinations were found to be the norm in Iran. Various recommendations for a possible second or third U/S exist (SA DoH, 2015:155;

55**Souka et al., 2012; Lynn et al., 2013),**

with benefits noted as an increased diagnosis of fetal growth restriction, polyhydramnios and suspected LGA (Al-Hafez, Chauhan, Riegel, Balogun, Hammad & Berghella, 2020:2). However, the consensus on the effect of U/S on the decrease of the perinatal rate has not been researched and still needs further investigation (Holmlund, Ntaganira, Edvardsson, Lan, Sengoma, Kidanto, Ngarina, Small and Mogren, 2018:2). Despite the conflicting opinions about the frequency of U/S, the overwhelming majority of healthcare professionals agree that U/S is decisive in pregnancy management (Holmlund et al., 2018:7). Recently, the face of U/S has changed yet again, which has had a major impact on IP midwifery care (ISUOG, 2018:128-139). In 2018 the

122**International Society of Ultrasound in Obstetrics and Gynaecology (ISUOG)** published **a** set **of** guidelines for **the use of**

IP U/S, which states the practical implications and recommendations that may affect labour management. This will be discussed in detail in Section 2.7.4. A shortage of sonographers, inadequate infrastructure, and variable power supply is only a few of the barriers to universal access of U/S during the childbearing period (Luntsi, Ugwu, Nkubli, et al., 2020:1). As discussed in Section 2.7, midwives are able to utilise U/S to the benefit of the childbearer and the midwifery profession. As seen in this brief history of the U/S, the ever-changing field of U/S has a variety of diagnostic abilities. The value of U/S as a diagnostic tool for midwives lies in the unequivocal philosophy of midwifery care that its clinical usefulness can be demonstrated, as quoted by Ian Donald, without harm, indignity or discomfort to the mother (ICM, 2014:2). Despite the industrial transformation that is evident since the first industrial revolution in the 1800s, the impact on midwifery has only gained momentum within the 4IR (Dino and Ong, 2019:4). The medicalisation of midwifery care contributed to the technocratic midwifery environment, which has seen the birth of the bio-medical model of care (Najafi, Roudsari and Ebrahimipour, 2017:5446). The inclusion of U/S to the array of medical interventions needs to be balanced between the midwifery philosophical foundation (ICM,2014:1) and the benefit it brings to birth in the current time of the fourth industrial revolution. As the midwife is the professional of choice to care for a mother during childbirth (ICM, 2014:1), midwifery U/S as a diagnostic tool can benefit the mother by contributing to a positive childbearing experience (WHO, 2016[b]:online). 2.3 The context of ultrasound in maternal and child health in South Africa The WHO published evidence-based recommendations as discussed in Section 1.2. The document emphasises that the focus should be a positive pregnancy and childbirth experience. As an experienced independent midwife specialist, the researcher agrees with the WHO that

70**a positive pregnancy and childbirth experience** is grounded in **the**

quality of care rendered during the critical childbearing period (WHO, 2016[e]:ix). With

82**target 3.1 of the SDGs** being **to reduce the** maternal mortality ratio **to less than 70 per 100 000 live births**

(WHO, 2020:online), the SBR can be used for global comparison of quality of maternal healthcare as it is calculated as one of the sensitive indicators for IP care (Lawn, Blencowe, Waiswa, et al., 2016:594; Madaj Smith, H., Mathai, et al., 2017:1-2). As an indicator of the quality of maternal healthcare, the reduction of the SBR to <12/1000 was reiterated in the

109**'Ending Preventable Newborn Deaths and Stillbirths by 2030'**

report. Stillbirths and neonatal deaths account for the most perinatal deaths. However, maternal and child health receives the lowest healthcare investment allocation (WHO & UNICEF, 2020:1-3).

24**Developing countries such as South Africa** contribute **to** 98% of **the**

global SB per year (WHO, 2016[d]:online; Lawn et al., 2016). Ineffective strategies to decrease the SBR, which can be linked to substandard quality of care in many health facilities, remains a significant obstacle on the road to ending preventable perinatal mortality and morbidity (Tuncalp, Pena-Rosas, Lawrie, et al., 2017:860; WHO & UNICEF, 2020:2). Therefore it is no surprise that in the context of healthcare in a developing country like South Africa, the reality is often that many women do not have a positive pregnancy and childbirth experience. Furthermore, the high SBR articulates the problems in maternal and child healthcare. Evaluating the SB in South Africa from 2002-2016, as indicated in Figure 2.3, shows an underwhelming decrease of only 3,5% in the overall SBR. The current SBR of 21/1000 live births indicates that South Africa needs to change the existing action plan and accelerate the reduction of SB to meet the SBR deadline in 2030. South African Stillbirth Rate: 2002 - 2016 30 25 24,5 23,4 22,2 21,8 20,7 20 15 Target 10 5 0 2002 - 2004 2005 -2007 2008 - 2010 2011 - 2013 2014 -2016 SBR: All births SBR: >500g SBR: > 1000g+ Figure 2.3 Graphic overview of SBR in SA from 2002-2016 (Saving Mothers Triennial Reports 2002 – 2016). The decline in the SBR for neonates below 1000g was the least impressive. The slow decline in South Africa may be attributed to the country's lack of infrastructure and human resources to support neonates <1000g or 28 weeks of gestation. However, contributors to the SBR, such as fetal growth restriction, maternal infections and IP asphyxia, are considered as preventable causes (SA DoH, 2017:24). In Table 2.2, a comparison between the WHO listed causes of SB and South Africa's statistical contribution to SBR-related to viable fetuses (>1000g) is presented. Table 2.2 Comparative causes of stillbirths: WHO vs South Africa (Adaptation from WHO, 2016a: online, and the

38**Saving Babies 2014-2016 Triennial report on Perinatal Mortality,**

2017:24). WHO main causes of stillbirths – antepartum South Africa primary causes of death: fetus> 1000g Fetal growth restriction Fetal growth restriction 2.4 % Congenital abnormalities Congenital abnormalities 5.7 % Maternal infections in pregnancy (malaria, syphilis and HIV) Maternal infections 3.3 % Maternal disorders (especially hypertension, obesity and diabetes) Hypertension Antepartum Haemorrhage 26.2 % NA Unexplained stillbirths 25.3% Childbirth complications Intra-partum asphyxia 18.6% Fetal growth restriction (2.4%) and congenital abnormalities (5.7%) are both conditions that can be diagnosed per U/S. They collectively contribute to 8.1% of SB in South Africa. It is noteworthy that maternal hypertension and antepartum haemorrhage, which are both related to abnormal placentation, add 26.2 % to the SBR. Both these conditions contribute to the major causes of maternal mortality in South Africa (SA DoH, 2017:iv). Combined, small for gestational age babies, congenital abnormalities, hypertension, antepartum haemorrhage and unexplained stillbirths collectively contribute to almost two thirds (71.4%) of the SBR in South Africa (SA DoH, 2017[a]:24). Intrapartum asphyxia contributes 18.6 % to the SBR, and was flagged as a significant contributor to the South African SBR. IP U/S could contribute to the reduction of IP asphyxia, as discussed in Section 2.6.4 The Provincial Assessors

163**Report of Confidential Enquiries into Maternal Deaths in South Africa**

(Solanki, Fawcus & Daviaud, 2019:5), states that reducing the SBR can be achieved by focusing on the management of hypertension, antepartum haemorrhage and small for gestational age babies as a subgroup of unexplained stillbirths. The U/S is a valuable and essential diagnostic tool used in antenatal care as a baseline investigation which could identify causes of SB and pregnancy complications (Ahman et al. 2018:241: Luntsi et al., 2020:1). The use of U/S has been globally accepted to have a positive impact on the reduction of the SBR. Nkosi et al. (2019:350) strengthened this notion by indicating that monitoring low-risk pregnancies between 28 – 32 weeks by means Umbiflow (continuous-wave-Doppler), which is a component of the U/S, showed an increase in the identification of small for gestational age babies. The Doppler U/S is used

54**for assessment of** the **blood flow** of the **fetal umbilical vessels.** It indicates the **placental function to identify**

abnormal flow that correlates with IUGR and adverse fetal and newborn outcomes (Hofmeyr, Haws, Bergström et al., 2009:S40; Nkosi et al., 2019:347). The Doppler flow is a non-invasive intervention that could directly influence a reduction of unexplained SB (Nkosi et al., 2019:351). In the study by Nkosi et al., 10% of the mothers with low-risk pregnancies had an abnormal resistance index that contributed to a 60% reduction of macerated SB in the study. In comparison, the control group that did not receive Doppler flow resistance in the same low-risk category had the highest SBR (Nkosi et al., 2019:351). Despite the proven benefit of U/S during the antenatal period, access and equality of care is a scarce commodity in Southern Africa (Tegnander & Eik-Nes, 2008:5). According to Carrera (2011:290), 68% of women receive one U/S during pregnancy in urban areas, in contrast to only 18% in rural areas in Southern Africa. The State of the World Midwifery Report (UNFPA, 2017:10-11) elaborates on how countries could ensure effective coverage of SBA for the childbearer by ensuring high quality of care that is accessible, available and is an acceptable method of care. Besides the issue of the lack of access to U/S , is the importance of the acceptance of an effective non-invasive intervention to the healthcare user. Intrapartum U/S is more acceptable to childbearing women than vaginal examination, and superior in

4**terms of identifying the correct fetal head position**

(Van Adrichem et al., 2018:251). Although the IP U/S was first described as early as 1977 (Usman et al., 2015:53), the guidelines published by the ISOUG (2018:137) have strengthened the use of IP U/S. Half of all stillborn babies begin labour alive but die before birth. The investment in assisting tools during pregnancy and childbirth, such as IP U/S, comes with a quadruple return, as it affects the health of mothers and newborns, stillbirths, and asphyxia- related disabilities. One important place for investment to improve

35**quality of care,** accessibility **and the availability of** care, is **the** training and deployment **of**

SBA (WHO and UNICEF, 2020:2,9), especially midwives, in the use of IP U/S. As midwives are the professional choice of SBA during childbirth (ICM, 2014:1), the availability of an acceptable diagnostic tool such as the IP U/S in South Africa could dramatically increase accessibility and quality of healthcare. Despite the ease of reaching competence in IP U/S (Van Adrichem et al., 2018:251), it is still under-utilised in South Africa.

16**According to the State of the World Midwifery Report**

(2017:iv),

110**South Africa is the only country in the**

Eastern and Southern African region that has the appropriate skill mix to apply the essential interventions to reduce the perinatal mortality rate. The skill mix is comparable to most developing countries in Sub-Saharan Africa. However, due to manner the skill mix was determined, it does not reflect actual midwifery competence. In South Africa, most registered nurses also hold a midwifery qualification, but does not have the competence required for the midwifery profession (SOMSA, 2017). Therefore, the quantification of midwives by the SANC is an unrealistic portrayal of the available competent midwifery workforce in South Africa. Despite the previous notion that midwives are not warranted to utilise U/S, the majority of women in the

8**public health sector in South Africa** birth with midwives. **South African**

midwives are therefore ideally positioned to implement IP U/S if allowed to acquire the necessary competency. With the technical advances in ultrasound equipment, where Android devices can be connected to a U/S probe, the cost of U/S has drastically decreased, making it more available for each birth facility (Leung, Amundson, Phan, Kimura & Mercy, 2018:1; Phillips, 2020:online; Fullerton et al., 2019:416). The midwife, as custodian of normal pregnancy and birth (ICM, 2014:1), is in an optimal position to render midwifery ultrasound the childbearing woman. Midwifery U/S could contribute not only to a positive pregnancy and birth experience (Fullerton, Gherissi, Johnson & Thompson, 2014:413) but can affect the direct and indirect costs related to perinatal indicators in

64**South Africa, as discussed in Section** 2.3 **.3. 2.**

3.1 Role-players in U/S in South Africa A wide range of healthcare practitioners in South Africa performs an obstetrical and gynaecological U/S. Despite the 4IR, U/S education and practice have been withheld from the greater spectrum of midwives in South Africa. Traditional U/S healthcare professionals such as obstetricians and gynaecologist, general practitioners, and sonographers/ radiologists have been using U/S for several decades. Notwithstanding some South African midwives being educated in various post-qualification U/S programmes, and midwives contributing to 68% of the total births as SBA (Statistics, SA, 2020:15), midwives are not perceived as appropriate healthcare professionals to utilise U/S for clinical practice (Steinberg, 2019:personal communication). According to Callen and Norton (2017:5), an unfortunate turf war exists between healthcare practitioners as to who has the right to perform U/S. The "magic of ultrasound" (Stewart, 2011:54) has been withheld from midwives, as U/S is wrongfully assumed as the scope of practice of the medical practitioner and radiologists (Steinberg, 2019:personal communication). The disempowerment of professional groups that serve women, such as midwives, is a described barrier to quality maternal healthcare (Renfrew, Atevia, Dennis-Antwi et al., 2019:396).

112**There is growing evidence to support the** systemic disempowerment **of**

midwives. As a female-focused profession, mostly practised by women, patriarchal systems reduce midwifery to a

45**low priority by decision-makers (Renfrew et al., 2019:**

397).

112There is growing evidence to support the systemic disempowerment of

midwives. As a female-focused profession, mostly practiced by women, patriarchal systems reduce midwifery to a

45low priority by decision-makers (Renfrew et al.,

47 2019:397). This internationally recognised disempowerment is also a reality in South Arica. In scientific publications regarding South African maternal healthcare, and in personal communication, esteemed decision-makers refer to midwives as low-level healthcare workers with a low status (Hofmeyr et al., 2009:S37; Pattinson, 2020:personal communication). Midwifery is reduced to merely the "monitoring and managing of labour" (Pattinson, 2020:personal communication). Apart from the disempowerment of midwives, a shortage of traditional U/S healthcare professionals has led to U/S not being available nor accessible in especially primary healthcare settings in South Africa. As midwives are the most accessible SBA in South Africa, they are included in midwifery U/S programmes in South Africa. These programmes aim at qualifying midwives for U/S within the public health setting. The implementation of a midwifery U/S programme in Kwa-Zulu Natal during 2004-2014 was seen as a task-shifting approach (Tegnander & Eik-nes, 2008:3). Midwives were to utilise U/S for the diagnosis of multiple pregnancies, location of the placenta and to give an overview of fetal anatomy to detect severe abnormalities with the aim of timeous upwards referral (Tegnander & Eik-nes, 2008:3). The Kwa- Zulu Natal midwifery U/S programme was supported by the National Department of Health and ISUOG. The U/S programme was implemented for more than a decade in South Africa. Despite the national and international support and funding of midwifery U/S, SANC considers U/S as the domain of traditional U/S healthcare professionals and has not published any communication about the inclusion of U/S as a midwifery competency (Tegnander & Eik-Nes, 2008:6-7; SOMSA, 2017:3). 2.3.2 Past and existing midwifery ultrasound programmes in South Africa Ultrasound

12education and training programmes for midwives in South Africa

have seen a variety of learning programmes within the last two decades. In Kwa-Zulu Natal, a 12 month internationally led programme by a Norwegian U/S specialist team was implemented (Tegnander & Eik-Nes, 2014). Subsequently, in Gauteng (Mashamba, 2017) and the Free State (SOMSA, 2017:2), other programmes for midwifery U/S education and training was implemented. The Norwegian team, after more than a decade of involvement, withdrew the programme because midwifery U/S were not being utilised within the vacuum of regulation and human resource deployment (Tegnander, 2016:personal communication). During 2016-2017, a 16-week midwifery U/S programmes was implemented in Gauteng. The midwifery U/S programme was commissioned within the province, and supported by a manufacturer of U/S equipment (Mashamba, 2017:2). The variation of the learning programmes over different provinces saw disparities in education standards, and currently there is no regulation or control of the quality of the training output. The lack of regulation is a major concern not only for the medico-legal risks involved in a non-regulated programme, but also for the indication of the quality of the competency acquisition and practice. The programmes reported in the Free State, Kwa-Zulu Natal and Gauteng might not be the only U/S programmes available to midwives in South Africa. The concern with the existing midwifery U/S programmes is the lack of a certification process, as midwifery U/S competency is not accredited with either SANC or SAQA. This lack of accreditation jeopardises the quality of current U/S education. In addition, the practice of midwifery U/S outside of the public healthcare setting has not been sanctioned. The fact that different unaccredited midwifery U/S programmes are still available in South Africa validates the need that midwifery U/S education programmes should comply with the competency as set out by the ICM (2013:8; 2018:13; SOMSA, 2017:3). Competency-based midwifery U/S education programmes could expedite the regulation and accreditation of midwifery U/S. 2.3.3

130Too little too late, (TLTL) and too much too Soon (TMTS) As the 2030 deadline for the

SDG's is fast approaching,

6low-income and middle-income countries

are re-engineering strategies to address pregnancy-related deaths

6**(Miller et al., 2016, 2176).** However, Miller **et al. (2016:**

2176) state that without the emphasis on quality maternal care, the advances made to reduce mortality and morbidity will be lost. Poor quality of care is often due to inadequate resources and compliance with evidence-based standards. Furthermore, health system failures to provide timeous healthcare interventions were phrased as TLTL (Miller et al., 2016:2176). Conversely, TMTS refers to the over-medicalisation of childbirth (Miller et al., 2016:2176). In respect to U/S during the child birthing period, the inequality between public and private healthcare speaks directly to the issue of TLTL and TMTS in South Africa. One example of TLTL is that 50% of pregnant women in public healthcare in metropolitan South Africa (Stewart, 2011:54) have access to U/S to receive the WHO recommended one U/S before 49 24 weeks of gestation (WHO, 2018[b]:1). According to Miller et al. (2016:2176), TLTL leads to an increase in the perinatal mortality and morbidity rate. The perception exists that U/S is the most expensive component of care during childbirth (Odent, 2011:91). The low number of first trimester U/S has often reinforced this cost-benefit perception (Fullerton et al., 2019:416). Not only is the initial cost of U/S equipment perceived as expensive, but the first point of care with U/S is usually at secondary-level healthcare, which increases the cost of access to healthcare for the healthcare user (Daily Maverick, 2020:online). In Table 2.3, a cost comparison of fetal surveillance with three different U/S technologies is given. Table 2.3 Cost comparison of fetal surveillance with different U/S devices Description of function U/S product Initial cost First year cost • Traditional U/S colour and spectral Doppler Vivid S6N R290 000 R290 000 • • Colour and spectral Doppler Tele-medical support Umbiflow® Doppler tools and computer, Administrative costs R37 014,09 R71 777.82 R108791,91 • • • Traditional ultrasound Colour Doppler Teleradiographic support Lumify® Probe Teleradiography Tablet R110 000,00 R 1 148,98 R6 000 R117 506,08 (Adapted from Bisset, 2020:personal communication; Rossouw, Spencer & Pattinson, 2017:5; Businesstech, 2019:online.) The cost of a traditional U/S device such as the Vivid S6N could be regarded as expensive compared to the Umbiflow® and new generation handheld smartphone devices such as the Lumify®. At approximately three times the cost it is the most expensive option (Table 2.3). However, you get what you pay for, with the full range of U/S including colour and pulse Doppler function (Philips, 2017:6). The traditional U/S devices at this price range do not include telecommunication support and is somewhat bulky, in a clinical sense, to move around. A U/S device such as the Vivid S6N is an expensive option to have in every healthcare facility in LMIC. The Umbiflow®, in comparison, is more affordable. However, with the limited utility of only Doppler functions, it does not offer the benefit of measurement or visual identification of normal and abnormal anatomy and physiology during the reproductive age. The Lumify® is in the same price range as the Umbiflow® (Table 2.3). However, the Lumify® as a handheld device, offers a range of bedside U/S measurements, colour Doppler and teleradiographic support, if needed. The disadvantage currently is the lack of pulse Doppler as an option with the Lumify® (Bisset, 2020:personal communication). However, the Lumify® is the ideal solution for midwifery IP U/S in South Africa, where pulse-Doppler is not a necessity, but rather the visualisation and measurement option of a transportable handheld device with teleradiographic support. Another contributory factor to the cost of U/S is the reality of litigation in South Africa that translates into the high cost of obstetrics and midwifery. The then Gauteng MEC of Health, Gwen Ramokgopa, stated that more than 70% of the R13.8 billion claims against the department in 2016 51 was related to maternal and neonatal health (Masweneng, 2017:online). According to Snyman (2019:4), cerebral palsy accounts for 30% of claims within obstetrics, with the main reason stated to be IP asphyxia. The high cost of litigation drains excessive amounts of the financial resources intended for the improvement of healthcare services in South Africa (Mokane, 2019:8). In addition, the cost of indemnity insurance for obstetricians, gynaecologists and midwives increased during the last five years with exuberant amounts, to the disadvantage of the healthcare end-user who has to absorb the additional costs. Accessibility to U/S outside of the one examination captured within the public healthcare becomes almost non-viable, with only 16.4% (Stats SA, 2020) of individuals in South Africa with medical aid coverage. No life should ever be quantified in terms of monetary value, and the cost of SB is the same. However, the effect of U/S on SB could decrease the ever-draining burden of disease on the South African healthcare system. The direct financial cost, that includes additional investigations of a stillbirth, contributes to between 10-70% of a live birth (Heazell, Siassakos, Blencow, et al., 2016:2). The non-direct financial cost of SB is reported as the burial costs, loss of income and additional medical expenses (Heazell et al., 2016:2), which are often not quantified for SB. In addition, the psychological and social aspects of SB are often neglected. In contrast with the reality of only one U/S during pregnancy in the public healthcare system in South Africa, private healthcare professionals perform numerous U/S examinations on low-risk pregnant women. The total of U/S during one pregnancy in the private sector in South Africa can easily tally to more than eight. The logistical arrangement in private healthcare allows for an increase in the accessibility of the equipment, and in the opportunity and subsequent usage of U/S examinations. Evidence shows that over-medicalised birth practices (with special reference to fetal surveillance), such as U/S examination for determination of fetal size in the third trimester, lead to unnecessary intervention (Moldeus, Cheng, Wikstrom & Setphansson, 2017:7). In addition, routine continuous cardiotocography may lead to an increase in caesarean sections without improvement in either the mortality or morbidity rate (Miller et al., 2016:2178: Robinson, 2020:84). According to Miller et al. (2016:2178), mothers are not being informed about the associated risks of over-medicalised care, nor have they given informed consent for the excessive interventions that do not necessarily improve birth outcomes. Not only does TMTS lead to an increase in the cost of healthcare and a negative impact on health system resources (Solanki, Fawcus & Daviaud, 2019:7), but it could also lead to serious violations of the rights of the mother (ICM, 2014:1-3). The dilemma that accompanies over-medicalised care contributes to what

Odent (2011:91) describes as the nocebo effect, that influences both the healthcare professional and the childbearing family. The nocebo effect can be related to the increase in caesarean sections due to fetal surveillance and early induction of large for gestational weight fetuses (Moldéus, Cheng, Wikström and Stephansson, 2017:7). Midwifery U/S however, should comply with the sentiments expressed in the ICM philosophy and model of care. The first departure is respect for the normality of the pregnancy and childbirth, and advocates for the appropriate use of technology while promoting and protecting women's and newborns' health and rights (ICM, 2014:1-3). Therefore, great care should be taken in avoiding over-medicalisation of midwifery U/S. Midwifery U/S within the confounds of the ICM philosophy and model of care provides an opportunity for a juxtaposed consideration between the increased demand of modern technology, limited resources, and maternal and health interests (Holmlund et al., 2017:4). 2.4 Effect of ultrasound The debate regarding the safety of the U/S has been ongoing since the development in the early 1940s. The consideration of advantages versus potential harm of the childbearing mother and the developing baby should be carefully evaluated before implementing any diagnostic tool. As Donald states, before being considered, any diagnostic tool should first prove its clinical use without any harm, indignity or discomfort to the person (Woo, 2008:9) 2.4.1 Advantages of ultrasound during pregnancy and childbirth Ultrasound is perceived as safe to use irrespective of the number of examinations (Holmlund et al., 2018:2). A point-of-care U/S referred to bedside diagnosis with the use of easily accessible devices, has increased the access of U/S to include LMIC (Bentley, Hexom & Nelson, 2015:1563- 1564). This increase of access has prompted a number of studies that have proven the advantages of U/S as a diagnostic tool during pregnancy, as illustrated in Table 2.4. Today, U/S is regarded as a standard component of quality antenatal care (McClure, Nathan, Saleem, et al. 2014:1). Table 2.4 Advantages of ultrasound screening during the childbearing period. 1st trimester 2nd trimester 3rd trimester IP and postpartum - - Identify gestational dating using the U/S Diagnosis of ectopic pregnancy - Establish amniotic fluid volume - - Evaluation of fetal heart rate and fetal position Assisting with visualisation with external cephalic version - Determine malpresentation and malposition Benefits of Ultrasound - Diagnosis of congenital anomalies - o o o Screening of anatomy includes, (not limited to): Placental position and function Amniotic fluid index Abnormal fetal development - Determine Doppler flow to evaluate the placental function - Confirmation of cervical progress position, attitude, amniotic fluid index, placental maturation, cord around the neck of the fetus - Confirmation of single or multiple intra-uterine pregnancy - Confirmation of gender. - Diagnosis of placenta location (placenta abruption/praevia) - Determine progress and the ability to labour using various measurements - Excluding abnormal development such as blighted ovum hydatiform mole) - Evaluate fetal growth or clinical complications due to growth - Evaluate fetal growth or clinical complications due to growth - Diagnosis of retained placental products to ascertain normal/abnormal involution (Adapted from Hofmeyr et al., 2019:S24-S25; Whitworth et al., 2010:2; Nathan, Swanson, Swanson, et al., 2017:210; Tegnander & Eik-Nes, 2008:5; Mashaba, 2017:13; Molander, Alehagen & Berterö, 2010:19; Holmlund et al., 2017:2) 54 Antenatal U/S aids in the increase of attendance of antenatal care (Greenwold, Wallace, Prost & Jauniaux, 2014:276; Holmlund et al., 2018:2), and motivates for birth with an SBA in hospital (Luntsi et al., 2020:2). The benefit of antenatal attendance leads to the identification of obstetrical risks, and can prevent life-threatening conditions. During the antenatal period, the use of early/first trimester U/S to identify the location of the pregnancy is the first significant benefit of U/S as a diagnostic tool. The benefit of U/S to diagnose an ectopic pregnancy (Abramowicz, 2009:296), a product of conception implanted extra-uterine, is directly measurable against the maternal mortality rate (Flores, Kassamali, Won, Stein & Reynolds, 2019:33). Utilising an early U/S examination during the routine management of mothers in

109**Sub-Saharan Africa** indicated **a** significant **increase in the** diagnosis **of**

ectopic pregnancy from 12.6% to 80% (Flores et al., 2019:33). However, Nzaumvila et al. (2018:6) describe a delay in the diagnosis of ectopic pregnancy (47%) in a district hospital in South Africa, showing the significance of competent healthcare professionals and the availability of resources. The importance of access to competent and available quality U/S during pregnancy was strengthened by Nkyerkyer (2006:1), stating that each polyclinic, district, and regional hospital should have access to U/S with qualified personnel who can also interpret serum β-HCG measurement. Dating of the gestational age is one of the most acknowledged antenatal diagnostic usages of the U/S (Hofmeyr

65**et al., 2009:** S25; Holmlund **et al., 2018:** 7 Whitworth **et al.,** 2010:2; McClure **et al.,**

2014:1). More so in South Africa, where the last normal menstrual period (LMP)

3**is unknown in 70 – 80% of pregnancies (Tegnander & Eik-Nes,** 2014 **:6).**

Although a known LMP is still the method of choice for gestational dating (SA DoH, 2016:36), the use of U/S for women presenting >20-24 weeks gestation is more accurate than an unsure LMP (Geerts, Poggenpoel & Theron, 2013:8). Accurate gestation dating with an early/first-trimester U/S (Tegnander & Eik-Nes, 2008:5; McClure et al., 2014:1) decreases the induction of post-dated pregnancies up to 40% (Abramowicz, 2009:296; Hofmeyr et al., 2009:S29; Whitworth et al., 2010:2). Furthermore, optimisation of genetic screening tests due to accurate gestational dating in high-risk mothers could increase the detection of congenital abnormalities (Tegnander & Eik-Nes, 2008:5). The benefits of U/S during the second and third trimesters, as described in Table 2.3, improves the diagnosis of placental location, congenital anomalies, multiple pregnancies, malpositions and malpresentation of the fetus (Hofmeyr et al., 2009:S24; Tegnander & Eik-Nes, 2008:5-6; Abramowicz, 2009:296; Whitworth et al., 2010:2; Nathan et al., 2017:211). The early identification of obstetrical risks such as placenta praevia, malpresentation and multiple pregnancies relates to a decrease in

6**maternal and neonatal morbidity and mortality** rate (Greenworld **et al., 2014:**

274, 276). Although the WHO recommends only one ultrasound in pregnancy, the monitoring of fetal growth during the third trimester is indicated as a benefit of U/S (WHO, 2018[b]:1). Nevertheless, the benefits of routine U/S during antenatal care do not seem to result in a reduction of perinatal mortality rates (Whitworth et al., 2010:2). Despite

89**the detection of small for gestational age** fetuses, **the**

perinatal mortality rate seems to be unchanged in low-risk pregnancies with the routine use of U/S (Henrichs, Verfaille, Jellema, et al., 2019:1; Mashaba, 2017:13). McClure et al. (2014:8) aimed to determine if the use of U/S in rural and low-income settings could positively affect the high maternal and perinatal mortality rate, but obtained the same findings as Henrichs et al. (2019:1) and Mashaba (2017:13). Furthermore, Goldenberg, Nathan, Swanson, et al. (2018:1593) state that early referral after routine U/S in low- risk pregnancies do not change the statistical influence on the perinatal mortality rate. However, it is important to mention that Goldenberg et al. (2018:1593) did not intend to measure the impact of an early U/S that could indicate benefit in the identification of complications related to miscarriages, abortions or ectopic pregnancy, as indicated by Flores et al. (2019:33) and Nkyerkyer (2006:1). So too has the quality of care at the referral hospitals not been evaluated in terms of management of high-risk pregnancies during the study, which could be a significant game-changer in the referral quality control cycle (Goldenberg et al., 2018:1597). In a follow-up article on Goldenberg et al. (2018:1597), Swanson, Franklin, Swanson, et al. (2019:273), reconsidered the fact that U/S screening during antenatal care does not increase the birth of high-risk pregnancies in hospitals. During a supplemental descriptive study, Swanson et al. (2019:273) found that there were communication concerns within the continuum of care between the field sonographer and the referral hospital. The referral sonographers were not available to assist the field sonographers, which led to the birth of mothers before they could be assisted (Swanson et al., 2019:276). Other concerns raised from the referral sonographers related to insufficient structural support of hospitalisation of high-risk patients. None of the issues raised by Swanson et al. (2019, 273-276) is new in the South African context. Hence, Mueller, Pattinson, Hlongwane, et al., (2019:3) allude to the significant impact of routine U/S in LMIC on the use of antenatal care, and its

136**improvement of patient management, and confirmation of clinically suspected obstetric complications. The**

Umbiflow®, as a continuous wave Doppler, is a component of U/S. The Umbiflow measures the resistance index of the umbilical artery with a Doppler device (Nkosi et al., 2019:347). In South Africa, research has indicated that the use of Doppler resistance index could reduce macerated stillbirths with a remarkable 60% (Nkosi et al., 2019:347; Pattinson, 2019:18). As an inexpensive option, Pattinson (2019, 15) state that any healthcare workers can use the device for effective screening at the primary healthcare level to identify fetuses at risk for stillbirth. Rightfully, Pattinson, Hlongwane and Vannevel (2019:18) recommend the Umbiflow® to be integrated as part of the basic antenatal care package in South Africa. However, the researchers of Umbiflow® does not equate for the concern about the impact on the referral system

100**in South Africa, as** previously discussed **by** Swanson **et al.** (2019, 273-276). **The**

Doppler resistance index used by the Umbiflow® with the remarkable shift in the reduction of macerated stillbirths is already a component of U/S. The researcher acknowledges the cost-benefit of a cheaper U/S device in an LMIC. However, as the midwifery philosophy and model of care is holistic in nature (ICM, 2014:1), fragmentation of a component of U/S that is easy to train to any level of the healthcare worker (Hofmeyr et al., 2009:S30; Pattinson et al., 2019:19), is not congruent to the philosophical foundation of midwifery. Bellussi, Ghi, Youssef, et al. (2017:633) acknowledge that the U/S during labour and birth is an objective and accurate diagnostic tool. Contributing to the benefit of perineal IP U/S was the recommendation of Wiafe, Whitehead, Venables and Dassah (2019:online) that women find the U/S in labour to be more tolerable than digital vaginal examinations. Intrapartum U/S has many benefits, of which some relate to the maternal experience and others to the management of IP care. A detailed discussion is given in Section 2.7.4. Apart from the healthcare benefits, the childbearing family progressively views U/S as a social event (Molander et al., 2010:20; Ahman, Edvardsson, Fagerli, Darj, Holmlund, Small & Mogren, 2019:2). Seemingly, the increased number of U/S carries benefit for the process of paternal bonding by adding a dimension of reality to the pregnancy (Abramowicz, 2009:296, Molander et al., 2010:19; Tegnander & Eik-Nes, 2008:6). Paternal bonding is found to be increasingly important, and U/S visualisation had a direct impact on a secure relationship and higher cognitive outcomes of the child (Atluru, Appleton & Plavsic, 2012:408). Commercial 3D/4D U/S businesses are becoming more common due to the benefit of enhanced parental bonding (Tegnander & Eik- Nes, 2008:6; Abramowicz, 2009:29; Goodchild & Chescheir, 2014:138). However, the benefit of parental bonding is not the only reason why the childbearing family would opt for a U/S (Molander et al., 2010:19). Other motivators include reassurance of the important aspect of fetal wellbeing and normality that it gives the parents (Molander et al., 2010:19; Ahman et al., 2019:4). Ultrasound enables the discernment of the fetus as a child. When the fetus is personified as a child, and medical care is required, the personified child is treated as a patient by the interdisciplinary team (Ahman et al., 2019:6). Midwifery U/S could increase the accessibility, availability and the acceptability of U/S to the benefit of the childbearing family. For midwifery U/S to be effective in addressing perinatal mortality rates, the referral structure will need to be assessed in further research outputs. The fact that certain studies do not relate to significant changes in the perinatal mortality rate in the routine use of U/S, does not deter from the benefit of U/S in pregnancy management during the first trimester, labour and birth (Mueller et al. 2019: 3: Goldenberg et al., 2018:1598). 2.4.2 Disadvantages of ultrasound Misconceptions of U/S emanated from the period after World War II, when research and development spilled over to the medical field with U/S used as heat therapy. According to Woo (2008:2-3), U/S was used for its therapeutic benefit of heat generation. Treatment modalities implemented ablation of the frontal lobe in the treatment of patients with rheumatic arthritis and Meniere's disease. As the use of U/S became more widely known, exaggerated claims led to a negative cycle of cynicism and concern. This concern about the risk of U/S is still present today and leads to unjustified avoidance of a valuable diagnostic test (Flanagan & Bell, 2019:1). In the early 1960s, Sunden published the earliest and most comprehensive research on the effect of U/S (Woo, 2008:12). One of the key findings was that no harmful effect of U/S on pregnant rats could be determined. More recently, Torloni, Vedmedovska, Merialki, et al. (2009: 604; Whitworth et al., 2010:22) found no evidence of physical harm to the pregnant woman or the fetus due to U/S. According to Harbarger, Weinberger, Borders and Hughes. (2013:4), U/S during the perinatal period does not have any effect on hearing loss of the fetus. Additionally, their study showed a positive correlation between improved hearing amongst several infants that passed hearing screening in both ears and who had an increased number of U/S examinations during pregnancy. 58 Furthermore,

41**Torloni et al. (2009:** 599) indicated **no association** with **adverse maternal or perinatal outcome, impaired physical or neurological development, increased risk** for **malignancy in childhood, subnormal intellectual performance or mental diseases**

(Fullerton et al., 2019:415). Interestingly, left-handedness in mostly male fetuses is stated as a possible effect of U/S exposure during pregnancy (Abramowicz, 2009:297; Whitworth et al., 2010:22). It is important to mention that the safety of U/S and the refuting of physical harm is based on the "as low as reasonably achievable" (ALARA) principle that lessens exposure time at lower intensity settings

92**for the safety of the mother and fetus.** Disregarding **the**

ALARA principles may lead to tissue heating, or cavitation, defined as pockets of gas in bodily fluid or tissue (Goodchild & Chescheir, 2014:138-139; Fullerton et al., 2019:415). Non-medical U/S, requested by parents for picturing or bonding, is associated with longer exposure time and therefore holds a risk for tissue heating or cavitation. Ensuring that exposure time in pulsed (spectral) Doppler during the early and first trimester U/S is limited, is strongly recommended (Abramowicz, 2009:297). The

29**American Institute of Ultrasound in Medicine (AIUM)** supports **the** discouragement **of** the routine use **of** pulsed Doppler **in the first trimester**

U/S examination (AIUM, 2018:E14). According to Mei, Afshar and Platt, 2019:832) the pulsed Doppler uses high frequency of sound waves with a greater energy output and therefore has a greater potential effect of the developing fetus. However, the prevalence of fatal and severe malformations with color Doppler for cardiac use in the first trimester is less significant as 1.39% (Mei et al., 2019:843). Most of the research findings on the potential risk of U/S are not current, and with the advancement of technology have not been updated, which leaves a gap in the inquiry which should inform the safe use of U/S (Fullerton et al., 2019:416). The disadvantages of U/S do not necessarily only relate to the physical harm of the instrument, but may rather influence the management of the childbearing mother. One such example is the use of U/S to determine fetal weight estimations during a late pregnancy U/S. According to Moldeus et al. (2017:2), induction due to large for gestation weight due to fetal surveillance in late pregnancy increases early inductions with no benefit to the neonatal morbidity. Fullerton et al. (2019:414) state that the use of U/S in late pregnancy should be used with caution, as benefits to the childbearing mother and baby have not been clearly indicated. Furthermore, it could contribute to an increase of the TMTS phenomenon/situation, which

> 22**increases the cost of care without** real **benefit,** or even increases **the**

nocebo effect (Odent, 2011:91) of a childbearing family with the diagnosis of fetal anomalies (Abramowicz, 2009:296; Fullerton et al., 2019:414). Another concern with the use of U/S is the increase in terminations due to congenital abnormalities. The risk of creating a society where only a 'perfect child' is accepted, was raised by Ahman et al. (2019:8). Due to the personification of the fetus as a child with the use of U/S, ethical dilemmas may present themselves when fetal anomalies are identified (Holmlund et al., 2017:2; Ahmen et al., 2019:9). The other side of the coin is underdiagnosed or underreporting of congenital abnormalities, where findings are missed or only partially diagnosed. This fact may worsen the disorder due to a lack of care available at birth, or influence the life quality and expectancy of the baby into adulthood (Abramowicz, 2009:297). It is noteworthy to mention that a recent systematic review demonstrated that the U/S could affect the emotions, cognitions and behaviour of the mother. According to Harris, Franck, Green, Wilson and Michie (2015:36), the over-medicalised use of U/S remains a concern, irrespective of the influence of the number of U/S during pregnancy or birthplace preference of the mother. Taking into consideration that the physical harm of the U/S has been disproven, the cost of care associated with implied management should be balanced with the benefit to the childbearing family. In the partnership model of care between a midwife and the mother (ICM, 2014:2), the informed decision should remain with the mother. 2.5 The midwife The midwife, as described in Section 1.1., is a competent professional that applies the

> 7**ICM's philosophy and model of midwifery care** to midwifery care **in** the partnership between **the** midwife **and**

the childbearing family (ICM, 2014:1-4). The midwife, as the professional of choice for the childbearing family (ICM, 2014:1), contributes to a positive pregnancy and childbirth experience (WHO, 2018:2). Midwifery care embodies holistic and continuous care that strives to empower women (Renfrew, McFadden, Bastos, et al., 2014:1129). A midwife respects

> 26**human dignity and** promotes **the human rights** for **all** persons while working **in**

a culturally sensitive and diverse manner (ICM, 2014:online; WHO, 2018:2). In the South African context, midwifery care often exists within the biomedical maternity model, where care relates to averting risk and preventing disease (Mathias, Davis & Ferguson, 2020:2). Despite the influence of the biomedical maternity model, midwifery care protects the normal physiological process of childbirth, supports

> 77**and enhances the health and social status of women**

(ICM, 2014:1), by developing their capacities and confidence (Mathias et al., 2020:2). Therefore, midwifery care fits better in the salutogenic framework, which perceives the health of the chilbearer

> 31**on a continuum from** full **health to the absence of health**

(Mathias et al., 2020:2). The salutogenic framework

> 31**does not ignore** the childbearer's **disease or risk factors,** but **frames their care in terms of supporting** beneficial **factors** in regards to **their current place on the continuum**

of health. According to SANC (2020(b):2), a midwife should have certain attributes. On a professional level, a midwife is a critical thinker who works independently within ethical and legal parameters. Therefore, the

> 125**midwife may practise in any** healthcare **setting** (SANC, 2020(b)), **including the home, community, clinics** and hospitals **(ICM, 2017:**

1). According to the ICM (2017:1-2), the midwife renders continuous midwifery care during the antenatal, labour and postnatal period that includes: • health education; • support of the childbearing family; •

128**preventative measures; • detection of complications; • accessing medical care;** and • **carrying out** of **emergency measures.** SANC, as **the**

23**regulatory body for the** midwifery and **nursing profession in South Africa,** is responsible for **the**

regulation and accreditation of all midwifery education and practice. The professional registration as a basic midwife could be attained via three professional educational pathways. Basic midwifery was included in the combined four-year Diploma, or Baccalaureate Degree (Regulation 425). The third professional educational pathway was the one-year Diploma in Midwifery (Regulation 254) for the person that followed the bridging course to general nurse to subsequently midwifery. As from 2020, the new midwifery qualification for basic midwifery includes a three

88**-year Diploma leading to** the **registration** of only **a** general **nurse (SANC,**

2020(a):online). The general nurse may continue with the Advanced Diploma in midwifery 61 (Regulation 1497) to qualify as a basic midwife (SANC, 2020(a):online). The Bachelor's Degree provides professional registration as a general nurse and a midwife. The second classification is the Midwife Specialist, which refers to the registered professional nurse and midwife that progressed from a basic midwife to a Specialist Midwife Neonatology (Regulation 368). One of the admission requirements for the Advanced Diploma in Midwifery and Neonatology is several years' practical experiences as a basic midwife to allow for maturation in the profession. A second postgraduate strand exists for a Midwife Specialist, namely a Clinical Magister (Masters in Nursing) that permits the midwife the title of Midwife Specialist. The SANC refers to the Midwife Specialist (SANC, 2014(b):1-2)

40**as a specialist clinician with a broad autonomous practice managing a specific caseload. The**

2**Midwife Specialist may function as first entry-point** for woman, **and needs the knowledge and expertise to be able** to **accurately assess, diagnose and manage the patient population in the speciality area (Duma et al., 2012:**

np). The care that the specialist midwife gives may include making a medical diagnosis and prescribing relevant treatment (Duma et al., 2012:np). Therefore the midwife

2**usually requires expertise in diagnostic testing and treatment beyond the** regular **practice of the nurse/midwife (Duma et al., 2012:**

np). Irrespective of the educational pathway that the person followed to qualify as a midwife, the ICM (2019) competence framework is clearly based on competence. 2.6 Competence-based education In terms of midwifery, the ICM (2012:3) states that there is no common definition of competence- based education (Fernandez, Dory, Ste-Marie, et al., 2012:357). However, the important aspects of competence-based education in midwifery are the acquisition of knowledge, skill and professional behaviour required to become competent (Fullerton et al., 2019:e414). The aim of competence-based education is to guide a person to competence. The act of being competent refers to a multi-layered concept that includes the

43**combination of knowledge, psychomotor, communication, and decision-making skills that enable an individual to perform a specific task**

(ICM, 2013:19; Fullerton et al., 2011:6). Competence is assessed, demonstrated or observed according

13**to a defined level of proficiency** (ICM, 2013:19). **This**

should take into account fast- evolving technological advances, the emergence of

25**knowledge and new evidence-based clinical**

25**practice (Fullerton et al.,** 2011:6). However, **the** definition **of**

competence is not stagnant (Fullerton et al. 2011:6). In addition, competency is defined as the specific minimum set of characteristics/concepts related to the combination of knowledge, skill and professional behaviour that underpins the performance of tasks associated with competence (Fullerton et al., 2011:6; ICM, 2013:19). The ICM

7**competencies are presented in a framework** consisting **of four categories**

(ICM, 2019:2), with specific competencies to link the content to the expected outcome of learning (ICM, 2012:3). It is positive to note that the competencies listed under the competency domain is not a task list but integrated statements (ICM, 2019:3). Therefore, competency-based education in midwifery, as for midwifery U/S education and practice, requires a description of the competencies needed to become a competent practitioner. Midwives who wish to incorporate the U/S as a diagnostic tool to include into their scopes of practice should have appropriate education and training, and acquire the necessary competence according to a defined level of competence. 2.7 Midwifery ultrasound competencies As midwifery U/S competencies have yet to be described

6**in South Africa, there is currently no** expected standard for **midwifery** U/S **education**

and practice. Therefore, the described competencies refer to generic competencies for U/S healthcare professionals (obstetricians and gynecologists, sonographers and midwives), which include, but are not limited to, basic U/S training course as described by the ISUOG Learning module (ISUOG, 2017). The literature search described in Section 2.7 was utilised for the development of the first round questionnaire, which was the tool used to reach consensus on midwifery U/S competencies for education and practice in

39**South Africa (as** described **in Chapter 4).** In **the** description **of**

U/S competencies, all available literature was included and reviewed. However, the focus was on South African midwifery U/S competencies, and therefore when available, South African literature was used to describe the U/S competencies. One such study was the post-qualification curriculum for midwifery U/S in South Africa developed by the National Centre

3**for Fetal Medicine in Norway (Tegnander & Eik-Nes,** 2008:3). **The**

developed U/S curriculum, as part of the research, was specifically designed for South African midwives. The macro and micro midwifery U/S curricula were informed by

3**ISUOG, the American Institute of** U/S **in Medicine (AIUM)** and **the WHO Technical Report Series 875**

(Tegnander & Eik-Nes, 2014:4). The postgraduate educational programmes of U/S

3**in obstetrics for** nurse **midwives at the National** Centre **for Fetal Medicine in Trondheim, Norway,**

also influenced the curriculum (Tegnander & Eik-Nes, 2014:4-5). Elements found in the literature informed the following competency domains. The domains identified in Table 2.5 include general principles of sonography, early and first trimester U/S, second and third trimester

118**U/S,** IP **U/S,** postpartum **U/S,**

and gynaecological U/S. Table 2.5 Description of the six proposed competency domains for midwifery U/S education and practice in South Africa. Competency domains for midwifery U/S Broad description #1 General principles of U/S Principles of physiology of instrumentation, knobology, safe use of U/S #2 Early and first trimester U/S Evaluation of early (up to 9 weeks and 6 days) and first- trimester U/S (10-13 weeks and 6 days) using fetometry. Identification of viability of pregnancy including tubal location. #3 Second and third trimester U/S Determining of fetal and placental position/ location, basic anatomy screening. Fetal age and growth evaluation with fetal surveillance per Doppler. #4 Intrapartum U/S Diagnosis of fetal and placental position during labour. Identification of labour progress with U/S measurements. #5 Postpartum U/S Evaluation of normal involution. #6 Gynaecological U/S Evaluation of normal non-pregnant structures related to reproductive health. 2.7.1 General principles of sonography As the quality of U/S is operator-dependent, the person should be competent in the safe and effective use of the instrumentation (Abuhamad et al., 2018:30). Therefore a good understanding of the physics and instrumentation of the U/S is crucial, and not only the skill in performing the examination (Tegnander & Eik-nes, 2014:8; Swanson, Kawooya, Swanson et al., 2014:509; The American College for Nurse-Midwives, 2018:1; Abuhammed et al., 2018:30-31). As the question of safety in the use of U/S during pregnancy is still rife today, the U/S healthcare professional should be competent in the safe use of U/S in various clinical situations (Tegnander & Eik-nes, 2014:8, 16; The American College for Nurse-Midwives, 2018:2; ISUOG, 2018:2). As highlighted by the current Covid-19 pandemic, infection control is a crucial part of performing a safe midwifery U/S. According to Abuhammed et al. (2018:31), a protocol for cleaning and disinfection of the transducer should be considered as part of the basic introduction of U/S education and practice. Furthermore, being comfortable with the instrument is essential for the smooth completion of a U/S examination. Factors such as probe selection and instrument settings, amongst others, are necessary to ensure optimal visualisation of the subject being examined (Griksiatis, Scott & Finn, 2014:20, Tegnander & Eik-Nes, 2014:8, 13, 16, Abuhammed et al., 2018:31; ISUOG, 2018:online). Apart from being able to work safely and effectively with the U/S instrument, the

> 52**midwife should have** in-depth **theoretical knowledge of** the **anatomy and physiology of the female reproductive organs**

and fetal anatomy, physiology and development (Tegnander & Eik-Nes, 2014:8, 13-23, Abuhammed et al., 2018:31; The American College for Nurse-Midwives, 2018:2). The theoretical foundation allows for evaluation, which is vital for effective diagnosis. Recording the data of the U/S examination provides a comprehensive report for professional use, and also protects the practitioner against possible medico-legal action. The U/S report is an important form of communication, especially in upward referral. The midwife should therefore be competent in writing a U/S report (Tegnander & Eik-Nes, 2014:23, Abuhammed et al., 2018:32; The American College for Nurse-Midwives, 2018:2). 2.7.2 Early and first-trimester ultrasound Once the domain of general principles is mastered, examinations during different times in the continuum of the reproductive health life require specific competencies. Having knowledge about the indications for early and first trimester U/S may reduce the over-medicalisation of U/S during the first trimester. The indications for early and first trimester U/S according to AIUM (2018: E15), ISUOG (2013:102-113) and Curado and Bhide (2018:30) are: • • • • • •

> 29**Confirmation of the presence of an intrauterine pregnancy Evaluation of a suspected ectopic pregnancy** Confirmation **of** cardiac activity **Evaluation of** the viability **of**

embryo/fetus

> 121**Estimation of gestational age Diagnosis or evaluation of multiple gestations, including determination of chorionicity**

and amnionicity • • • •

> 15**Evaluation of the cause of vaginal bleeding Evaluation of pelvic pain Evaluation of suspected gestational trophoblastic disease** Evaluation of major **fetal** abnormalities **The**

ISUOG has stated that merely evaluating chorionicity and amnionicity during the first trimester is unacceptable, and that the U/S healthcare professional should also evaluate gross fetal malformation. According to Curado and Bhide (2018:301), the childbearer

> 28**should be offered an early** U/S **between 10 weeks 0 days and 13 weeks 6 days** for **gestational** dating **and**

confirmation of a single or multiple pregnancy. The childbearing family should also be offered the opportunity to evaluate genetic screening by using U/S as one of the components in diagnosis the common trisomies

(21, 18 and 13) (Curado & Bhide, 2018:301). With an increase in competence, half of the antenatal detectable fetal

15**structural abnormalities** could **be diagnosed in the first trimester**

(Curado & Bhide, 2018:301). According to Liao et al. (2020:13), the use of a standard anatomical protocol for routine first trimester U/S can detect half of all fetal anomalies found during pregnancy. For competency of early and first trimester U/S, the U/S healthcare practitioner should have in- depth knowledge of the normal sonographic morphology for early (5-10 week) and first trimester (11-14 weeks) gestation (Tegnander & Eik-Nes, 2014:14; ISUOG, 2018:8-9; Abuhammed et al., 2018:31). Two of the basic knowledge applications required for this competency are the identification of the indications for an early and first trimester U/S and the criteria for the application of an appropriate probe (transvaginal or transabdominal) (Tegnander & Eik-Nes, 2014:13; Abuhammed et al., 2018:31; ISUOG, 2014:8). According to Mei et al. (2019:830), the transabdominal and transperineal U/S should be uitilised as the situation prescribes. To evaluate sonographic dating, the U/S healthcare professional needs to be familiar with fetometry, which is defined as the sonographic measurement of the fetus (Tegnander & Eik-Nes, 2014:13). This 66 includes the evaluation of fetal growth restriction (Abuhammed et al., 2018:31; ISUOG, 2018:9). Not only does the indication for early or first trimester U/S hold medical and medico-legal implications, but the care and sensitive professional demeanour plays a significant role in the care of the mother, especially with the diagnosis of miscarriage (Jansson & Adolfsson, 2010:70). The healthcare professional should be able to identify a singleton or multiple pregnancies (Tegnander & Eik-Nes, 2014; Abuhammed et al., 2018:31; ISUOG, 2018:9). The identification and early referral of abnormal findings such as ectopic pregnancy, sub-chorionic hematoma and a molar pregnancy are vital components of the competency for early and first trimester U/S (Swanson et al., 2014:509; Abuhammed et al., 2018:31; ISUOG, 2018:9). The healthcare professional should be knowledgeable and skilled in the diagnosis and referral of abnormal findings, embryonic/fetal demise in the first trimester, and U/S findings in case of a threatened abortion (Tegnander & Eik-Nes, 2014; Abuhammed et al., 2018:31; ISUOG, 2018:9). 2.7.3 Second- and third-trimester ultrasound According to Callen and Norton (2017:4), most congenital anomalies occur in the population with no known risk factors, and therefore the second trimester ultrasound screening should be offered routinely. The healthcare professional should be competent in the basic fetal anatomy of the second and third trimester U/S (Tegnander & Eik-Nes, 2014:18; Abuhammed et al., 2014:31). The ISUOG (2017:13-15) defines fetal anatomy as separate systems (encompassing the face and neck, thorax and heart, brain and central nervous system, skeleton and abdomen). The evaluation of U/S findings and their subsequent influence on clinical decision-making is an essential competence that every U/S healthcare professional should master in the care of each childbearer (Tegnander & Eik-Nes, 2014:19; Abuhammed et al., 2014:31-32; ISUOG, 2018:16). From the literature the assessment of fetal wellbeing with Doppler studies is seen as a vital inclusion. According to Tegnander and Eik-Nes (2014:18,19), the principles of Doppler, the spectral Doppler, the colour Doppler, and continuous-wave Doppler of the uterine arteries, and the umbilical arteries and vein should be evaluated for conditions related to fetal growth, twin-to- twin transfusion, and placental sufficiency (Nkosi et al., 2019:350). The Umbiflow®, as previously discussed in Section 2.2.3, could be an effective alternative to the traditional Doppler for all women in low resource settings (Nkosi et al., 2019:350). Placental insufficiency has been underappreciated as a cause of perinatal death (Pattinson, 2019:4). During the second and third trimesters, the position and type of implantation of the placenta and umbilical cord (Swanson et al., 2014:509; Fullerton et al., 2019:), as well as the amniotic fluid volume, should be evaluated (Tegnander & Eik-Nes, 2014:18,19; Abuhammed et al., 2014:31, ISUOG, 2018:18). According to ISUOG (2014:114) and AIUM (2018:E14),

34**placental assessment, including** its **relation to the internal cervical os,**

34**amniotic fluid estimation and conditions associated with abnormal amniotic fluid volume,**

are elements of a basic obstetric and gynecological U/S. According to ISUOG (2018:13), the identification of preterm birth, including cervical assessment (Abuhammed et al., 2014:32), with predisposing factors such as gestational diabetes and fetal growth restriction in the third trimester, could be a valuable competence included for the basic U/S. The U/S healthcare professional should be able to determine the lie, presentation, position (Tegnander & Eik-nes, 2014:19) and attitude of the fetus in the third trimester. This will allow the SBA to evaluate the biophysical profile of the fetus in preparation for birth. According to Abuhammed et al. (2018:41), the biophysical profile includes a series of evaluations that include the monitoring of fetal breathing, movement, tonus, flexion of extremities and the normal amniotic fluid index. The biophysical profile is classified as a specialist evaluation that does not form part of the basic U/S (Callen & Norton, 2017:5). As a U/S healthcare professional, the foundational competence of managing ethical issues (ICM, 2014:2) associated with prenatal diagnostic procedures may lead to conflict of personal and professional opinion. An example of the appreciation of ethical issues pertaining to prenatal diagnostic procedures is the

62**implementation of the Choice on Termination of Pregnancy** Amendment **Act** (1 **of**

2008) which allows for termination up to 28 weeks of gestation. The evaluation of the criteria for a second and the third trimester U/S should always be analysed according to the potential of the healthcare practitioner to effectively refer a person with a high- risk profile or abnormal finding (ICM, 2019:12) to appropriate healthcare. This is an essential competency in U/S. 2.7.4 Intrapartum ultrasound According to Bellussi et al. (2017:633), IP U/S is found to be an objective, accurate and reliable diagnostic tool (Usman et al., 2015:53). In South Africa, fresh SB, which represents mainly IP deaths, contribute to 23% of all perinatal deaths >1000g (Pattinson, 2019:5). Pattinson (2019:5) further states that IP asphyxia and birth trauma cause 18.6% of SB in South Africa. As previously discussed in Section 2.2.3, the burden of disease of asphyxia on live births contribute to life-long disability due to cerebral palsy with the added financial burden on both the childbearing family and the health system. The benefit of IP U/S lies within the spectrum of early referral, and the ability to reduce the impact of fresh SB and related asphyxia during labour. According to Siergiej et al. (2019:296), the accuracy of digital vaginal assessment for labour progress has long been perceived as inadequate. The cumbersome deduction that the inadequate measurement of cervical dilatation has for many years been the cause for medical intervention leads the researcher to question the effectivity of plotting cervical dilatation on the partograph. One of the vital benefits for a low-risk birth is the precise examination of the fetal station as an indicator of labour progress (Yousuf

134**et al., 2013:** 429; Siergiej **et al.,** 2019:295; **Van** Adrichem **et al.,**

2018:252) for the progression of positions where the occiput as the denominator is anterior than vaginal examination. The IP U/S holds a high degree of precision of the fetal position (Siergiej et al., 2019:295). Therefore, the benefits include the identification of cephalic malpresentation such as occipital posterior or occipital transverse, anterior and posterior asynclitism, and deflexed presentations such as brow and face presentations (Bellussi et al., 2017:633-637). The diagnosis of cephalic malpresentation during prolonged or obstructed labour (Bellussi et al., 2017:633-637) can lead to an early referral and access to appropriate emergency care. As malposition and malpresentation affect 10% of all pregnancies, the ability of the healthcare provider to determine abnormalities and implement timely referral (Bellussi et al., 2017:633) is critically important. Evaluation of cervical assessment using IP U/S may be valuable where the digital vaginal exam is contra-indicated, such as with placenta praevia or preterm labour (Usman, 2015:53). Utilising a transvaginal or transperineal U/S, also referred to as a translabial U/S, may pose as an alternative and more acceptable means of evaluating the progress of the childbearing woman during labour. As midwives promote non-intervention with appropriate use of technology (ICM, 69 2014:2), transperineal IP U/S holds immense value for women that may experience vaginal examination as traumatic, degrading and offensive due to personal experience, beliefs or culture (Downe, Gyte, Dahlen & Singata, 2013:5). The acceptability of IP U/S between various cultures and beliefs are indicated, as childbearers in China, Turkey, Romania, Ghana and the United Kingdom collectively indicated a high acceptability (Wiafe et al., 2019:4). Therefore the U/S healthcare professional should be competent in using the transabdominal, transvaginal or transperineal application of IP U/S (Khalil, Elbadawi, Abdelnaby & Zayed, 2012:298; ICM, 2014:2; Van Adrichem et al., 2018:252). The angle of progression (AOP) is

4**defined as the angle between the length axis of the symphysis and a line from the inferior border of the symphysis tangential to the fetal skull**

(Khalil

145**et al., 2012:** 298; Usman **et al., 2015:** 54; Van Adrichem **et al., 2018:** 252; Dall'Asta **et al.,**

2019:5). As part of the IP U/S competency, the U/S healthcare professional should be able to evaluate the AOP and the implication of the outcome regarding the mode of birth (Khalil et al., 2012:298; Van Adrichem et al., 2018:252). In addition to fetal surveillance, the U/S healthcare professional should be competent in the evaluation of the position of the placenta, umbilical cord and the measurement of the amniotic fluid (Ebrahim, Zaitn & Elkamash, 2013:658). It cannot go unmentioned that prompt obstetrical intervention is

138**crucial to prevent** IP **-related fetal hypoxic injury and** related **maternal** mortality **and** morbidity **associated with**

obstetrical emergencies (Hofmeyr et al., 2009:S21). In a country where resources to ensure accessible care is not readily available, the use of IP U/S has the potential to address IP stillbirths and birth asphyxia-related injuries. In addition, Siergiej et al. (2019:296) state that IP U/S is best applied as bedside point-of-care U/S, which points to the cost-effective implementation of IP U/S in a low resource county such as South Africa. 2.7.5 Postpartum ultrasound The U/S healthcare professional should be able to select the correct ultrasound equipment for producing the optimal U/S image to evaluate the normal anatomy of the uterus, ovaries, cervix and adnexa during the postpartum period (Tegnander & Eik-Nes, 2014:25-26). The U/S healthcare professional should present with professional behaviour and provide quality care and communication during a gynaecological examination (Tegnander & Eik-Nes, 2014:25-26). Competency in the U/S examination of the perineal floor muscles and intactness of the anal 70 sphincter should form part of the basic ultrasound (ISUOG, 2018:7,18). According to Wang, Shum and Kennedy (2019:436), evaluation of retained placenta increases risk for postpartum Haemorrhage and should therefore be included in the evaluation of uterus and adnexae for normal involution to ensure. 2.7.6 Gynaecological ultrasound The basic gynaecological ultrasound focuses on examining and evaluating the normal structure of the uterus, ovaries, and adnexa during the non-pregnant state (Tegnander & Eik-Nes, 2014:18, 9; ISUOG, 2018:4). A U/S healthcare practitioners should be able to visualise and evaluate the normal structures of the pelvic floor (ISUOG, 2018:4,8) and refer a person with a high-risk profile or abnormal findings to an appropriate healthcare professional (ICM, 2014:2). 2.8 Midwifery ultrasound Midwifery U/S has been practised in Norway since 1973 (Molander et al., 2010:19) and in various other countries around the world for several decades (Ahman et al., 2019:2). The U/S skill set of the midwife has expanded to the

84**estimation of gestational age,** evaluating **amniotic fluid,** localisation **of the placenta, early detection of multiple pregnancies,** identification **of fetal** anomalies **and** Doppler assessment **(Ahman**

et al., 2019:2). Midwives in various African countries such as Liberia (Bentley et al., 2015:1567), Uganda (Swanson, Kawooya, Swanson, et al, 2014:512), and Tanzania (Ahman, et al., 2018:28) and Mozambique (Greenworld et al., 2014:274) has successfully implemented midwifery U/S education and practice. According to Carrera (2011:292), midwifery U/S has been positively experienced in Ghana, Kenya, Sudan, Ethiopia and Tanzania. According to the ICM (ICM, 2013:online), a basic midwife should be able to use U/S for gestational dating and the skill to evaluate fetal

22**growth placental location and amniotic fluid volume using** U/S **visualisation and measurement**

(Fullerton et al., 2019:416). With a review of the Essential Competencies for Basic Midwives (ICM, 2017:online) differences in opinion were noted between low-to-middle-income countries and higher-income countries about midwifery U/S competency. The ICM concluded the difference in the opinion stating that pregnancy dating, identification of a single or multiple pregnancies, fetal anatomy, fetal position, placental placement and amniotic fluid volume via U/S is considered a basic skill for the basic midwife (Fullerton et al., 2019:419). However, in South Africa, midwifery U/S regulation and accreditation has been met with resistance (Tegnander and Eik-Nes, 2008:6), and unequal education and practice opportunities for midwives. The benefit of the diagnostic impact of midwifery U/S benefits the childbearer by increasing the safety of pregnancy and birth (Greenworld et al., 2014:276). Identification of high-risk pregnancies and improved diagnosis of early pregnancy complications, twin pregnancies and malpresentation contributes to the diagnostic impact of midwifery U/S (Swanson, Kawooya et al., 2014:512). Midwifery U/S competence has been repeatedly demonstrated (Nathan et al., 2017:210; Fullerton et al., 2019:416; Mashamba, 2017:130. A variation of curricula have shown midwives with 90- 100% similarity

17**between the control and the experimental group'** s midwife placing **the**

U/S competence midwives to identify fetal anomalies comparable with tertiary institutions (Fullerton et al., 2019:416). Congruency between midwives U/S trainee and reviewer were confirmed by Nathan et al. (2017:210) as 99.4% for 41 trainees in five countries performing 3801 U/S for high- risk conditions. Interestingly, midwifery U/S competence is the same irrespective of auxiliary midwives or midwives functioning

22**within the** full **scope of midwifery practice,**

as demonstrated by

22**auxiliary midwives in Nepal** exceeding **90% congruence compared to certified ultrasonographers**

(Fullerton et al., 2019:416). The ability of midwives to demonstrate competence in U/S confirms the inclusion in the Essential competencies for the Basic Midwife (ICM, 2019:13,16). As the statistics mentioned indicates the ability of the basic midwife to be found competent in midwifery U/S, in addition to the ICM's Essential Competencies for the Basic Midwife (ICM, 2019:13,16), the question raised by SOMSA (2017:3) as to which of the midwifery categories should be the applicable cadre to perform U/S, seem to be answered. Midwives in Tanzania view U/S as a crucial component of midwifery care that improves the management of pregnancy complications (Ahman et al., 2018:30). Midwives in Mozambique reported feeling empowered, which translated into an increase in quality of midwifery care (Greenwold et al., 2014:276). In Norway where

116**midwives are the main providers of routine antenatal care,**

midwives describe U/S as a very valuable and that it plays a vital

116**role in pregnancy management by** improving **outcomes**

(Ahman et al., 2019:1). The "magic of ultrasound" (Steward, 2011:54) increases work satisfaction for midwives (Ahman et al., 2019:8). Midwives acknowledge the value of U/S, as well as the impact on midwifery care. However, the additional responsibility which U/S places on midwives could conflict with the reward (Ahman et al., 2019:8) Despite midwives desire to reach competency in U/S, a perception exists in certain LMIC income countries that U/S is the work of the physician (Holmlund et al., 2017:5). As U/S was also demanded by the childbearing family, midwives contested the system. As no guarantee can be given for fetal health, an ultrasound may strengthen the expectancy of the childbearing family that the pregnancy or birth is progressing well. Identifying fetal anomalies increases the support, counselling for the childbearing family that may an ethical conflict for the midwife (Ahman et al., 2019:6-8). 2.9 Concluding remarks The benefits of U/S outweigh the risk of potential harm to the mother and fetus. The focus on the childbearer as participant in the midwifery care partnership (ICM, 2014:1) should be acknowledged in the process of development of new competencies. In the current technological era, midwives need to be mindful of doing

16**too much too soon** and **too little too late.**

However, as midwives living in the time of the fourth industrial revolution, the midwifery care should evolve to the benefit of the childbearing family. To answer the research question, the researcher compiled a set of six midwifery U/S competencies that were presented to the experts, founded on the principles of competency-based education and practice. In Chapter 3, the researcher discussed the

46**research design and** implementation that **was used to** reach **the aim of**

expert consensus on competencies for midwifery U/S education and practice

39**in South Africa. Chapter 3 Research** findings **3.1**

Introduction There are various reasons why we do research. It is not intrinsically tied purely to knowledge development, but research can also be theory-orientated (knowledge for understanding), or to create knowledge for action relating to practice or policy (De Vos, 2011:80). The motivation for this study was guided by an aspiration to generate knowledge in support of quality midwifery U/S education and practice in South Africa. Midwifery U/S competencies are captured as one of the ICM's Essential Competencies for the Basic Midwife (Fullerton et al., 2019:e416; ICM, 2019:13, 16). Therefore, as

132**group opinion is more valid than individual opinion (Keeney,** 2015:275; Keeney **et al., 2011:3),**

or as C.S. Lewis quoted: "Two heads are better than one", reaching consensus on the competencies for midwifery U/S education and practice for South Africa will endorse global parity of competence. As a concept, research methodology

98**refers to the** systematic process **of** conducting **research (Creswell & Creswell, 2018:**

51; Mertens, 2015:50). Irrespective of the type of methodology, a research process is guided by a specific paradigmatic approach (Mertens, 2015:56). In this study, a postpositivist approach directed the selection of the overall research design, as discussed in Section 1.8. In this chapter, the researcher will describe, amongst others, the research design that was appropriate to answer the research question: What is the consensus on competencies for midwifery U/S for education and practice in South Africa? The description of the methodology in this chapter will further include the research technique, the

74**development of the research** instrument, **the population and sampling, the**

process used to gather data, ethical considerations, and how methodological rigour was ensured (Cohen, Manion & Morrison, 2018:186). 3.2 Research design and approach Grove and Gray (2019:68, 246) refer to the

8**research design as the** architectural plan **of the study, while** Creswell **and**

Creswell (2018:38) prefer ‘a procedure of inquiry that answers the research question’. Nevertheless, the end game is to develop an empirical body of knowledge related to the field of study (Grove & Gray, 2019:22, 54; Mertens, 2015:63). In general, researchers make use of two main types of research design, namely quantitative and qualitative. According to Creswell and Creswell (2018:35), the methods are not polar-opposites from each other, but a study usually leans more towards the one method rather than the other (Creswell & Creswell, 2018:35). Cohen et al. (2018:173) emphasise that there is no single blueprint for planning research, and therefore the aim of the research should inform the research design. Quantitative research is defined as the measure of variables in a calculable way (Mertens, 2015:54), or as defined by Maree (2020:184), as the objective use of numerical data from a selected subgroup of a population for generalisation. Grove and Gray (2019:54) add that the rigorous and systematic process of quantitative research explains new situations or concepts about the world in which we live. The researcher selected a quantitative, descriptive research design that uses objective-driven numerical data from a sample population to support the aim of the study (Burns & Grove, 2009:22). The numerical data used in this quantitative descriptive design is in essence non-experimental (Grove & Gray, 2019:246, 286; Maree, 2020:193), as the research focus was on the significance of consensus of expert opinion. A quantitative research design benefits a topic where little knowledge is available, as was the case in this study (Creswell & Creswell, 2018:168; Giannarou & Zervas, 2011:77; Grove & Grey, 2019:54, 68). Descriptive studies allow a researcher to observe new meaning, describe what is currently available, and are useful in building foundational knowledge for future research projects on the topic by using a survey technique (Grove & Gray, 2019:54, 68, 286; Maree, 2020:193). Therefore, the benefit of a descriptive research design for this study was the identification and description of the consensus reached by expert opinion on midwifery U/S competencies for education and practice (Grove & Gray, 2019:55). In contrast with quantitative research,

58**qualitative research is defined as a systematic approach** that describes **experiences and situations from the perspective of** the person **in the situation (Grove & Gray, 2019:**

89; Taylor & Francis, 2013:3). The participants’ words are studied to ensure a deeper understanding of the perspective of the person in the situation (Grove & Gray, 2019:89; Taylor & Francis, 2013:3). Qualitative research aims to make meaning out of participants’ lived experiences (phenomenology), description of social processes (grounded theory), description of a culture (ethnography), or description of a research question or problem (Grove & Gray, 2019:95; Maree, 2020:50; Taylor & Francis, 2013:3). Due to the nature of the healthcare profession, understanding the lives and circumstances of the people to whom we render care can be very valuable. However, as this study focused on expert consensus and not the experts’ experiences, a qualitative research design would not have adequately served the

17**aim of the study. The** selected **study** design **was** appropriate **to** reach **the** aim **of the**

study. A quantitative descriptive design allowed for new knowledge development in the area where gaps were identified regarding the concepts of midwifery U/S in South Africa (Grove & Gray, 2019:54; Hohmann, Cote & Brand, 2018:3278). The

118**opinion of** the **experts in the field of** U/S about **the** competencies **for**

midwifery was important

79**for the future** development **of** midwifery **U/S education and** practice. Furthermore, the numerical significance of the consensus reached by the experts created an opportunity to identify each of the elements which form the content within the six domains applicable to midwifery U/S competencies in

14**South Africa. 3.** 3 **Research** technique **The research** technique refers to **the** tool **or**

method used to gather data

74**in line with the aim of the study** within **the**

research design (Grove & Gray, 2019:70; Polit & Beck, 2012:257). Due to the lack of knowledge on the required competencies for midwifery U/S education and practice, a group consensus method was most applicable to this study (Hohmann, Cote & Brand, 2018:3278). The two consensus methods often used in research

53**are the nominal group** technique **and the Delphi technique (McMillan,** Kind &**Tully, 2016:** 655). **The nominal group**

technique is a structured process that includes face-to-face meetings during which participants generate ideas and reach consensus about solving a specific problem or issue (Hohmann, Cote & Brand, 2018:3278; McMillan et al., 2016:656). The disadvantage of using a nominal group technique for this study 76 would have been the heterogeneous nature of the sample, as discussed in Section 3.4. The researcher anticipated peer domination due to the differences in the traditional perceived expertise between the two groups (Hohmann, Brand, Rossi & Lubowitz, 2018:350). In addition, the cost and logistical and time implications of arranging a group session for a geographically distributed group of experts would have been difficult to manage. The characteristics of the Delphi technique made it the most appropriate consensus method to reach the aim of the study (Hsu & Sandford, 2012:2; Keeney, 2015:273). The Delphi technique is a flexible and adaptable tool to gather information about real-world knowledge in real-time (Louw, 2014:28; Hsu & Sandford, 2007:6). In addition, the egalitarian environment created by anonymity prevents group dominance or peer influence, and also prevents vocal minorities from influencing expert opinion (Hohmann, Brand et al., 2018:350; Shariff, 2015:2). According to Gill, Leslie, Grech & Latour (2013:1322) and Keeney (2015:268-269), a Delphi technique is frequently used for its advantages in health sciences research.

79**Since its development in the** early **1950s, the** original **Delphi** technique **has been**

adapted to include several variations, such as the classical Delphi, the e-modified Delphi, the real-time Delphi and the policy Delphi, to name a few (Avella, 2016:306; Hasson & Keeney, 2011:1697; Yousuf, 2007:4). The main characteristics of a Delphi technique are the iterative rounds of questionnaires, with statistical aggregation of data and controlled feedback to experts between the rounds while ensuring participant anonymity (Gill et al., 2013:1322; Hasson et al., 2000:1009; Keeney, 2015:268). Although the variations of the Delphi technique all have the same aim, which is to reach consensus, the different variations are applied differently. Therefore it is beneficial to select the most appropriate type of Delphi technique for the topic under study (Keeney, 2015:272). The original Delphi technique, also referred to as the classical Delphi, begins with a round of open-ended questions that produce relatively large amounts of data. The rounds continue until consensus is reached (Proctor & Hunt as cited in Keeney et al., 2011:11; Linstone & Turnoff, 2002:225). The experts may develop fatigue due to the large amounts of data, or number of rounds, and this can lead to a decline in the response rate (Hsu & Sandford, 2012:20; Keeney et al., 2011:69-70). A modified Delphi differs from the classical Delphi by adapting the open-ended first-round questionnaire to statements that were developed from existing literature (Avella, 2016:8; Hasson & Keeney, 2011:1697; Keeney et al., 2011:71). Instead of a continuation of rounds

65**until consensus is reached, the** modified Delphi limits **the number of rounds**

to a maximum of three (Hasson & Keeney, 2011:1697; Linstone & Turnoff, 2002:225; Shariff, 2015:3). The researcher selected a modified e-Delphi technique, which means that the questionnaire was administered via an online survey. In a country such as South Africa with its vast geographical distribution of experts, an online survey is easy to use, environmentally friendly and cost-effective (Louw, 2014:29). The online software programmes used to gather data is called Evasys®. A benefit of the online distribution of a questionnaire and data collection with a software programme such as Evasys® is the time-efficiency of distribution, and rapid feedback of experts. The distribution of the questionnaires and capturing of data, processing and storing of data, added to the quality of data using an online platform (Avella, 2016:314-315; Gill et al., 2013:1321-1322; Hsu & Stanford, 2007:4). Therefore the modified e-Delphi was most suited to

99**reach the** research **objectives as** depicted **in Table 3.1.**

Table 3.1 Motivation for a modified e-Delphi technique for a quantitative, descriptive design. Research objectives Modified e-Delphi motivation Identify competencies for midwifery U/S education and practice from literature The first-round questionnaire was based on literature instead of being an open-question round • Decreased risk of long questionnaires • Increased participation and response rate Compile a list of competencies for midwifery U/S education and practice in the continuum of female reproductive health The first-round questionnaire was developed from a literature search by including available knowledge on the research topic • Increased reliability of the instrument Describe competencies for midwifery U/S education and practice as validated by expert opinion Expert consensus was reached based on a set of competencies developed from the literature • Increased anonymity • Expert opinion allows for judgement of subject with limited prior information The first research objective was the identification of midwifery U/S competencies from existing literature, and the second objective was compiling a list of midwifery U/S competencies. The modified e-Delphi served the purpose of the first two research aims, allowing the researcher to develop a structured questionnaire, based on existing literature, for the purpose of the third research objective, namely validation of the midwifery U/S competencies by consensus of expert opinion. The modified e-Delphi contributed to the reliability of the research technique while 78 allowing expert opinion on a subject with limited prior information. As the questionnaire did not consist of only open-ended items, it was not lengthy, and therefore had the benefit of an increased participation and response rate (Avella, 2016:312-313; Keeney et al., 2011:69-70; Linstone and Turnoff, 2002:225). Information from the literature review was used to develop the first-round questionnaire, mostly including quantitative (closed-ended) questions and to a lesser extent qualitative (open-ended) questions (Hsu & Sandford, 2007:4; Millar et al., 2007:18). The development of the questionnaire is discussed in detail in Section 3.4. For this research, the consensus level was set at 70%, as suggested by the Biostatistics Department

8**at the University of the Free State.** Consensus at 70% **is**

supported by literature stating that two-thirds of the responses for any particular statement should be set for the two highest levels of the interval scale (Avella, 2016:306; Du Plessis & Human, 2007:22).The researcher determined consensus by calculating the statistical aggregate of the group responses. Although anonymity is discussed in Section 3.9 as an ethical consideration of the study, it is important to note that anonymity is a crucial characteristic of the Delphi technique (Keeney, 2015:273; Millar et al., 2007:10). Avella (2016:309) states very clearly that without anonymity, which he describes as being

155**independent of individual personality and influence of professional reputation, the**

Delphi technique is flawed. 3.3.1 Development of the first-round questionnaire The development of the first-round questionnaire, as the first step in the modified e-Delphi technique, was

75**based on the literature review** as described **in Chapter 2.** It was beyond **the** scope **of**

this study to do a systematic review of the literature. The literature review did therefore not follow an all-inclusive approach. Instead, the researcher conducted a literature search with the assistance of an experienced librarian. The literature search encompassed midwifery ultrasound, pregnancy U/S, intrapartum U/S and curriculums of U/S. Databases included for the literature search was Academic Search Ultimate, Cochrane Review Library, Medline, Science Direct, the Wiley library and Google Scholar. A total of six domains of midwifery U/S competencies were identified that formed the structure of the questionnaire, as indicated in Table 3.2. The various elements that relates to midwifery U/S were categorised under the six domains of midwifery U/S competencies. These included all possible content related to U/S that falls within the compounds of the basic U/S (ICM, 2017:13, 16). The related association between the six identified domains of midwifery U/S and the ICM's scope of practice of the midwife (ICM, 2017:1) is illustrated in Table 3.2. Although gynaecological U/S is not perceived as the traditional domain of the midwife, it is included in the basic U/S of ISUOG (ISUOG, 2014). Due

154**to women's health** and **sexual or reproductive health** being included in **the** scope **of** the midwife (ICM, 2017:1), gynaecological U/S was included as part of the six domains. Table 3.2 The six domains of midwifery U/S competencies applicable to the midwifery scope of practice. Domains of midwifery U/S competencies The Scope of Practice of a midwife (ICM, 2017:1) Competency ONE: General principles of sonography Within the midwifery scope of practice,

> 43**a midwife has the knowledge, skills** and **professional** behaviour to safely **and**

effectively perform a midwifery U/S based on the general principles of sonography. “The midwife is recognised as a responsible and accountable professional who works in partnership with women ....” “This care includes preventative measures, the promotion of normal birth, the detection of complications in mother and child, the accessing of medical care or other appropriate assistance and the carrying out of emergency measures.” Competency TWO: Early and first-trimester U/S Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to perform an early and first-trimester midwifery U/S. • • • “…give the necessary support, care and advice during pregnancy…” “… detection of complications in mother and child…” “…accessing of medical care or other appropriate assistance…” Competency THREE: Second and third-trimester U/S Within the midwifery

> 13**scope of practice, a midwife** has **the**

knowledge, skills and professional behaviour to perform a second and third-trimester U/S. • • • “…give the necessary support, care and advice during pregnancy…” “… detection of complications in mother and child…” “…accessing of medical care or other appropriate assistance…” Domains of midwifery U/S competencies The Scope of Practice of a midwife (ICM, 2017:1) Competency FOUR: Intrapartum U/S Within the midwifery scope of practice, a midwife has the knowledge, skills and professional behaviour to perform an intrapartum U/S. • • • “…give the necessary support, care and advice during labour…” “… detection of complications in mother and child…” “…accessing of medical care or other appropriate assistance…” Competency FIVE: Postpartum U/S Within the midwifery

> 13**scope of practice, a midwife** has **the**

> 13**knowledge, skills and professional behaviour** to perform **a**

postpartum midwifery U/S. • • • “…give the necessary support, care and advice during labour…” “… detection of complications in mother and child…” “…accessing of medical care or other appropriate assistance…” Competency SIX: Gynaecological U/S Within the midwifery

> 13**scope of practice, a midwife** has **the**

> 13**knowledge, skills and professional behaviour** to perform **a**

basic gynaecological midwifery U/S “This work should involve antenatal education and preparation for parenthood and may extend to women’s health, sexual or reproductive health and child care.” The six domains of midwifery U/S competencies relate directly to the ICM

> 142**scope of practice of the midwife** (ICM, 2017:1). **The midwife as** an **accountable professional**

should hold adequate knowledge, skill and behaviour about the general principles of U/S to allow for safe and effective application. As such, the midwife should be able to apply the competencies related to the general principles of midwifery U/S to early and first-trimester, second and third trimester, intrapartum, postpartum period, and gynaecological U/S (ICM, 2017:1). The midwife should use the U/S as an appropriate technological measure to promote normal birth, as a measure to detect complications, and to advance timeous referral (ICM, 2014:1). The elements for each of the six domains of midwifery U/S were captured as quantitative questions in the questionnaire (Addendum B). The questionnaire did not include any demographical questions. According to Keeney et al. (2011:86), it is not essential to collect demographical data of the experts. The target population was divided into two groups. The reason for this was to ensure a heterogeneous sample that was inclusive of the South African obstetrical and gynaecological U/S context, and therefore no distinction between Group A and B was needed on the basis of demographical data to reach expert consensus on the competencies of midwifery U/S education and practice. The ICM (2019:5) emphasises that competency is not a list of tasks, but rather integrated statements referring to knowledge, skill and professional behaviour. Therefore, the six domains of the midwifery U/S competencies were divided into the three components of competency (Fullerton et al., 2011:6), namely knowledge, skill and behaviour. Refer to the example, as indicated in Table 3.3. Table 3.3 Example of competency-based structure for first-round questionnaire development Draft questionnaire Competency 1: Within the midwifery scope of practice, a midwife has the knowledge, skill and professional behaviour to safely and effectively do a midwifery U/S based on the general principles of sonography. Statement 1: A midwife has the foundational knowledge, skill and professional behaviour to perform a safe and effective midwifery U/S. Essential Useful Potential for inclusion Not needed A midwife has foundational KNOWLEGDE about: 1.1. physics of U/S related to instrumentation 1.2. basic maintenance of: 1.2.1.U/S instrumentation 1.2.2.U/S safety 1.2.3.infection control 1.3. the principles of knobology 1.4. writing a complete U/S report 1.5. anatomy and physiology of the internal organs of the female reproductive system related to the reproductive age 83 Draft questionnaire Competency 1: Within the midwifery scope of practice, a midwife has the knowledge, skill and professional behaviour to safely and effectively do a midwifery U/S based on the general principles of sonography. Statement 1: A midwife has the foundational knowledge, skill and professional behaviour to perform a safe and effective midwifery U/S. Essential Useful Potential for inclusion Not needed A midwife has the SKILL AND PROFESSIONAL behaviour to: 1.6. apply physics of U/S and related instrumentation 1.7. apply basic maintenance 1.8. apply the principles of knobology 1.9. write a complete U/S report 1.10. In your opinion, would you say that the components above capture the foundational knowledge, skills and professional behavior of midwifery U/S? If your answer is NO, please recommend additional components. Yes No 84 As the example indicates, each of the six domains of midwifery U/S commenced with a statement describing what the domain entails. The questionnaire was structured according to the three components of competence (Fullerton, 2011:6; ICM, 2019:6). Despite this the competency components of skill and professional behaviour are classified as two different entities, so the researcher followed the example of combining skill and professional behaviour as in the updated

13**version of the ICM Essential** Competency **for Basic Midwifery**

(ICM, 2019:6). The first-round questionnaire consisted of 91 closed-ended questions, referred to as the elements of the six domains of midwifery U/S.

50**The researcher used a** ranking **Likert scale to** measure **the**

consensus level (Grove & Gray, 2019:35; Maree, 2020:243; Millar et al., 2007:18-20) of each the elements proposed for midwifery U/S. To exclude an option for a neutral opinion, a four-level Likert scale was used (Hohmann, Cote & Brand, 2018:3281; Millar et al., 2007:18-20). Accordingly, the

44**experts were asked to rate the** importance **of** inclusion **of the**

elements for of the midwifery U/S according to essential (1), useful (2), the potential for inclusion (3) or not needed (4). As a Delphi technique can generate both qualitative and quantitative data during each round (Hsu & Sandford, 2007:4; Millar et al., 2007:18), a standard

156**open-ended question** was added **at the end of each** competency. **The** open-ended questions **were**

formulated in the same way for each of the subsequent rounds. The purpose of these open-ended questions was to allow the experts to relate specific knowledge, skills and behaviour drawn from their expertise to the specific competency (Hsu & Sandford, 2007:4). The qualitative data collected per round was converted to closed-ended questions that were added to subsequent rounds. In this way, the experts were allowed to evaluate the data quantitatively in the consecutive rounds, while staying informed about the collective group opinion (Louw, 2014:26).

51**The reliability and** internal **validity of the instrument were**

increased by utilising the experts as moderators of the instrument (Hasson & Keeney, 2011:1700-1701). The justification for the additional data/questions was that experts reached consensus on the additional questions in the subsequent rounds, as discussed in Chapter 4. In addition to the standard six open-ended questions related to each of the competency domains, the researcher formulated two additional open-ended questions that emerged from the literature review. The questions were related to the South African midwifery U/S context as seen in Addendum B. 3.4 Population The

32**population is defined as a** particular type **of** individual **who** is **the focus of the research (Grove & Gray,**

2019:293), or can also be referred to as the total population (Cohen et al., 2019,203). The total population of this study therefore included obstetricians and gynaecologists, sonographers, and midwives who are healthcare workers with expertise in U/S during the child- birthing period (refer to Figure 3.1). According to Grove and Gray (2019:292, 3) and Polit and Beck (2012:274), the

83**target population is defined as the entire set of individuals who meet the sampling criteria** of **the population.** As the **study**

focused on reaching expert consensus, the researcher agrees with Yousuf (2007:6) that the information obtained from a Delphi technique can only be as good as the experts who contributed to the study (Keeney, 2015:269). It is therefore important to be very clear about the inclusion criteria for the target population. According to Shanteau, Weiss, Thomas and Pounds (2003:1), there is no universal manner to define an expert. However, Shantaeu et al. (2003:1) state that experience, accreditation, peer identification, expert reliability and being a subject matter expert are noted as previous approaches used to define an expert (2003:3-9). The researcher selected three of the approaches as described by Shantaeu et al. (2003:3-6) to define the inclusion criteria for an individual to be included in the target population. Therefore, an expert should be: • accredited by the applicable medical regulatory body, • a member of the executive committee of his/her professional society/association; and • an expert by means of peer identification. In addition to the above-mentioned features, the researcher included the following categories of expertise, as described by Shariff (2015:3): a) Subjective expertise – a person who has knowledge due to being affected by the topic of the research b) Mandated expertise – a person who has

68**knowledge and experience related to the job description and role**

requirements (Giannarou & Zervas, 2011:67); and c) Objective expertise – a person who has

68**knowledge gained due to** an **academic position, education and research.**

86 The combination between the inclusion criteria as adopted from Shantaeu et al. (2003:3-6) and the categories of expertise as described by Shariff (2015:3), has led the researcher to compile the inclusion criteria for experts in

158**this study** as **depicted in Table 3.3. Table 3.3**

Inclusion criteria comprising specific features and categories of expertise Category of expertise Inclusion criteria Subjective expertise • • • Midwife with U/S experience or completed a U/S programme, and/or Sonographer with U/S experience that practices in the field of obstetrical and gynaecological U/S, and/or Obstetrician/gynaecologist with current U/S experience Mandated expertise • • • • Executive member of an organisation related to the field of midwifery, and/or U/S, and/or midwifery education or U/S education, and/or Registered professional in the field of midwifery, and/or Registered professional in the field of U/S, and/or Registered professional in the field of midwifery education or U/S education. Objective expertise • A minimum of one publication in the field of: o Midwifery, and/or o U/S, and/or o Midwifery U/S-related education The subjective and mandated experts included midwives, sonographers, obstetricians and gynaecologists who complied with the inclusion criteria of organisation or committee membership, professional registration and clinical experience. Due to limited knowledge in the field of midwifery U/S, the category of an objective expert would exclude midwives with clinical experience of U/S in the target population of this study. As midwifery U/S education and practice in South Africa is unaccredited and unregistered, there are a limited number of clinically experienced midwifery U/S experts in South Africa. Including objective expertise with a publication in the field as inclusion criteria for the target population, would have silenced the voice of representation for midwifery U/S. Therefore, in order not to decrease the target population to the extent that the inclusion of midwives with U/S experience would be jeopardised, objective expertise was not included as an inclusion criteria as depicted in Figure 3.1. The accessible population refers to the

14**target population to which** the researcher has **reasonable access** (Asiamah **et al., 2017:**

1612). Due to limited information about midwifery U/S in South Africa, it was not possible to identify only midwifery U/S experts. Therefore, traditional U/S 87 healthcare practitioners such as obstetricians and gynaecologist, as well as sonographers, were included in the target population. Equal access to U/S experts in South Africa where ensured by dividing the accessible population into two groups. The researcher stratified the accessible population from the two groups into five strata that represented experts in South Africa (refer to

24**Figure 3.1). Figure 3.1** Classification **of population,**

target population and accessible population. Group A represented experts in midwifery U/S as per peer identification, clinical experience in midwifery U/S, and/or part of the executive committee representing SOMSA. Group A consisted of SOMSA executive members, SOMSA association members within the U/S working group, and independent midwives with U/S training or experience registered on the Sensitive Midwifery registry. The accessible population of Group A represented midwives with clinical experience in U/S. The inclusion criteria represented both public and private healthcare. In addition, Group A represented both public and private healthcare experts

25**in the** field **of midwifery** U/S **education and practice. The** experts included members **of**

the executive committees that represent the midwifery profession on regulatory, leadership and education level in South Africa. The aim was to have 50% of the experts of the accessible population representing midwives in South Africa Group B represented healthcare professionals within the related field of clinical obstetric and gynaecological U/S, U/S education or the policy making environment. Experts from SORSA (Society of Radiography in South Africa) represented sonographers that do not necessarily have experience in maternal and child health, but have expertise in obstetrical and gynaecological U/S. The aim was to ensure both public and private healthcare experts. The accessible population for Group B consisted of

16**members of the National Committee on** the **Confidential** Enquiry of **Maternal Deaths** (NCCEMD), which includes **a**

variety of experts related to maternal deaths in South Africa. To include traditional U/S healthcare professional representation, executive committee members of the South African Society of U/S for Obstetricians and Gynaecology (SASUOG) and Society of Radiographers South Africa (SORSA) were included in the accessible population group. The aim was to have 50% of the experts of the accessible population representing traditional healthcare professionals in South Africa. 3.5 Sampling A sampling method defines how the selection process of the experts was performed (Grove & Gray, 2019:293). According to Cohen et al. (2018:202), the sample is a smaller set or a subgroup of the total population from which consensus of expert opinion is gained, to represent the total population under study. The two main sampling methods are described as either probable (random) or non-probable (purposive) (Cohen et al., 2018:214). With probability sampling methods, the random selection of experts creates an equal opportunity to be selected and represent the target population (Grove & Gray, 2019:304; Polit & Beck, 2012:280). Sampling allows the researcher to achieve statistical validity and to

51**generalise the** results **of the study to** 90 **the** wider **population**

(Cohen et al., 2018:214; Polit & Beck, 2012:273-5, 280). However, a Delphi technique does not intend to generalise, but actively pursues expertise (Avella, 2016:308; Keeney et al. 2011:7). Purposive sampling seeks to select specific persons for the richness of the knowledge that they contribute to the study (Cohen et al., 2018:214; Mertens, 2015:397). Purposive sampling supports the research question and therefore not every member of the total population is selected (Grove & Gray, 2019:310). A heterogeneous sample was chosen to ensure that a more comprehensive expert opinion is formed over the spectrum of the field of study (Gill et al., 2013:1324; Shariff, 2015:3). The identification of a pre-determined number of experts per professional body ensured a heterogeneous sample group. The heterogeneous sample included midwives, obstetricians and gynaecologists, and sonographers in the field of U/S. The identification of the experts in these strata determined the sample size, as discussed in Section 3.5.3. Inclusion criteria to identify the experts were used to increase validity and to deter from the possibility of ambiguous expertise (Keeney et al., 2011:8; Louw, 2014:49; Millar et al., 2017:61). No exclusion criteria were necessary, as the population was specific to the study. 3.5.1 The sampling method: purposive stratified sampling As not everyone in the target population of this study had the same opportunity to be selected for the sample due to the inclusion criteria and selection of specific strata, a stratified purposive sampling technique was the method of choice (Grove & Gray 2019:310, 317; Mertens 2015:399). A stratified sampling technique refers to the combination of sampling strategies where the researcher uses the subgroups based on specific criteria to sample several participants (Mertens, 2015:399). Maree (2020:178) confirms that non-probability sampling, such as stratified purposive sampling, applies in special situations where the researcher has a specific purpose in mind. A heterogeneous group was identified by means of stratified sampling of the accessible population (Grove & Gray 2019:310), discussed in Section 3.4, which allowed inclusivity of the various healthcare workers in the field of U/S in South Africa. Although the sampling technique may be criticised due to the difficulty to evaluate the accuracy or relevance of the researcher's judgment in the selection process, specific characteristics as 91 previously discussed in Table 3.4 gives a clear understanding of the reasons for sample selection (Grove & Gray, 2019:37). The ultimate goal for the researcher was to select experts with the ability to contribute information-rich data from which in-depth information could be retrieved (Grove & Gray, 2019:317). 3.5.2 Sample population recruitment process The researcher identified five experts per accessible population strata. The contact details were accessed via open resources on the internet (website listings) or by requesting the information from the contact persons listed for the various strata.

137**An email was sent to the** experts by **the** researcher, explaining **the** aim **of the study, the**

inclusion criteria and strata on which they were selected, the estimated timeframe of the study and the expected time occupancy per questionnaire. According to Keeney et al. (2011:12), personal communication increases the feeling of the partnership, while interest in the field ensures the longevity of the partnership. The experts were requested to respond to the email if they were interested in participating. The researcher continued with the recruitment process until the desired sample size was reached or the experts per strata were depleted. 3.5.3 Sampling size Various authors agree that there are no concrete guidelines regarding sample size (Giannarou & Zervas, 2014:66; Hong, Pluye, Faregues et al., 2019:57; McMillan et al., 2016:658). However, the smaller the sample size, the higher the risk for selection bias and group error (Gainnarou & Zervas, 2014:67; Keeney et al., 2011:22). In determining the sample size, Giannarou and Zervas (2014:67) state that a homogenous sample of 10-15 is sufficient, and Shariff (2015:3) mention that selecting five to ten experts per professional group is sufficient for stratification. Therefore, the researcher aimed at 15-30 experts for a heterogeneous

157**sample, as illustrated in Figure 3.2. Figure 3.2**

Stratified purposive sampling: sampling size. From Group A, the researcher was able to identify 12 out of the planned 15 experts. This was related to the

78**limited number of experts** in **the** field **of** midwifery U/S **in South Africa.**

A total of nine experts from Group A agreed to

149**participate in the study. From** Group B, **a total of** 20 experts **were** identified, from **which**

nine agreed to participate in the study. Group A and B were equally represented with nine experts each. The strata allowed for equal distribution in each group to ensure a heterogeneous sample group. The total of 18 experts was within the desired sample size. 3.6 Pilot survey The questionnaire was tested with a small sample that was similar to the accessible population, following the same process of administration that the researcher planned to use in the study (Grove & Gray, 2019:583; Mertens, 2015:257). The benefit of a pilot survey is not necessarily to provide statistical validation and reliability (Avella, 2016:317), but rather to ensure the best possible methodology (Grove & Gray, 2019:583) for ease of application to the larger study. After the first-round questionnaire was developed, a pilot survey was implemented to evaluate content validity and to determine the functionality of the instrument for data collection (Hong et al., 2019:52; Keeney et al., 2011:144). The three participants of the pilot survey were chosen according to the same inclusion criteria and recruitment process as the main study, as indicated in Table 3.4. The experts were informed via email of the study aim, and their role in the research. Table 3.4 Distribution of pilot survey participants. Nr Accessible population strata Constituency Rationale Group A: Experts in midwifery U/S 2 Associations related to midwifery U/S (SOMSA, Sensitive Midwifery Independent Midwifery registry and Fetal Medicine Foundation Midwifery U/S experts Represents midwives with clinical experience in U/S Group B: Healthcare professionals within the related field of U/S and/or U/S education or policy environment. 1 SORSA Association representing radiographers in South Africa Represents radiographers in all four radiographic categories: Diagnostic, Nuclear Medicine, Radiotherapy and U/S The Evasys® web link with an individual, auto-generated password was sent to all participants after confirmation via email. The experts were asked to complete the questionnaire and answer four additional questions. The applicable feedback from the pilot participants, as discussed in Table 3.5, was incorporated in the first-round questionnaire. Table 3.5 Pilot survey feedback on the first-round questionnaire Additional question Information acquired Influence on the first-round questionnaire

14**How long** did **it take** you **to complete the questionnaire?**

20 -25 minutes Information was shared in the initial email to experts participating in the study. Are there any grammatical or technical mistakes that you noticed that I need to change? Various issues were noted The questionnaire was adjusted where needed to ensure a professional appearance Is there anything that you did not understand? • • Certain terminology was unfamiliar to the participants The levels of U/S training • • Terminology relates to the level of expertise. Different strata of the target population would have various levels of U/S experience, and the terminology was left unchanged. An explanation of the levels of U/S was included in the participant information letter to ensure the same understanding for all participants. Would you like to add anything to the content or competencies of midwifery U/S? No additional information was added None The experts' main contribution to the pilot survey was regarding the time estimation and the professional appearance of the questionnaire. Although Avella (2016:308) debates the accuracy of estimation on the time commitment the experts were required to make, the benefit of giving a time estimation helps with recruitment and reducing attrition due to reality being different from the expectation. Defining the levels of U/S

6**for the South African context** was added to **the** description **of the**

question as a positive contribution of the pilot survey. No changes to the elements nor the six competency domains were necessary. 3.7 Data collection The data collection process of a Delphi technique is a time-consuming process due to the iterative rounds. The iterative rounds call for the same

63**process of data collection in** all **three rounds. The** experts that completed **the**

previous round

44**were included in the subsequent rounds. The** reason was **to**

include experts where motivation still existed, instead of working with experts that were not motivated to continue (Shariff, 2015:4).

11**Preparing the expert group for the Delphi process is an important step, which if not carried out appropriately, could adversely affect response rates in** subsequent **rounds**

(Millar et al., 2007:17). When experts agree to

11**participate, they need to be informed of exactly what they will be asked to do,** the **time**

occupancy expectation, what information

11**they will be expected to contribute, and what use will be made of the information they provide**

(Keeney et al., 2011:83) 3.7.1 Instructions to participants In cases where experts are given clear instructions on the completion of the rounds, the result is usually a more reliable response rate with a lower attrition rate in the different rounds (Millar et al., 2007:16). The researcher included instructions on how to access the Evasys® platform via the web link with the password that was sent to the experts via email. The date for completion, with a motivation for continuing participation, was included in the communication. On accessing the online questionnaire, instructions for the use of the Likert scale

45**for the** closed **-ended questions, and** completion of **the open-ended questions,**

were given. 3.7.2 Timeframe for data collection According to Louw (2014:43), the timeframe for a Delphi study is estimated to be on average eight weeks per round. However, Hohmann, Cote and Brand (2018:3279) mention that a total turnaround time of 45 days to five months is be acceptable. The data collection of the online questionnaires was planned to start in April 2020, as illustrated in Table 3.6. Table 3.6 Data collection time-frame. Rounds Questionnaire distribution Follow-up email Completion of round Controlled feedback 1 Planned April 2020 As needed Mid-April 2020 (2 weeks) End of April 2020 (2 weeks) Actual 8-12 May 2020 22 May 2020 1 June 2020 (± 3 weeks) 12 June 2020 (2 weeks) 2 Planned Beginning of May 2020 As needed Mid-May 2020 (2 weeks) End of May 2020 (2 weeks) Actual 16 June 2020 3 July 2020 9 July 2020 (± 3 weeks) 14 Aug 2020 (4 weeks) 3 Planned Beginning of June 2020 As needed Mid-June 2020 (2 weeks) End of June 2020 (2 weeks) Actual 14 Aug 2020 26 Aug 2020 2 Sep 2020 (± 3 weeks) End of November 2020 Although the distribution of the online questionnaires was planned to start in April 2020, uncertainty associated with the SARS-CoV-2 pandemic necessitated a postponement of the data collection to the 8th of May 2020. Despite giving the experts two weeks to complete the questionnaire, they did not comply with this. The researcher sent emails as reminders and motivation for the completion of each round. The emails were successful in achieving a lower attrition rate, as discussed in Chapter 4. The researcher scheduled two weeks between rounds for data analysis and development of the subsequent questionnaire and feedback. The complete schedule for the distribution of the questionnaires was planned for 12 weeks, but ended at 19 weeks, which is in line with the suggested time-frames of both Louw (2014:43) and Hohmann, Cote and Brand (2018:3279). 3.7.3 Implementation of rounds In this section, the researcher describes how

147**the three rounds of the modified** e **-Delphi** was implemented. **A** detailed discussion **of the** statistical analysis **of**

consensus, including the frequency distribution, response rate, and feedback to the experts after each round, is given in Chapter 4. 3.7.3.1 Round 1 The researcher emailed a web link for the Evasys® programme to the experts. Each expert was granted access to Evasys® with an individual, auto-generated password which was included in the email. The information letter, informed consent and the first-round questionnaire were accessible with the password. As mentioned in Section 3.7.1, a poor response to the questionnaire was received after the initial two-week period. This led to the researcher sending an email to motivate for completion. The experts completed the first round after the motivation email was sent and an extension was given. After completion, data was retrieved by the researcher via the Evasys® programme. The researcher analysed the quantitative qualitative data and verified the results with the study leaders. The consensus statements were removed

85**from the first-round questionnaire. The** non-consensus **statements** and **the**

new questions, developed from the qualitative data from round1, collectively formed the second-round questionnaire. The researcher gave controlled feedback to the experts via email. All data and the second-round questionnaire were verified by the study leaders, as discussed in Chapter 4. 3.7.3.2 Round 2 The experts who completed the first round received a new auto-generated password with the Evasys® web link via email. The data collection process was identical to that of round 1. After the data collection, the researcher removed the consensus statements and developed one new open- ended question from the qualitative data. The non-consensus questions and 11 newly developed closed–ended questions collectively formed the third-round questionnaire, as discussed in Chapter 4. Controlled feedback was given to the experts via email. 3.7.3.3 Round 3 The experts who completed the second round received the Evasys® web link with a new auto- generated individual password for the third-round questionnaire. The process of data collection in 98 round three was identical to that of rounds 1 and 2, as discussed in Chapter 4. Feedback of the final results was sent via email to the experts that completed round 3. As the modified e-Delphi consists of only three rounds, all data were analysed for consensus and stability, as discussed in Chapter 4. 3.8 Data analysis Data analysis uses statistical techniques to

19**give meaning to numerical data in a study**

(Grove & Gray, 2019:378). The researcher may then use descriptive or inferential statistics to report on the data.

19**Descriptive statistics are** a **summary that** allows **the researcher to** organise data **in ways that give meaning and facilitate insight. Inferential statistics are designed to address objectives, questions and hypotheses** to allow inference **to the**

target population (Grove & Gray, 2019:378). The aim of the study was not to generalise findings, so descriptive statistics

37**were used to report** on **the data. The main** statistics used in the Delphi technique measure

5**central tendency (mean, median and mode), and** the **level of dispersion (standard deviation and** interquartile **range), to present information concerning the collective judgements of respondents**

(Du Plessis & Human, 2007:21; Keeney et al., 2011:84). However, other studies use a frequency distribution to determine consensus (Giannarou & Zervas, 2014:67). In Chapter 4, the researcher reports on consensus of the elements for each of the six competency domains, using

5**measures of central tendency and level of dispersion**

to report on consensus. Stability, defined as

5**no significant difference between the frequencies for the responses for two consecutive rounds**

(Keeney et al., 2011:90), is described in Section 4.3. In addition, Keeney et al. (2011:90) indicate that many studies do not report on non-consensus elements. However, the researcher reported on significant outliers of non-consensus statements that were significant for the South African

25**context of midwifery** U/S **education and practice.** Data analysis of **qualitative**

data entails grouping similar themes together (Du Plessis & Human, 2007:21). The researcher verified the thematic analysis of the data with the supervisors of the study to ensure validity of the analysis (Hassan & Keeney, 2011:1699; Du Plessis & Human, 2007:21). Conceptualising the qualitative data into new closed-ended questions for subsequent rounds made it possible to: • reiterate the experts' own words to them, which increased the reliability of the instruments, and • allow for group judgement of individual expert opinion, despite infrequent-occurring items (Du Plessis & Human, 2007:21). As previously discussed, anonymity is one of the key characteristics of a Delphi technique. Therefore, all raw data of the three rounds are password protected by Evasys®. The raw data were retrieved in a CSV Excel® file after each round closed for participation. The data retrieved from Evasys® were already coded. Therefore the researcher could not link any expert with a specific response. All data were managed confidentially, and data were password protected and stored securely on UFS password-protected computers. An independent academic researcher from the UFS with extensive statistical data expertise assisted the researcher to statistically analyse the data. 3.9 Methodological rigour Methodological rigour is defined by Hasson and Keeney (2011:1675) as the responsibility of the researcher to ensure that all research procedures have been adhered to. Where possible, factors that could influence results should be removed to produce reliable results. In addition, Marquard (2017:online) stipulates that the soundness

119**of a study in terms of planning, data collection, analysis and reporting,** indicates the **rigour** of a **study.** The foundation **of**

methodological rigour in quantitative research is indicated in the reporting of reliability and validity (Hasson & Keeney, 2011:1675). The Delphi technique has been perceived as lacking methodological rigour. This notion can be contributed to two factors, namely selection of appropriate measurement and the continuing modifications of questionnaires (Hasson & Keeney, 2011:1696). Despite limited universal guidelines to guide a researcher implementing the Delphi in its application, administration and reporting (Hasson et al., 2000:1009-1014), various indicators

105**to increase the reliability** and validity **of the Delphi** technique, **and**

how these were applied to this study, are described below. 3.9.1 Reliability Reliability is defined as the consistency of measurement over time (Grove & Gray, 2019:338). Various methodological approaches may enhance the reliability of a quantitative study, namely 1) the test-retest measure, 2) internal consistency, and 3) internal observer reliability. The test-retest method, also referred to as stability reliability, is concerned with reproducing the same results of the same questionnaire in another period of time (Grove & Gray, 2019:340; Hasson & Keeney, 2011:1698). However, this study did not aim to measure the consistency of the expert opinion over time, and therefore the test-retest method was not applicable (Hasson & Keeney, 2011:1698-

1699). The test-retest method may be recommended for further research to determine the stability of expert opinion on the competencies of midwifery U/S education and practice in South Africa. The

98**internal consistency refers to a** high degree **of** similarity **between** several **items**

that were formulated to measure the same construct (DeVillis, 2020:51; Maree, 2020:261). The construct for this study was consensus. The items that were formulated referred to the elements of the six competency domains (closed-ended questions). The questionnaires measured consensus of the elements of competency using a nominal Likert scale. The Cronbach alpha, which is used to measure the internal reliability of a questionnaire, can indicate

50**internal consistency** using **interval and ratio-level data (Grove**

& Gray, 2019:341).

129**Cronbach's alpha is the most widely used objective measure of reliability, and**

a measure of >0.7 indicates reliability of the questionnaire

62**(Tavakol & Dennick, 2011:53). Cronbach's alpha is** not traditionally used **in**

a Delphi study, but as a point of interest, the researcher retrospectively calculated the Cronbach's alpha. The Cronbach alpha for the first-round questionnaire was 0.97, for the second-round questionnaire it was 0.96, and for the third-round questionnaire 0.97. Therefore the questionnaires for all three rounds were found to be reliable. In addition, reporting on the response rate of the experts between rounds, feedback that was given by the researcher to the experts, and how consensus was achieved, all increase the methodological rigour of a study (Hohman, Cote & Brand, 2018:3281). Therefore, the researcher undertook additional measures to report on aspects as indicated by Hohman, Cote & Brand (2018:3281), and a detailed description of these measures follows in Chapter 4. Inter-observer reliability measures the similarity between experts regarding a particular idea, using a percentage agreement (Hasson & Keeney, 2011:1695). During round 1, qualitative data indicated an expert's contribution to an already existing question. Although the question reached consensus in round 1, the question was rephrased and added to rounds 2 and 3. After the changes to the already consented-to element, stability was determined in round 3, as will be discussed in Section 4.4. Stability of the question in round 3 infers inter-observer reliability (Hasson & Keeney, 2011:1696). Due to changes made to the subsequent questionnaires, based on the consensus statements and the data from the open-ended questions, the reliability of the instrument could be questioned. The study supervisors therefore validated the changes made by the researcher before sending the subsequent rounds of questionnaires to the experts. In addition, the evaluation of the quantitative data in the subsequent rounds increased the reliability of the questionnaire, as the experts themselves were included as internal moderators in the democratic process of the Delphi technique (Louw, 2014:26), as discussed in Section 3.3.1. A threat to the reliability of the study was the anonymity of the expert responses, as it may not always be beneficial to a Delphi technique. The lack of responsibility or accountability should be considered in terms of receiving an unaffected opinion (Louw, 2014:25). To counter the effect of unreliable responses, the researcher chose experts who willingly agreed to participate (Louw, 2014:25). 3.9.2 Validity The quality of the study design rests in the researcher's ability to identify the strengths of the design, and carefully evaluate any threats to validity (Grove & Gray, 2019:253). Discussing multiple sources of evidence of validity indicates the appropriateness of a questionnaire for a particular purpose (Mertens, 2015:469). There are three types of validity applicable to the conventional interpretation of validity, namely content, criterion-related and construct validity (DeVillis, 2020:86). However, criterion validity is defined as the

17**ability to measure the** degree **of** correlation between **the** existing **questionnaire and**

scores previously measured (Maree, 2020:262). As the questionnaire was newly developed, with no empirical knowledge available, criterion validity could not be proven. 102 According to Maree (2020:261), face validity should be included in the critique of validity of a study. Furthermore, discussing the internal and external validity of the questionnaire (Maree, 2020:43) may increase the validity of the conclusions or inferences drawn from the data. Although some of the evidence overlaps in the different types of validity, the researcher describes face and content validity, construct, internal and external validity, and how these were applied to this study. 3.9.2.1 Face validity and content validity According to Maree (2020:262), 107face validity refers to whether an instrument appears to measure what it is supposed to measure. In

contrast,

12content validity refers to the representativeness of the content of

a questionnaire (De Vos, 2011:174). Therefore, in this study,

131content validity refers to the degree to which the elements of the six competencies of the

questionnaire were relevant and representative of what it claimed

14to measure. Both face and content validity were measured by submitting the

first-round questionnaire to the School of Nursing Evaluation Committee, which comprised of experts in the field of Delphi research, research methodology and U/S experts. In addition, the first-round

108questionnaire was tested for face and content validity

with a pilot survey, as discussed in Section 3.6. Contributing to content validity is the number of experts in the sample. According to Gill et al. (2013:1324) and Hong et al. (2019:57), no clear recommendations exist about the number of experts needed to determine content validity. However, a homogeneous sample of 10 to 15 experts are considered sufficient (Hong et al., 2019:57). Therefore, the sample ranging from 14-18 experts in a heterogeneous group was found acceptable for this study. 3.9.2.2 Construct validity

75In the context of survey research, the construct is the

underlying theme or subject that the researcher measures, using questions (Dew, 2008:2).

26Construct validity refers to the ability of an instrument to measure what it set out to measure (Grove

& Gray, 2019:254). A quantitative research design with a modified e-Delphi technique allowed the quantification of consensus reached by expert opinion. This ensured the construct validity of the design.

78A key feature of the Delphi technique is that it

contributes to construct validity, using confirmation of the individual elements through expert validation in the subsequent rounds (Okoli & Pawlowski, 2004:27). A threat to the construct validity is the Rosenthal effect, defined as the researcher's expectation of the outcome that may influence the study (Grove & Gray. 2019:254). As the researcher was not able to withdraw from the data collection phase due to the Delphi technique construct validity was protected from the Rosenthal effect in a number of ways. The first was the School of Nursing Evaluation Committee, consisting of experts in the field of U/S and research, approval of the study design and first-round questionnaire. The second was participant anonymity by using the Evasys® programme. As the Evasys® programme coded the experts' responses before the researcher could access the data, the researcher could not be influenced by a particular individual's responses. Lastly, the thematic grouping of qualitative data

46was verified by the study leaders, and therefore the researcher's

expectations of the outcome could not affect construct validity. Apart from the pilot survey contributing to face validity, Okoli and Pawlowski (2004:19) state that the pilot survey further contributes to testing the questionnaire to ensure construct validity. 3.9.2.3 Internal validity Internal validity

126**ensures that the findings of the study are** a true reflection **of** reality **rather than the** influence **of**

external factors (Maree, 2020:191). The reliability of the questionnaire, as indicated in Section 3.9.1, can be a contributing factor in increasing internal validity (Maree, 2020:191). In addition, the questionnaire was validated by the School of Nursing Evaluation Committee, which comprised of clinical U/S and research experts. Researcher bias is one of the main concerns of a Delphi technique (Avella, 2016:315). According to Gill et al. (2013:1324), clear selection criteria minimises the possibility of researcher bias. The selection criteria is discussed in detail in Sections 3.4. Researcher bias may become evident in the formulation of questions (Avella, 2016:315). To ensure the researcher stayed objective about the research, the validation of the first-round questionnaire by the School of Nursing Evaluation Committee, and the continuous evaluation of the adjustments to the subsequent rounds of questionnaires by the supervisors minimised the risk for researcher bias. In addition, using the experts' own words in the qualitative questions which served to reduce researcher bias and increase internal validity (Hasson & Keeney, 2011:1700-1701). A high attrition rate may decrease the internal validity (Maree, 2020:192). A classical Delphi method, as with any other research method, runs the risk of attrition (Keeney et al., 2011:70). Therefore, the benefit of the structured modified e-Delphi, as well as removing the consensus statements between rounds, kept the length of the questionnaire to a minimum. According to Grove and Gray (2019:255), an attrition rate of less than 25% is acceptable. For this study, the attrition rate was 22.2% between rounds and 3, which contributed to the interval validity of the study. In addition, the attrition rate between the rounds did not affect the distribution of experts between Groups A and B. A major threat to internal validity is selection bias (Maree, 2020:192). The purposive sampling method could have been interpreted as a threat to internal validity, but the measure of pre- selection criteria minimised this risk (Grove & Gray, 2019:253). 3

77**.9.2.** 4 **External validity External validity** considers **the** degree **of** generalisation between **the**

study and other variations of groups, settings, conditions, treatment and outcomes (Grove & Gray, 2019:255; Maree, 2020:191; Polit & Beck, 2012:250). Although generalisation was not the aim of

59**this study, a heterogeneous group of** healthcare professionals **in the** field **of**

U/S related to midwifery provided valid consensus on the competencies of midwifery U/S for the South African context. The inclusion criteria of experts excluded bias and increased external validity. The attention to rigour throughout the research process will enable other researchers to duplicate the study in similar contexts. According to Maree (2020:192), a major threat to external validity, amongst others, is insufficient realism. Purposive sampling is an example of insufficient realism due to the lack of generalisability. However, the apposition of generalisation and expert opinion has been discussed in detail in this study report. The modified e-Delphi contributed in establishing an egalitarian environment, which increased external validity. According to Maree (2020:192), ecological validity refers to the research conditions that could influence a study. Conditions such as the presence of an experimenter, physical surroundings or pre-test or post-test sensitisation were not applicable. Although the researcher's background and interest in the field of midwifery were explained via email to the experts, the Hawthorne Effect was minimised by using an online research technique. Lastly, 105 despite changes to the instrument (Maree, 2020:192) that was a crucial part of the study's design, the external validity was not diminished, as indicated by the stable Cronbach's alpha during the three rounds of questionnaires. As a threat to external validity, item bias could be created, as the experts represented either midwives or traditional U/S healthcare professionals (Maree, 2020:263). It was, however, seen as both a strength and a threat to the external validity, due to the heterogeneous nature of the sample population. Although it was not the aim of the research to distinguish between the consensuses of Group A (midwives) and Group B (traditional U/S healthcare professionals), professional bias was possible in both groups. Consensus was therefore determined on the combined data to eliminate the high and low responses of both groups due to bias. 3.10

91**Ethical considerations Due to the nature of research**

in health sciences, and also from a post-positivist point of view, the

113**Belmont Report (The National Commission for the Protection of Human** Services **of Biomedical and** Behavioral **Research, 1979:**

online) was best suited to ensure sound ethical principles (Mertens, 2015:61). The conduct of the researcher was based on the underlying Belmont principles of a) Respect of person, 27b) Beneficence, and c) Justice (The National Commission for the Protection of Human Services of Biomedical and Behavioral Research,

1979:26-13; Mertens, 2015:61-62). 3.10.1 Respect for persons

87The Belmont Report (The National Commission for the Protection of Human Services of Biomedical and Behavioral Research,

1979:26-13) elaborates on the right of the expert to be treated as an autonomous person, which includes being treated with respect and courtesy (Mertens, 2015:61). Therefore, the researcher included an information letter on Evasys® (Addendum B) which allowed for informed consent to be given. The completion of the questionnaire on the Evasys® system, as well as an individual auto-generated password, served as confirmation that informed consent was given. Confidentiality of personal information and the data received during the study, were

12managed in a strictly professional and confidential manner.

The information letter informed the participants that all data would be managed confidentially, due to the need for the researcher to track the data between rounds (Gill et al., 2013:1324). The researcher also reiterated this concept in the first email to the experts.

148No names or personal identifiers appear on any data sheet.

All data stored by the researcher are password-protected. The researcher is aware of the identities of the experts, but cannot link any data sheet to any of the experts. Due to the concerns of information privacy and security on the internet, the information letter included a statement to inform the experts that their responses were

59password-protected. All data were collected and hosted on secure web servers

(Gill et al., 2014:1325). The Evasys® programme is administrated by the domain

9of the University of the Free State, where the research was conducted. The

programme license only allows for users within the University, and not public users. The security of the programme is therefore guaranteed by the University. Only participants that received an individual password that was auto-generated by Evasys® could access the programme, which contributed to the safety and quality of the data (Liebenberg, 2019:personal communication). The data retrieved from Evasys® was already number coded, and therefore the researcher could not identify a person or any other personal identifiers to a specific response. Yousuf (2007:3), defines anonymity as the

106use of questionnaires or other communication, where expressed responses are not identified as being from a specific

participant. Millar et al. (2007:60) refer to anonymity as the ability of each individual to submit their feedback on a questionnaire without the influence of peer domination in an exclusive group of experts. The importance of anonymity is emphasised by Millar et al. (2007:10) as an important feature to reduce bias. In addition, Avella (2016:309) clearly states that without anonymity, the Delphi technique is flawed. To ensure that the participants felt safe and had the freedom to express their opinions without fear of judgement or influence, participant anonymity was implemented (Hsu & Sandford, 2010:5; Shariff, 2015:5). The researcher emailed the participants individually with their passwords at the beginning of every round. Although the researcher could link the password to the participant, Evasys® is

14responsible for the data collection process, including the storing of the

raw data, and does not have the option to allow for any identifiers (including password and respondent correlation) with data extraction. It is therefore not possible for the researcher to extrapolate data with any identifiers that could link the passwords to the responses. The benefit of anonymity creates an egalitarian environment, and the suppression of bias due to external influence (Millar et al., 2007:10). As one of the reasons for choosing the modified e- Delphi was the ability to achieve subjective opinions from experts on a topic not widely researched before, it was crucial to minimise the possibility of conformity, or the bandwagon effect (Hsu & Sandford, 2012:4; Shariff, 2015:2; Yousuf, 2007:5). Due to the varied nature of the experts in the field of U/S, group pressure due to individual personalities and influence of professional reputation is a possibility (Avella, 2016:309; Hsu & Sandford, 2019:5). Even more so, participant anonymity (Yousuf, 2007:4) was crucial for the experts to be able to voice their opinion freely and without fear of reprisal. Adding to the egalitarian environment of the modified e-Delphi technique is the vast geographic distribution of the experts (Keeney et al., 2011:1; Hsu & Sandford, 2012:4-5; Yousuf, 2007:5). As such, the likelihood of experts being aware of each other's identities are small.

8**3.10.2 Beneficence The principle of beneficence**

is based on doing good and not doing harm (The

36**National Commission for the Protection of Human Services of Biomedical and Behavioural Research:**

26- 12,13). According to Berg (2007:59-60) a positive offset of the risk and benefit scale, set in the utilitarian approach, is the establishing factor to determine if research is permissible or not. To confirm the application of the principle, the researcher ensured maximum benefit and reduced any possible risks for the experts. Benefits for the experts participating in the study: • Collaboration with peers to form a collective opinion on the subject matter in which they are perceived as experts; • Forming part of an egalitarian group that stimulates new ideas and perspectives (Millar et al., 2007:60); • Contributing their expertise to the development of a standard of practice within the field of Health Sciences. The researcher did not foresee any significant risk or injury to any party. Although the expert group was purposefully sampled, which may have posed a risk of selection bias, measures such as the pre-set criteria for inclusion minimised this risk. It served the purpose of the study to make use of the risk of bias to the benefit of the outcome of the expert opinion. 108 Another possible risk was that as the expert pool in South Africa is not large, the experts might have been aware of each other's participation in the study. 3.10.3

26**Justice The principle of justice refers to the** researcher's ability **to** apply **fairness to** issues such as **the**

selection of

114**participants (The National Commission for the Protection of Human** Services **of Biomedical and** Behavioural **Research, 1979:** online). To ensure **that**

no discrimination took place against any vulnerable groups such as minority groups or race classifications, the researcher identified the target population using a sampling technique that consisted of experts that complied with selection criteria from all healthcare fields related to the aim of the study (The

36**National Commission for the Protection of Human Services of Biomedical and Behavioural Research, 1979:**

online). 3.11 Approval

12**Approval for the research project was obtained from the Ethics Committee of the Faculty of Health Sciences at the University of the Free State: UFS-**

HSD2020/0022/2104 (see Addendum A). As no patients were involved in this study, approval from the provincial Department of Health was not necessary (Bezuidenhout, 2018:34). Approval for the study was also given by the Head of the School of Nursing, from where this research was conducted. 3.12 Concluding remarks A modified e-Delphi technique was applied in a quantitative descriptive design to reach consensus on competencies for midwifery U/S education and practice in South Africa. The experts were explicitly classified within the population of the study. Although purposive sampling

81**could be seen as a limitation of** the **study,** the significance of expert opinion on a subject where prior knowledge is limited, is of great value as it creates the foundation for further research. The methodological rigour of the study has indicated that reliable results were obtained, and done so in an ethical respected manner. In the data analysis in

46**Chapter 4, the researcher discusses the findings of**

consensus of expert opinion on midwifery U/S education and practice.

9**Chapter 4 Data analysis 4.1 Introduction** In Chapter 2, **the**

literature review confirmed the positive contribution that midwifery U/S competence can have on maternal and child

9**health in South Africa.** To effect **the** needed **change,** experts **in the**

field of U/S in South Africa voiced their opinion on elements which could constitute midwifery U/S competence. Reaching expert consensus could validate the use of midwifery U/S and therefor the change needed as indicated by the literature. Moreover, the global equivalence of midwifery U/S competence can be achieved. According to Giannarou and Zervas (2014:67) there are no standard guidelines for data analysis of the Delphi technique. Authors refer to the use of descriptive statistics in a Delphi as using of the percentages, standard deviation, frequency distribution or the interquartile range (Giannarou & Zervas 2014:67; Milevska-Kostova and Dunn, 2010:431). However, the use of the median and the mode is also used to report on the data of a Delphi technique (Hsu & Sandford, 2007:4; Milevska-Kostova & Dunn, 2010:431). The mean refers to the arithmetic average or summary of the frequency distribution of the sample (n) in terms of the centrality tendency of the responses (Mertens, 2015:491). Furthermore, the median as a descriptive statistic in reporting on consensus refers to the midpoint of the data set, which is central from the lowest and highest scores (Mertens, 2015:491). However, the use of the mean or median to determine consensus with a Delphi technique could be misleading due to the possibility of convergence of opinion around two or more points (Hsu & Sandford, 2007:4). Moreover, the mode is reported as the most frequently occurring score in the distribution of results (Mertens, 2015:491). Using the mode as a component of descriptive statistics to describe the central tendency (Hsu & Sandford, 2007:4) was best suited for a meaningful discussion on the expert consensus reached for this study. Although the researcher did not include the

44**mean, median,** mode, **standard deviation and the** range as part **of** the discussion **of the**

data, a graphic representation of the descriptive statistics was included for each round and its related competency to enhance the overview of the data. The researcher analysed a total of 118 elements involving the six competency domains of midwifery U/S per iterative round. Furthermore, two categories were compiled for the additional open-ended questions, 1) task shifting of midwifery ultrasound to the basic or specialist midwife, and 2) the level of midwifery U/S education and practice and discussed in rounds 2 and 3. To increase the methodological rigour of a study, Hohman et al. (2018:3281) recommend reporting on the response rate of the experts between rounds and the feedback that was given by the researcher to the experts. Therefore, in a bid to comply with this recommendation by Hohman et al. (2018:3281), the researcher included the response rate and feedback that were given to the

66**experts for the three rounds of** the **Delphi.** Lastly, **the**

researcher reported of stability gained from non-consensus elements in repetitive rounds. According to Keeney et al., (2011:91), stability is inferred

66**when there is no significant difference between the** frequency **of** responses for **two** consecutive **rounds**

of the Delphi. The data collection process, concluded in Section 3.7,

99**was followed by the data analysis** as described **in** this **chapter.**

As for this study utilised quantitative data, the

80**open-ended questions** served **to** augment **the** quantitative **data** that **were** generated **and** analysed **in the**

iterative rounds. Therefore, the complete datasheet of all three rounds (Addendum C) and the tables included in this chapter, contains two sets of question numbers. The first set of question numbers is refers to the original question number (OQN) as indicated in the questionnaires that the experts completed per round. The three questionnaires with the OQN that were sent to the experts are included in Addendum B for reference purposes. For data analysis, the questions where re-numbered with a chronological question number (CQN) that is also displayed in the discussion. Due to the additional closed-ended questions included in the iterative rounds, the OQN and the CQN do not correlate. An open space with a CQN in some of the tables or figures represents additional closed- ended questions to follow in the subsequent rounds. In addition, Addendum D contains the data of the open-ended questions, and Addendum E the descriptive statistical graphs for reference. 4.2 Round 1 The experts for the first-round questionnaire were a heterogeneous group of n=18 experts with equal distribution between groups A and B of n=9 experts each. The first round yielded a 100% response rate. The first round consisted of 91 closed-ended questions in the six domains of midwifery U/S competencies (refer to Addendum C). The 91 questions which formed the elements of the six domains were analysed. Consensus was reached in 27 (29.7%) of the 91 elements, with 0.7% incomplete answers reported. All the consensus levels were declared at 70%, as confirmed by a biostatician

9**from the University of the Free State.** Level 1 of **the**

Likert scale, which represented elements deemed essential for inclusion, was the mode of choice that reached consensus.

162**Open-ended questions were included at the end of** each of **the**

six domains of midwifery U/S competencies to provide the experts with the opportunity to reflect on the comprehensive inclusion of all elements deemed necessary. An additional two

86**questions were asked at the end of the** questionnaire that referred **to**

the context of midwifery U/S in South Africa, specifically pertaining to task shifting and the level at which the midwife should perform U/S. The consensus elements were distributed between the first four midwifery U/S domains (general principles of sonography, early and first-trimester U/S, second and third-trimester U/S, and intrapartum U/S). No consensus was reached in competency five, (postpartum midwifery U/S), and competency six (gynaecological midwifery U/S). The intention was to carry over the non- consensus elements from round 1 to round 2. Therefore, the following report will include only the consensus elements per competency domain that were reached in the first round. The acronyms CQN and OQN refer to the chronological question number and the original question number, respectively. As mentioned earlier, a graphic illustration of the descriptive statistics is included for each round and the related competency. 4.2.1 Round 1, competency #1: General principles of sonography Table 4.1 illustrates the consensus elements for competency #1, which refers to the general principles of sonography that was foundational to all the other competency domains. In total, there were 11 questions of which 6 (55%) reached consensus in the first-round. 112 As indicated in Table 4.1, the knowledge component of competency #1 had a total of 5 consensus elements, while skill and professional behaviour had only 1 consensus element. For ease of visual identification, the consensus elements are shaded in colour. Table 4.1 Consensus elements of round 1 - competency #1: General principles of sonography. CQN OQN Round 1, competency #1 elements n Essential 1 % n Useful 2 % Potential for inclusion n 3 % Not needed n 4 % A midwife has foundational knowledge about: 2 3 4 5 7 2,2 2,3 2,4 2,5 2,7 basic maintenance of ultrasound instrumentation ultrasound safety infection control the principles of knobology anatomy and physiology of the internal organs of the female reproductive system related to the productive age 13 15 18 15 13 72% 83% 100% 83% 72% 2 3 0 2 1 11% 17% 0% 11% 6% 3 0 0 1 1 17% 0% 0% 6% 6% 0 0 0 0 3 0% 0% 0% 0% 17% A midwife has the skill and professional behaviour to: 10 2,10 apply the principles of knobology 13 72% 3 17% 2 11% 0 0% CQN: Chronological question number OQN: Original question number 114 The descriptive statistics for round 1, competency #1

104**is displayed in Figure 4.1. Figure 4.**

1 Descriptive statistics - round 1, competency #1 CQN 2 in Table 4.1 refers to the importance of general maintenance of equipment for midwifery U/S. In a developing country such as South Africa, expert consensus n=13 (72%) on the basic maintenance of U/S instrumentation indicates the importance of maintenance plans that are independent of service providers. The use of U/S includes aspects of safety

related to amongst others, the precautions necessary to ensure the quality of U/S imaging (Tegnander & Eik-Nes, 2014:16). The use of U/S is regarded as safe for the childbearer and fetus (Torloni et al., 2009: 604; Whitworth et al., 2010:2). However, as discussed in Section 2.3, U/S safety (CQN 3) refers to more than purely physical harm. Over-medicalisation of the use of U/S and under-reporting of findings which could influence management during the childbearing period represent safety risks. Furthermore, U/S safety risks could be caused by a lack of proper U/S training (Carrera, 2020:294), as is possible for unaccredited midwifery U/S training in South Africa. As the use of U/S also could affect litigation costs due to higher medico-legal risk (Snyman, 2019:4), the safe use of U/S by midwives as stated in CQN 3 in Table 4.1, are appropriately regarded as essential by expert consensus (n=15, 83%). Infection control, CQN 4, reached 100% expert consensus (n=18). Abuhamad et al. (2018:31) affirm the importance of including a protocol for infection control measures of the U/S equipment as part of a U/S curriculum. Infection control measures during the childbearing period became even more important this year with the Covid-19 pandemic. The Royal College of Obstetrics and Gynaecology (RCOG) issued guidelines for the use of U/S during the current pandemic. The guidelines focused on reducing the risk of exposure to Covid-19 by combining essential U/S screening with other reproductive care activities (RCOG, 2020:6-7). CQN 5 refers to the principles of knobology. Although technological advances have led to pre-set obstetrical and gynaecological functions and tele-radiography support, the fundamentals of U/S imaging has remained the same. Therefore, the importance of understanding the instrumentation and knobology for image generation, as discussed in Section 2.5.1, was reiterated by Enriquez and Wu (2014:26, 44). The experts confirmed the importance of knowledge of knobology (n=15, 83%). It was also the only element of skill and professional behaviour (n=13, 72%) to reach consensus in round 1. The integration of anatomy and physiology as an existing body of knowledge in midwifery was confirmed by expert opinion (n=13, 72%). Specific anatomy and physiology of the internal organs of the female reproductive system related to the reproductive age (Abuhamad, 2018:30), was confirmed as essential by expert consensus. 4.2.2 Round 1, competency #2: early and first trimester midwifery U/S Tables 4.2 and 4.3 show the consensus elements for competency #2, which refers to the early and first trimester midwifery U/S. In total, there were 30 questions of which 8 (27%) reached consensus in the first round. As indicated in Tables 4.2 and 4.3, both the knowledge, skill and professional behaviour elements had 4 consensus elements each. Table 4.2 Consensus elements round 1 - competency #2: early and first trimester midwifery U/S (knowledge) Essential Useful Potential for inclusion Not needed CQN OQN Round 1, competency #2 elements 1 2 3 4 n % n % n % n % A midwife has foundational knowledge about: 16 3,3 indications for an early and first-trimester ultrasound 14 78% 3 17% 0 0% 1 6% 17 3,4 criteria for a transabdominal early and first trimester ultrasound 14 78% 2 11% 1 6% 1 6% 21 3,8 components of sonographic dating in trimester 16 89% 2 11% 0 0% 0 0% 28 3,15 single intrauterine demise 14 78% 3 17% 1 6% 0 0% 117 Table 4.3 Consensus elements round 1 - competency #2: early and first trimester midwifery U/S (skills and professional behaviour) Essential Useful Potential for inclusion Not needed CQR OQR Round 1,competency #2 elements 1 2 3 4 n % n % n % n % A midwife has the skills and professional behaviour to recognise the sonographic presentation of normal embryonic and fetal development with regard to: 30 3,17 single and multiple pregnancy 13 72% 3 17% 2 11% 0 0% 35 3,22 evaluate embryo/fetus cardiac activity and documenting 14 78% 2 11% 1 6% 1 6% 36 3,23 determine the indication for an early or first trimester ultrasound 15 83% 3 17% 0 0% 0 0% 44 3,30 refer persons with a high risk profile or abnormal findings to an appropriate healthcare professional 18 100% 0 0% 0 0% 0 0% CQN: Chronological question number QNR: Original question number 118 The descriptive statistics of round 1, competency #2 is presented in Figure 4.2. Figure 4.2 Descriptive Statistics - round 1, competency #2. Over-medicalisation as a component of TMTS (Section 2.3.3) could be reduced by strengthening competence regarding the appropriate use of early and first-trimester U/S. A total of 78% (n=14) of the experts reached consensus on CQN 16, which refers to the indications for U/S use during the first trimester, for inclusion as an essential element of knowledge. In addition, 83% of experts (n=15) agreed on the importance of having skills and professional behaviour as a competency element for midwifery U/S education and practice. The indications for early and first trimester U/S was reiterated by RCOG who despite the Covid-19 pandemic, still emphasised the importance of the first trimester U/S for trisomy screening, anatomy screening in the second trimester, and growth U/S screening where indicated (RCOG, 2020:6-7). Experts in this research are of the opinion that midwives should utilise transabdominal U/S and not transvaginal U/S. In round 1, consensus of 78% (n=14) was reached on the inclusion of the associated knowledge of transabdominal U/S. In contrast, the expert opinion did not reach consensus, and hence stability was declared in round 3 on the knowledge of transvaginal U/S, as illustrated in Figure 4.3. Stability: Criteria for a transvaginal early and first trimester U/S 100% 90% 80% 67% 70% 63% 60% 56% 53% 57% 57% 57% 50% 44% 44% 40% 30% 20% 10% 0%

159**Round 1 Round 2 Round 3 Group A Group B**

Combined Consensus Figure 4.3 Stability, round 3, CQN 18, criteria for a transvaginal early and first-trimester U/S The experts in group A had indicated lower consensus on the essential nature of transvaginal U/S during early and first trimester pregnancy. The consistency of the lower consensus level in group A could translate to non-intervention as a philosophical foundation of midwifery care (ICM, 2014:2). However, with the rate of

15**advancements in high-resolution transvaginal** U/S **transducers, the**

15**ability to** visualise **key anatomic landmarks** and **major** embryonic **abnormalities** during **the**

first- trimester have enhanced the opportunity for early diagnosis (Mei, et al., 2019: 829). In Southern 120 Africa, only 18% of the population in rural areas have at least one ultrasound during pregnancy, and 6% has more than three ultrasounds during pregnancy (Carrera, 2020:290). The importance of ensuring the best possible diagnosis with U/S irrespective of the gestational period in a demographical area where the childbearer has access to only one opportunity for diagnosis, should be taken into consideration. Despite non-consensus by the experts, the value of transvaginal U/S for midwives is strengthened by Murugan, Murphy, Dupuis, Goldstein and Kim (2020:178), as visualisation of cardiac activity is far superior with transvaginal viewing than with transabdominal U/S. According to Mei et al. (2019:830), the transabdominal and transvaginal U/S should be used in combination for the best results. ISUOG (2014:114) includes the recognition of the normal features of fetal viability as a part of the basic U/S. Expert consensus supports (n=14, 78%) knowledge of intrauterine demise and evaluating of embryonic and fetal cardiac activity as elements of competency #2. Experts (n=13, 72%) agreed that the midwifery U/S diagnosis of single or multiple pregnancies during the early and first trimester is an essential component of midwifery U/S. As discussed in Section 2.7.2, early or first trimester

21**ultrasound improves the early detection of multiple pregnancies,**

which directly influences the risk profile for midwifery management. Whitworth et al. (2010:2), further elaborate on the benefit of improved gestational dating with early and first trimester U/S that

21**may result in fewer inductions for post maturity.** According **to**

Carrera (2020:261), a significant number of African women do not know their last menstrual period.

28**Gestational age is** crucial for **the** quality **of** antenatal **care,** as **the** lack **of**

accurate dating leads to incorrect diagnoses IUGR and premature birth (Carrera, 2020:261). Consensus of 89% (n=16) indicated that the experts agree on the importance of including the knowledge element of sonographic dating in the first trimester. Although midwives practice their profession autonomously, a midwife should always adhere to the boundaries of her competence and the midwifery scope of practice (ICM, 2019:10) and therefore

111**be able to work** effectively **as part of** the multidisciplinary **team.**

It should come as no surprise, then, that timeous referral of the childbearer with a high-risk profile or abnormal findings to an appropriate healthcare professional (CQN 44) reached 100% consensus as an essential inclusion for midwifery U/S education and practice. 4.2.3 Round 1, competency #3: second and third-trimester midwifery U/S. Tables 4.4 and 4.5 illustrate the consensus elements for competency #3, which refers to the second and third trimester midwifery U/S. In total, there were 28 questions of which 9 (32%) reached consensus in the first round. As indicated in Table 4.4, the knowledge component of competence reached 4 consensus elements. In Table 4.5, the skill and professional behaviour depicts 5 consensus elements. Table 4.4 Consensus round 1 - competency #3: second and third trimester midwifery U/S. Essential Useful Potential for inclusion Not needed CQN OQR Round 1, Competency #3 elements 1 2 3 4 n % n % n % n % A midwife has foundational knowledge about: 54 4,6

1**components of fetal biometry in sonographic dating in** the **second and third trimesters**

14 78% 3 17% 1 6% 0 0% 55 4,7 normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during fetal examination in the second and third trimesters 13 72% 2 11% 3 17% 0 0% 59 4,11 presentation, position and attitude of the fetus in the third trimester 17 94% 0 0% 1 6% 0 0% 61 4,13 indications for the referral to healthcare professionals 18 100% 0 0% 0 0% 0 0% CQN: Chronological question number QNR: Original question number 123 Table 4.5 Consensus round 1 - competency #3: second and third-trimester midwifery U/S Essential Useful Potential for inclusion Not needed CQN OQR Round 1, competency #3 elements 1 2 3 4 n % n % N % n % A midwife has skill and professional behaviour to: 68 4,20 measure the basic structures to estimate the age of the fetus 17 94% 0 0% 1 6% 0 0% 69 4,21 measure basic fetal morphology in the second and third trimesters for the purpose of establishing normal fetal growth 15 83% 0 0% 2 11% 1 6% 71 4,23

3examine the placenta, umbilical cord and amniotic fluid and

adnexa during fetal examination in the second and third trimesters 13 72% 2 11% 3 17% 0 0% 75 4,27 appreciate the ethical issues associated with prenatal diagnostic procedures 13 72% 3 17% 2 11% 0 0% 76 4,28 referral of a person with a high risk profile or of abnormal findings to an appropriate healthcare professional 17 94% 0 0% 1 6% 0 0% CQN: Chronological question number QNR: Original question number 124 The descriptive statistics for round 1, competency #3 is presented in Figure 4.4. All consensus elements reached was yet again indicated on level 1: essential, with only CQN 74 (biophysical profiling of a fetus) reflecting a mode preference of level 3: potential for inclusion. Figure 4.4 Descriptive statistics - round 1, competency #3. CQN 54 of Table 4.4, referred to the knowledge component of

1fetal biometry in sonographic dating in the second and third trimesters.

A total of 14 experts (78%) reached consensus and thereby indicated the essential inclusion of the competency element. A further 17% of experts indicated that the inclusion could be useful for midwifery U/S education and practice. In addition, in CQN 68, 94% of the experts (n=17) stated that it is essential for a midwife to have the skill and professional behaviour for estimation of the fetal age by measuring the basic anatomical structures. Furthermore, CQN 69 in Table 4.5 links with the previous elements, referring to the applicable measurements to establishing normal fetal growth. Experts reached 83% consensus on the essential inclusion of establishing fetal growth in the third trimester, which is a vital component of antenatal care of the midwife (ICM, 2019:13). In addition, CQN 55 and 59 refer to the evaluation of the fetal and placental presentation in the third trimester as risk stratification in preparation for labour is crucial (Ahman, 2019:8). Most of the experts (n=17, 94%) agreed with the importance of adding the two elements of fetal and placental identification to midwifery U/S competency #3. The ICM (2014:2) states that midwives should practice their profession in an ethically sound manner. Midwifery care further supports the ICM Bill of Rights for women and midwives (2018[a]:2), that highlights the right of the childbearer to actively take part in the decisions about her health while receiving up-to-date health information without any discrimination. Therefore, midwifery U/S education and practice should encompass sensitive and ethically sound practice in dealing with prenatal diagnosis and diagnostics procedures. Experts agree (n=13, 72%) that midwives should appreciate the ethical issues associated with prenatal diagnosis. As previously discussed in Section 4.2.2, the timeous referral of a person with a high-risk profile or abnormal findings to an appropriate healthcare professional, is part of the philosophical foundation of midwifery care. Experts agreed (n=18, 100%) that knowledge about the indications for the referral is crucial for midwifery U/S education and practice (CQN, 76 - Table 4.4.). 4.2.4 Round 1, competency #4: intrapartum midwifery U/S Table 4.6 shows the consensus elements for competency #4, which refers to intrapartum midwifery U/S. In total, there were 7 questions of which 4 (57%) reached consensus in the first- round. As indicated in Table 4.6, both the knowledge component of competence and the skill and professional behaviour reached 2 consensus elements each. Table 4.6 Consensus round 1 - competency #4: intrapartum midwifery U/S CQN OQR Round 1, competency #4 elements n Essential 1 % n Useful 2 % Potential for inclusion n 3 % Not needed n 4 % A midwife has foundational knowledge about: the presentation, lie, position and attitude of the 77 5,1 fetus during labour normal and potential pathological ultrasound appearance of the placenta, umbilical cord and 78 5,2 amniotic fluid during labour 16 14 89% 78% 1 3 6% 17% 1 0 6% 0% 0 1 0% 6% A midwife has the skill and behaviour to: examine the position of the placenta, umbilical 81 5,5 cord and amniotic fluid review the presentation, lie, position and attitude 82 5,6 of the fetus 14 16 78% 89% 2 1 11% 6% 2 1 11% 6% 0 0 0% 0% 127 The descriptive statistics for round 1, competency #4 is presented in Figure 4.5. As competency of intrapartum measurements such as the angle of progression and the symphysis-head measurements as easily transferable (Fidalgo, 2020:307), other reasons for expert inclination toward not including transperineal U/S (CQN 85) as part on competency #4 should be examined. Figure 4.5 Descriptive statistics - round 1, competency #4. From CQN 77 and 82 in Table 4.6, it is evident that the experts (n=16) agreed on the importance of including the evaluation of fetal presentation, lie and attitude during labour as part of midwifery U/S competence. The experts (n=14) agreed that midwives should be competent in U/S evaluation of the placenta, umbilical cord and amniotic fluid abnormalities during the intrapartum period. The practical implication of this including the competence for midwifery U/S relates to the prevention of obstetrical haemorrhage as the second-highest direct cause of maternal death in South Africa (SA DoH[b], 2017:7). With the limited number of U/S during the antenatal period in Southern Africa, as previously discussed in Section 4.2.2, intrapartum midwifery U/S could decrease maternal mortality and morbidity due to early diagnosis of placental, umbilical cord or amniotic fluid abnormalities. 4.2.5 Open-ended questions In Addendum D, the data of the open-ended questions for round 1 are given. The experts contributed three additional elements in the domain-specific open-ended questions. Two of the elements were relevant to CQN 7, namely the inclusion of embryology as well as fetal anatomy and physiology. Although CQN 7 reached consensus in round 1, the addition of anatomy and physiology of the embryo and fetus to the question, compelled the researcher to repeat it in round 2. The third domain-specific element was related to clinical integration with imaging, which was developed into CQN 11 as a closed-ended question for expert consensus. In the first-round, OQN 8.1 asked the experts if the basic or specialist midwife should be competent in midwifery U/S. The thematic analysis of the data (Addendum D) led to the development of eight additional close-ended questions related to task-shifting to be added to round 2, as indicated in the second-round questionnaire (Addendum B). OQN 8.2 in the first-round questionnaire asked the experts that if midwives were to perform U/S, according to which level of obstetric and gynaecological U/S should midwifery U/S be performed. Similarly to OQN 8.2, the data analysis added four closed-ended questions relating to the levels of midwifery U/S education and practice to Round 2, as indicated in the second-round questionnaire (Addendum B). Furthermore, the data reveal a supplementary theme that the researcher included in an additional question as part of task shifting in round 2. An expert stated that the midwife is best positioned to offer the service if they have been appropriately trained, while emphasising the time it takes to perform a U/S. Another expert alluded to the fact that the basic midwife has enough on her plate. Both of the statements by the experts led to the following question (Table 4.7) being added in Round 2. Table 4.7 Open-ended question developed from data in round 1. OQN 8.8: Please read the following statement and give your answer below: The number of qualified health care professionals offering obstetric ultrasound services is grossly inadequate for the needs of the country. Midwives are best positioned to offer the service if they are appropriately trained. Due consideration should be given to the workload of the midwife. In your opinion, how would you propose the midwife in the field should absorb this additional workload? 4.2.6 Round 1: feedback to experts The researcher reported on the sample size and the response rate of the experts in the first round. A motivation was given for the extension on time to two experts to complete the questionnaire. The unique finding of the strong expert affinity for favouring level 1 as the highest confirmation of the competency elements for midwifery U/S was captured as essential for inclusion. The open-ended questions yielded the contribution of three elements from experts that applied to competency #1 in Round 2. Although 5.5% of the experts in round 1 indicated that they are of the opinion that elements should be added to competency #4 (intrapartum U/S), competency #5 (postpartum U/S), and competency #6 (gynaecological U/S), no elements or statements were received in response. 4.3 Round 2 The experts that completed the first round (n=18) were invited to continue with the second round. The second round yielded a 94% response rate, which contributed to a heterogeneous group of n=17 experts. The frequency distribution for Group A was n=9 experts, and Group B consisted of n=8. The second round contained 84

95**closed-ended questions and** 6 **open-ended questions** across **the**

six domains of midwifery U/S competencies. The exclusion of consensus elements of round 1 and the additional 12 questions, as discussed in Section 4.2.5 are indicated in Addendum B. However, two consensus elements were unintentionally included in the second-round questionnaire. The unintentional inclusion of the consensus elements created an opportunity to confirm consensus reliability (Hasson & Keeney, 2011:1695). Round 2 yielded consensus on 16 (19%) of the elements with 1.4% incomplete answers reported. Yet again, the consensus levels were reached on level 1 of the Likert scale, indicating the essential inclusion of the elements for midwifery U/S education and practice. Similar to round 1, the consensus elements were distributed between the first four midwifery U/S domains (general principles of sonography, early and first-trimester U/S, second and third trimester U/S, and intrapartum U/S). No consensus was reached in competency #5 (postpartum U/S), and competency #6 (gynaecological midwifery U/S). 130 4.3.1 Round 2, Competency #1: general principles of sonography In round 2, only one element of competency #1 reached consensus. CQN 10 refers to the skill and professional behaviour in the application of the principles of knobology (Addendum C). Although the question, as discussed in Section 4.2.1, reached consensus in Round 1, the repetition confirmed consensus reliability (Hasson & Keeney, 2011:1695), as the results reached consensus in both round 1 and 2. The descriptive statistics for round 2, competency #1, as presented in Figure 4.6, indicated all elements favouring level 1: essential for inclusion irrespective of consensus. Figure 4.6 Descriptive statistics - round 2, competency #1. 4.3.2 Round 2, competency #2: early and first trimester U/S Table 4.8 illustrates the consensus elements for competency #2, which refers to the early and first trimester midwifery U/S. In total, there were 22 questions of which 8 (36%) reached consensus in the second round. The experts reached consensus on 1 knowledge element and 7 skill and professional behaviour elements Table 4.8 Round 2 - competency #2: early and first-trimester midwifery U/S Essential Useful Potential for inclusion Not needed CQN OQN Round 2, competency #2 elements 1 2 3 4 n % n % n % n % A midwife has foundational knowledge about: criteria for definitive diagnosis and referral of 23 3,6 embryonic/fetal death in the first trimester 12 71% 4 24% 0 0% 1 6% A midwife has the skills and professional behaviour to recognise the sonographic presentation of normal embryonic and fetal development with regards to: 29 30 31 32 37 3,11 3,12 3,13 3,14 3,17 embryonic and fetal biometry single and multiple pregnancy gestational sac yolk sac distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound 12 16 12 12 13 71% 94% 71% 71% 76% 2 1 5 3 3 12% 6% 29% 18% 18% 2 0 0 1 0 12% 0% 0% 6% 0% 1 0 0 0 1 6% 0% 0% 0% 6% 132 Essential Useful Potential for inclusion Not needed CQN OQN Round 2, competency #2 elements 1 2 3 4 n % n % n % n % A midwife has the skills and professional behaviour to recognise the sonographic presentation of normal embryonic and fetal development with regards to: distinguish between normal pathological ultrasound images for a transabdominal first- 39 3,19 trimester midwifery ultrasound 12 71% 3 18% 1 6% 1 6% use the principles of fetometry to estimate embryonic/fetal age in the first trimester by 41 3,21 means of transabdominal ultrasound fetometry 12 71% 2 12% 2 12% 1 6% CQN: Chronological question number QNR: Original question number 133 The descriptive statistics for round 2 indicates frequency distribution between essential and useful for elements of competency #2

93**(Figure 4.7). Figure 4.7 Descriptive statistics**

- round 2, competency #2 The element of definitive diagnosis and referral for embryonic or fetal death in the first trimester, indicated as question 23 in Table 4.8, reached 71% consensus in round 2. In round 1, question 28 in Table 4.2 reached consensus on the knowledge element of the diagnosis of single intrauterine demise. The content of CQN 23 and 28 is closely related. The loss of life can be diagnosed by a lack of cardiac activity, which is an element that the experts indicated as essential 134 for midwifery U/S (CQN 35 in Table 4.2). However, the

90**mean gestational sac diameter and crown- rump length** ratio as **a**

measurement during the early and first-trimester U/S has a high predictive value for spontaneous miscarriage (El-Mekkawi, El-Shahawy and Alyamni, 2015:17). The professional behaviour of midwives during a sensitive time, such as loss of life forms part of the core values of midwifery care (ICM, 2014:2; 2019:9). In addition, the

90**mean gestational sac and crown-rump length** are used as **measurements**

for basic embryonic biometry. After 11 weeks of gestation fetal bi-parietal diameter and the head circumference are, added as measurement parameters for fetal biometry (Mei et al., 2019:833). Experts (n=12) agreed that embryonic and fetal biometry, CQN 29 in Table 4.7, is an essential competency for midwifery U/S education and practise. The identification of the gestational sac, CQN 31, and the yolk sac, CQN 32 in Table 4.8 are important features of fetal biometry for dating. In addition, the visualisation of the gestational and yolk sac in the uterine cavity contributes to the exclusion of an ectopic pregnancy. According to Abramowicz, (2009:296), early U/S have shown to increase the diagnosis of ectopic pregnancy in Southern Africa (Abramowicz, 2009:296). Expert consensus (n=12, 71%) indicated the importance of the sonographic presentation of the gestational and yolk sac for midwifery U/S education and practice, while not reaching consensus on the evaluation of ampullary tubal and non-tubal ectopic pregnancy (CQN 20 in Addendum C). CQN 30 in Table 4.8 is another example of consensus reliability (Hasson & Keeney, 2011:1695). In the first round, as discussed in Section 4.2.2, reached 72% (n=13) experts consensus on the identification of single and multiple pregnancy with an increase to n=16 experts (94%)

105**in the second round.** As **in the** first **round, the**

experts again indicated their preference for abdominal U/S for midwives. CQN 37 and 39 referred to the transabdominal U/S of the normal and pathological imaging during the early and first trimester U/S screening, as depicted in Table 4.8. Distinguishing between normal and pathological U/S images for the early and first-trimester U/S refers to the competence of the midwife to visualise normal U/S features, and the ability to refer a person when appropriate (ICM, 2019:9). 4.3.3 Round 2, competency #3: second and third -trimester midwifery U/S Round 2, competency #3 refers to the second and third-trimester midwifery U/S. A total of 22 questions were included, of which 2 elements (9%) reached consensus in the second round (Addendum C). Both of the consensus elements were related to skill and professional behaviour. Experts (n=13, 76%) agreed that it is essential for the midwife to review the basic fetal anatomy in the second and third trimester as part of midwifery U/S. An additional n=4 experts conferred on the usefulness for midwives to be competent in fetal anatomy screening during the second and third trimesters. According to the AIUM (2018:E14) and ISOUG, (2014:14), anatomic screening is part of the basic training in obstetric and gynaecological U/S. Furthermore, the recommended time for the anatomy screening is between 18 + 0 and 20 + 6 weeks (Curado & Bhide, 2018:301) which coincides with the timeframe for the one recommended ultrasound as prescribed

76**by the Department of Health** in **South Africa** (2015:155), **and the** WHO **(2018(**

b):1). The childbearer should attend a routine antenatal visit, according to the Basic Antenatal Care plan in South Africa (SA DoH, 2016:33), between 20 – 24 weeks of gestation. As the majority (83.6%) of the South African population does not have medical aid coverage (Stats SA, 2020), midwifery management with the additional competence of antenatal U/S screening in the second and third trimesters creates the ideal opportunity to increase the limited number of antenatal U/S. The value of including the identification of the placental position, umbilical cord and amniotic fluid as discussed Section 2.7.3, and reiterated by ISUOG (2014:114) as part the basic U/S, was supported by expert consensus of 94% (n=16). The descriptive statistics for round 2, competency #3 is presented in Figure 4.8. Despite the range variance, the frequency distribution inclined toward essential and useful for the inclusion of elements for competency #3. Figure 4.8 Description of statistics - round 2, competency #3 4.3.4 Round 2, competency #4: intrapartum midwifery U/S Two elements of competency #4 reached consensus in Round 2. CQN 82 showed a 94 % consensus on the importance of the identification of the presentation, lie, position and attitude of the fetus during labour. As a skill, the U/S examination of the fetus during labour could lead to the timeous referral of malpresentation and malpositions such as posterior, brow or face presentation (ISUOG, 2018:129). Similarly to the antenatal application of the use of U/S for the identification of the placenta and amniotic fluid as in Section 4.2.3., the use of U/S during labour could capture missed opportunities for identification of placenta praevia and oligohydramnios that hold an increased risk during the intrapartum period. The descriptive statistics for round 2, competency #4 is presented in Figure 4.9. Yet again, as discussed in Section 4.2.4, transperineal U/S indicated mode preference of level 4. Figure 4.9 The descriptive statistics of round 2, competency #4 4.3.5 Round 2, competency #6: gynaecological U/S Expert consensus (n=12, 76%) was reached in Round 2 on the first competency element for competency #6. The CQN 99, as illustrated in Addendum C, is concerned with the referral of a person with a high-risk profile or abnormal findings to the appropriate healthcare professional or level of healthcare. The ICM agrees that midwives should recognise situations where care is required above expertise of midwifery care, and should implement timely and appropriate intervention (ICM, 2019:12). 4.3.6 Round 2: additional questions

14**A total of** 12 additional **questions were included in** Round 2. For **the**

task shifting theme, 2 elements reached consensus, and 1 element reached consensus for the levels of midwifery U/S education and practice in South Africa. For task shifting, the experts (n=13, 76%), indicated that the basic midwife working at primary health care level should be able to perform a basic U/S. The question was phrased by the expert's own words that the basic midwife is mostly the only person who performs a U/S, especially in rural areas, due to the shortage of appropriately qualified healthcare professionals. Furthermore, experts (n=15, 88%) expressed that the specialist midwifes should be allowed to add midwifery U/S as an additional skills set after their education, and should be allowed to train as a specialist midwife. From the data received in Round 1 (Addendum D), 89% of the experts indicated that midwives should perform U/S at level 1, with the added requirement of referral to the appropriate healthcare professional or higher level of care if the childbearer presents with high-risk indicators or abnormal findings. Therefore, it is no surprise that 88% expert consensus were reached on CQN 110 indicating midwifery U/S on level 1, with the referral of abnormal findings or high-risk indicators as a part of midwifery care (ICM, 2019:12). The descriptive statistics for round 2, related to task-shifting, is presented in Figure 4.11. CQN 102 referred to the basic midwife that should rather be encouraged to continue with routine midwifery care. The difference in opinion on the statement can be seen clustered around the two modes as bi-modal response (Figure 4.10.) Figure 4.10 Descriptive statistics - round 2, task shifting The descriptive statistics for round 2, related to the levels of midwifery U/S education and practice in South Africa, is presented in Figure 4.11. Figure 4.11 Descriptive statistics - round 2, levels of midwifery U/S education and practice in South Africa 4.3.7 Open-ended questions In Addendum D, the data of the open-ended questions for round 2 are presented. The experts contributed seven additional elements in the domain-specific open-ended questions. Competencies #5 and #6 did not reach consensus on any of the elements in rounds 1 and 2. In addition, one expert referred to the steep learning curve involved in transvaginal screening as is required for postpartum and gynaecological U/S. The expert further elaborated that if competencies #5 and #6 should be included for midwifery U/S, sufficient hours for practice should be included to reach competence. Therefore, as indicated in Table 4.9 and Addendum C, the researcher opted for a yes/no question related to the inclusion of gynaecological U/S for midwifery U/S competence. Table 4.9 Additional question for round 3, competency #6. CQN 101/ OQN 7.8, round 3 Yes No A prerequisite for including gynaecological scanning for midwifery ultrasound should only be included if sufficient hours of clinical practice can be provided to achieve competency. No additional questions were included for task shifting, level of midwifery U/S education and practice in South Africa, nor for workload distribution of midwifery U/S. 4.3.8 Round 2: feedback to the experts The researcher reported on the consensus percentage in Round 2. As motivation for completion of Round 3, elements that reached consensus were highlighted. The open-ended questions that yielded responses were acknowledged. 4.4 Round 3 The experts that completed the second round (n=17) was invited to continue with the third round. The third round yielded an 82% response rate, which contributed to a heterogeneous group of n=14 experts. There was an equal frequency distribution of seven experts in each group. In Section 3.9.2.3, the researcher indicated that an attrition rate of less than 25% is acceptable (Grove & Gray, 2019:255). The attrition rate between rounds 1 and 3 was 22%, and therefore declared to be within normal limits. The second round consisted of 81

95**closed-ended questions and** 6 **open-ended questions** across **the**

six domains of midwifery U/S competencies. One additional open-ended questions was included, as illustrated in Table 4.9. Consensus was reached on 9 (11.1%) of the elements with 2.1% incomplete answers reported. All the consensus levels were reached on level 1 of the Likert scale, indicating the essential inclusion of the elements for midwifery U/S education and practice. The consensus elements were distributed between all six of the midwifery U/S domains (general principles of sonography, early and first trimester U/S, second and third-trimester U/S, intrapartum U/S, postpartum and gynaecological midwifery U/S). After data collection, the elements were analysed for stability. Stability refers to a measure that remains stable over time (Keeney et al., 2011:91). Stability was declared on the remaining elements that did not reach consensus. The expert opinion did however, remained constant over two or three rounds (Addendum F). 4.4.1 Round 3, competency #1: general principles of sonography Round 3 contributed one consensus statement to competency #1. The identification of the normal embryology, and the maternal and fetal anatomy and physiology reached 71% consensus (n-10), as shown in Addendum C. This is supported by the ISUOG (2014:113). The importance of knowledge on physics and related instrumentation remained stable between 59% in Round 2 and 57% in Round 3. However, the inner workings of U/S is crucial as a point of departure for basic U/S training (ISUOG, 2014:114). Although experts agreed that midwives should have knowledge about the maintenance of U/S machinery, midwives do not need to have the skill thereof. Stability between rounds 1 and 2 could be interpreted that the technical skill of U/S maintenance is not applicable to midwives, or it could refer to the skill to implement a maintenance plan. Despite only one element reaching consensus in Round 3, as indicated Figure 4.12, the mode for the remaining elements was indicated as essential level 1. The descriptive statistics for round 3, competency #1, is was depicted

93**in Figure 4.12. Figure 4.12 Descriptive statistics**

- round 3, competency #1 4.4.2 Round 3, competency #2: early and first trimester midwifery U/S Consensus on the identification of normal sonographic morphology for 11 to 14 weeks gestation, as portrayed in Addendum C, confirmed the inclusion as ISUOG indicated the importance for the basic U/S. Being able to identify the normal structures will allow for referral of grossly abnormal findings (ISUOG, 2014:114). The preference of transvaginal U/S with higher resolution images, especially for the use of the gynaecological examination, was yet again reiterated by ISUOG Education Committee (ISUOG, 2014:115). As indicated in Figure 4.13, CQN 18 reached stability in rounds 1, 2 and 3 between 53% and 56% consensus on level 1 of the Likert scale. Stability Competency #2 recognise adnexal masses and distinguish between physiological and pathological. use the principles of fetometry to estimate embryo / foetal age in the first trimester by means of transvaginal ultrasound fetometry distinguish between normal pathological ultrasound images for a transvaginal first trimester ultrasound distinguish between normal and pathological ultrasound images for a transvaginal early pregnancy midwifery ultrasound chrionicity amnion selective foetal growth restriction

1**association between thickened nuchal** transparency **and** foetal **chromosomal anomalies ultrasound** findings **in the**

case of threatened abortion - fluid and funneling sonographic features of molar pregnancy subchorionic hematoma ultrasound evaluation of ampullary tubal ectopic and non-tubal ectopic normal and early embryonic development: singletons and twins criteria for a transvaginal early and first trimester ultrasound normal sonographic morphology for 5 to 10 weeks gestation 0% 10% 20% 30% 40% 50% 60% 70%

47**Round 1 Round 2 Round 3** Figure **4.** 13 Stability **round**

3, competence #2 There was a slight increase in expert opinion on the inclusion of CQN 20 (evaluation of ectopic pregnancy) from 44% in Round 1 to 50 % in Round 3. As ectopic pregnancy is the third highest direct cause of maternal death reported in 2017 (SA DoH, 2017:7), the importance of ensuring competence in the identification of ectopic pregnancies in South Africa is crucial. The opposite is true for CQN 24 (molar pregnancy) and 25 (threatening miscarriage) with a decrease in opinion for both these questions. The experts were indecisive about the inclusion of midwifery U/S for screening of genetic conditions during the first trimester. Rounds 1 and 3 both yielded a 50% response rate from the experts. The use of transvaginal U/S for distinguishing between normal and pathological findings with transvaginal U/S (CQN 40) or for the use of fetometry (CQN 42) indicated stability between rounds 1 and 2. Both questions saw an increase in expert opinion in Round 3 to a 50% response rate. The descriptive statistics for round 3, competency #2 represented a positive inclination towards the inclusion of the element for competency #2 (Figure 4.14). Figure 4.14 Descriptive statistics - round 3, competency 2# In competency #2, contrary to competency #1, the mode was dispersed around level 1 and 2 on the Likert scale. The importance of the mode in the distribution of the responses leads to the inductive conclusion that the remaining elements, although not by consensus, is either essential or useful for midwifery U/S education and practice in South Africa. 4.4.3 Round 3, competency #3: second and third trimester midwifery U/S In the last round, expert consensus on an additional 3 of competency #3 elements were given as indicated in Table 4.10. Table 4.10 Round 3 - competency #3: second and third trimester midwifery U/S (consensus elements and data distribution) CQN. OQN Round 3, competency #3 elements n Essential 1 % n Useful 2 % Potential for inclusion n 3 % Not needed n 4 % A midwife has foundational knowledge about: 46 4,1 normal sonographic morphology normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid and adnexa during fetal 55 4,8 examination in the second and third trimester 12 10 86% 71% 2 3 14% 21% 0 0 0% 0% 0 1 0% 7% A midwife has the skill and professional behaviour to: appreciate the ethical issues associated with 75 4,23 prenatal diagnostic procedures 10 71% 4 29% 0 0% 0 0% CQN: Chronological question number QNR: Original question number 147 CQN 46 refers to the detailed sonographic representation of all structures related to the second and third –trimester U/S. It is noteworthy that CQN 46 is a sub-question of CQN 13 (basic anatomy of the fetus)

104**that reached consensus in round 2. The** identification of **the** normal morphology is highlighted on the consensus on CQN 75 that relates to the ethical issues of prenatal diagnosis. As midwifery care is founded on the premise of being ethical and culturally sensitive (ICM, 2014:2), the professional behaviour and skill needed to appreciate the ethical issues related to prenatal diagnosis could be accepted as pre-existing midwifery knowledge. Knowledge about the placenta, umbilical cord and amniotic fluid and adnexa (CQN 55) indicated consensus at 72% (n=13) in round 3. However, the skill and professional behaviour only reached stability in round 3 with a stronger inclination towards favouring level 1 as the

160**mode as illustrated in Figure 4.15. Figure 4.15**

Descriptive statistics - round 3, competency #3 In total, 30 elements were included during the three rounds for competency #3, of which 30% reached expert consensus. Of the remaining 21 questions, 4 did not reach consensus or stability, as indicated in Addendum F. The biophysical profile (CQN 60) indicated the highest level of stability between all three rounds. According to ISUOG (2014), the biophysical profile is not indicated as part of the basic U/S training. Therefore, the exclusion of the biophysical profile as an element of competency #3 may be of value if experts agree on level 1 U/S education and practice for midwives in South Africa. Furthermore, the knowledge on heart, face, neck and thorax, and the skeletal structure of the fetus reached stability. These individual elements form part of the anatomy screening (CQN 70) performed during the second and third trimester, on which consensus was established in Round 2. U/S screening and evaluating the cervical condition and other related growth abnormalities which could influence preterm birth, showed a slight increase in opinion in round 3. According to ISUOG, the evaluation of fetal growth impairment is regarded as part of the basic U/S (2014:114). CQNs 62 - 66 are the elements of Doppler fetal surveillance. Despite strong evidence for the benefit of Doppler evaluation, as discussed in Section 2.3.1, experts are of the opinion that the competence should not be included for midwifery U/S education and practice in South Africa. 4.4.4 Round 3, competency #4: intrapartum midwifery U/S Consensus in Round 3, competency #4 included CQN 84 (confirmation of fetal heartbeat). ISUOG (2018:137) confirms the inclusion of the element as part of intrapartum U/S. Furthermore, CQN 79, measurement of the fetal skull during labour, was unintentionally omitted in rounds 2 or 3. As the element indicated consensus at 61%, CQN 79 was accounted for as a missed opportunity. In Figure 4.16, the stability of competency #4 is depicted. Stability Competency #4 perform a transvaginal (transperineal or translabial ultrasound to determine labour progress) normal measurements of the anatomy of the infrapubic plane normal measurements of the anatomical structures of the foetal skull during labour 0% 10% 20% 30% 40% 50% 60% 70%

47**Round 1 Round 2 Round 3** Figure **4.** 16 Stability **round**

3, competence #4 The descriptive statistics for round 3, competency #4, as illustrated in Figure 4.17. Figure 4.17 Descriptive statistics, round 3, competency #4 CQN 83, perform a transperineal U/S to determine the labour progress indicated the bi-model distribution of responses. As the use of transperineal U/S for measurements related to the labour progress is not widely practised in South Africa, the distribution of responses may be linked to inexperience with the technique. 4.4.5 Round 3, competency #5: postnatal midwifery U/S Competency #5 incorporated consensus elements for the first time in round 3, as depicted in Table 4.11. CQN 85 included consensus (n=10, 71%) knowledge of normal involution of the organs involved during the childbearing period (ICM, 2019:19). This is regarded as pre-existing midwifery knowledge. However, incorporating U/S imaging may contribute to the early identification and referral of obstetrical haemorrhage in the critical postpartum period (SA DoH, 2017:5). In addition, CQN92 reiterated referral of a high-risk person to the appropriate healthcare professional or level of healthcare. As midwifery care promotes normal physiology, timely referral with access to medical care is promoted (ICM, 2019:12). Table 4.11 Consensus round 3 – competency #5: postpartum midwifery U/S. Essential Useful Potential for inclusion Not needed CQN OQN Round 3, competency #5 elements 1 2 3 4 n % n % n % n % A midwife has foundational knowledge about: 85 6,1 normal involution of the reproductive organs after childbirth 10 71% 3 21% 0 0% 1 7% 55 4,8 normal and potential pathological ultrasound appearance of the placenta, umbilical cord, amniotic fluid and adnexa during fetal examination in the second and third trimesters 10 71% 3 21% 0 0% 1 7% A midwife has the skill and professional behaviour to: refer a person with a high-risk profile or abnormal findings to a medial healthcare 92 6,8 provider 11 79% 2 14% 0 0% 1 7% CQN: Chronological question number QNR: Original question number 152 The descriptive statistics for round 3, competency #5, as illustrated in Figure 4.18. Figure 4.18 Descriptive statistics, round 3, competency# 5 The bi-modal distribution was yet again visible, indicating the pooling of expert responses around two core opinions (Hsu & Sandford, 2007:4). CQN 89, referring to the U/S screening of the vaginal canal during the postpartum period, reporting both essential inclusion (n=5) and not needed (n=5). The evaluation of the vaginal canal may be interpreted as a part of the gynaecological U/S, which experts continuously indicated as having a low probability of inclusion for midwifery U/S education and training. Figure 4.19 depicts the stability of six elements of competence #5 during rounds 1 to 3. Stability Competency #5 intactness of anal sphincter perineal floor muscles vaginal canal uterus and adnexae review the normal of the reproductive… normal and potential pathological… 0% 10% 20% 30% 40% 50% 60% Round 1 Round 2 Round 3 Figure 4.19 Stability round 3, competence #5 CQN 88 (examining the uterus and adnexae) indicated a steady increase in opinion from the first to the third rounds. As retained placenta increases postpartum haemorrhage, U/S imaging could influence effective management to prevent postpartum haemorrhage and sepsis (Jauniaux, Putri, Vasireddy, et al., 2020:online). Furthermore, the U/S evaluation of perineal trauma that relates to CQN 86, 87, 89, 90, and 91 each resulted in an individual response of 36% in Round 3. Although it is not within the scope of a midwife to repair a third-degree tear, immediate diagnosis and referral is crucial in its management. 4.4.6 Round 3, competency #6: gynaecological midwifery U/S In addition to the one competency element that reached consensus in round 2, the researcher converted an open-ended statement into a closed-ended question that was added to competence #6, as discussed in Section 4.3.7. The question (CQN 101) asked the experts to indicate if they agreed that gynaecological U/S should not be included in the competence of midwifery U/S education and training in South Africa. The majority of experts (n=9, 64%) agreed that gynaecological U/S should not form part of the midwifery U/S competence. However, the following question (CQN 102) asked the experts to re- evaluate their statement based on the inclusion of sufficient hours of clinical practice to provide and achieve competence in gynaecological midwifery U/S. The experts (n=12, 86%) then agreed. Stability on the elements of competency #6 are indicated in Figure 4.20. The responses increased during the second round pertaining to the normal structures of the female reproductive organs. However, during the third round it stabilised below 45% in line with the remaining elements. Stability Competency #6 examine the basic pelvic floor structures… examine the uterus, ovaries and adnexa… visualize the normal structures of the… visualize the normal structure of the… the normal structures of the pelvic floor the normal structures of the uterus,… 0% 10% 20% 30% 40% 50% 60%

47**Round 1 Round 2 Round 3** Figure **4.** 20 Stability **round** 3, competence **#6.**

The descriptive statistics for round 3, competency #6, as illustrated in Figure 4.20, clearly indicate the wide distribution of response. A total of three questions are categorised as not needed according to the mode. In contrast, only two elements are indicated as essential. Figure 4.21 Descriptive statistics, round 3, competency #6. Stability of additional questions. In round 3, an increase in expert opinion indicated that experts acknowledge the limited scope of practice of the basic midwife (Addendum F). CQN 102 motivates the exclusion of the basic midwife due to their close involvement with the clinical management of 'patients'. In addition, stability in the expert's opinion indicated that the specialist midwives' should rather have the ability to integrate expertise with U/S in CQN 107. This is in support of the SOMSA report (Section 1.1) that the specialist midwife should be the applicable midwife to integrate US with practice. However, CQN 105 confirmed that irrespective of qualification, passion should be the driving force behind competence of midwifery U/S education and practice in South Africa. Furthermore, an increase in experts' opinion during round 3 of 16% on CQN116 showed a positive trend toward favouring the basic midwife for level 1 U/S and the specialist midwife for level 2 education and practice, as included in the ICM's Essential competencies for the basic midwife (ICM, 2019). As the elements relating to workload distribution was included for the first time in round 3, stability cannot be deducted. However, Figure 4.22 refers to the benefit of U/S that outweighs the workload. The benefit of midwifery ultrasound for the mother outweighs the addition to workload. CQN 114 80% 70% 60% 50% 40% 30% 20% 10% 0% 1 2 3 4 All Group B Group A Figure 4.22 Additional question related to workload distribution of midwifery U/S. Group A (midwives) are in unison regarding the benefit of U/S, despite the increase in workload. The positive attitude of midwives confirms the benefit of U/S in situations where complications were adverted in management of complication, despite the additional workload. How midwives perceive U/S as an additional skills set and the effect on the workload should be investigated in future after the implementation of an accredited midwifery U/S education programme. 4.4.7 Expert consensus reached on competence for midwifery U/S education and practice in South Africa. Based on expert consensus, a total of 52% consensus was reached in this study, which established 61 competency elements for the six competency domains for midwifery U/S education and practice in South Africa. The open-ended questions about task shifting, the level of midwifery U/S and the expert opinion on the workload distribution created a platform to start the discussion about the landscape of midwifery U/S education and practice in South Africa. A summary of each of the competency domains are illustrated in Tables 4.12 – 4.16. Table 4.12 Expert consensus on competency #1 for midwifery U/S education and practice in South Africa Competency #1: General principles of sonography Knowledge • basic maintenance of ultrasound instrumentation • ultrasound safety • infection control • the principles of knobology Skills and professional behaviour • • • anatomy and physiology of the internal organs of the female reproductive system related to the productive age apply the principles of knobology identify the normal maternal and fetal anatomy, physiology and embryology. The first domain focuses on using midwifery U/S effectively (knobology) and safely while ensuring the U/S equipment and instrumentation as an expensive and scarce resource is maintained. The functionality and longevity of the equipment will ensure increased access to quality healthcare. A further research avenue that arises from this research is the pre-requisite knowledge as a criterion for admission to a midwifery U/S programme (recognition of prior learning), or whether the anatomy and physiology component will have to be included as a refresher in the curriculum for midwifery U/S. Table 4.13 Expert consensus on competency #2 for midwifery U/S education and practice in South Africa. Competency #2: Early and first trimester midwifery U/S Knowledge • normal sonographic morphology for 11 to 14 weeks gestation • indications for an early and first trimester ultrasound • criteria for a transabdominal early and

1**first trimester** ultrasound • **components of sonographic dating in trimester**

•

1criteria for definitive diagnosis and referral of embryonic/fetal death in the first trimester

• single intrauterine demise Competency #2: Early and first trimester midwifery U/S Skills and professional behaviour • • • • • • • embryonic and fetal biometry single and multiple pregnancy gestational sac yolk sac evaluate embryotic/fetal cardiac activity and documenting determine the indication for an early or first trimester ultrasound distinguish between normal and pathological ultrasound images for a transabdominal early pregnancy midwifery ultrasound • distinguish between normal pathological ultrasound images for a transabdominal first- trimester midwifery ultrasound • use the principles of fetometry to estimate embryotic/fetal age in the first trimester using transabdominal ultrasound fetometry • refer persons with a high-risk profile or abnormal findings to an appropriate healthcare professional Competency #2, as depicted in Table 4.13, refers to a midwife's ability to ensure the appropriate use of U/S technology (ICM, 2014:2). Midwifery U/S is used to determine pregnancy viability by assessing the basic morphology of the fetus during the early and first trimester. The early identification of a singleton or multiple pregnancy, placental location and biometric measurements of age and size directly influences midwifery care. Despite expert consensus on the use of only transabdominal U/S, further investigation should be done about the applicable use of midwifery transvaginal U/S during the first trimester. Table 4.14 Expert consensus on competency #3 for midwifery U/S education and practice in South Africa Competency #3: second and third trimester midwifery U/S Knowledge • normal sonographic morphology •

1components of fetal biometry in sonographic dating in second and third trimesters

• presentation, position and attitude of the fetus in the third trimester • indications for the referral to healthcare professionals Skills and professional behaviour • • measure the basic structures to estimate the age of the fetus measure basic fetal morphology

103in the second and third trimester for the purpose of

establishing normal fetal growth • • review the basic

28fetal anatomy in the second and third trimesters

3examine the placenta, umbilical cord and amniotic fluid and

adnexa during fetal examination in the second and third trimesters • • appreciate the ethical issues associated with prenatal diagnostic procedures referral of a person with a high-risk profile or with abnormal findings to an appropriate healthcare professional Competence #3, as illustrated in Table 4.14, focuses on the use of midwifery U/S to identify normal morphology of the fetus, placenta, amniotic fluid and umbilical cord (including anatomical structures). The ethical issues related to diagnostic procedures and appropriate referral is captured within the skill and professional behaviour of midwifery U/S. The establishing of fetal age and weight directly impact midwifery care applicable to competency #4, as indicated in Table 4.15. Table 4.15 Expert consensus on competency #4 for midwifery U/S education and practice in South Africa Competency #4: Intrapartum U/S Knowledge • • • the presentation, lie, position and attitude of the fetus during labour normal and potential pathological ultrasound appearance of the placenta, umbilical cord and amniotic fluid during labour examine the position of

3placenta umbilical cord and amniotic fluid Skills and professional behaviour • • • examine the

position of

3placenta umbilical cord and amniotic fluid review the presentation, lie, position and attitude of the fetus

confirmation of a positive fetal heartbeat The application of U/S during the intrapartum period has evolved over the last decade to include more than just the identification of fetal position, placental location and the presence of a fetal heartbeat, as indicated as competencies for midwifery U/S in Table 4.15. An array of measurement are now included in the ISUOG intrapartum guidelines (ISUOG, 2018:128-139), as discussed in Section 2.7.4. As the midwife is regarded as the most appropriate SBA to attend to women during childbirth (WHO, 2011:5; ICM, 2017:1), the researcher identified intrapartum U/S as a possible niche area for midwifery U/S in South Africa. However, gynaecological U/S as contained in competency #6 in Table 4.17, should debatably not be included within the midwifery U/S field. Table 4.16 Expert consensus on competency #5 for midwifery U/S education and practice in South Africa Competency #5: postpartum midwifery U/S Knowledge • normal involution of the reproductive organs after childbirth • refer a person with a high-risk profile or abnormal findings to a medical healthcare provider Skills and professional behaviour None Elements regarding postpartum midwifery U/S is limited to knowledge about normal involution after childbirth. Knowing the sonographic imaging of normal involution will guide a midwife to appropriate referral of a person with a high risk or abnormal findings for further management. According to ISUOG (2014:115), the transvaginal U/S approach yields better results than transabdominal U/S due to the higher resolution of imaging. As experts' consensus indicated a preference to transabdominal midwifery U/S, the elements of the postpartum midwifery and gynaecological U/S (Table 4.17) should be considered for inclusion of U/S education and practice in South Africa. Table 4.17 Expert consensus on competency #6 for midwifery U/S education and practice in South Africa Competency #6: gynaecological midwifery U/S Knowledge None Skills and professional behaviour • refer a person with a high-risk profile or abnormal findings to an appropriate healthcare professional Competency #6 indicated that midwives should refer a person with a high risk or abnormal findings in need of a gynaecological U/S to the appropriate healthcare professions. As discussed in rounds 3, Section 4.4.6, experts are in agreement that gynaecological U/S should only be included in midwifery U/S if sufficient time and practice are allocated for competence. 4.5 Comparison of ISUOG basic U/S training and intrapartum guidelines with expert consensus on competence for midwifery U/S education and practice in South Africa The ISUOG is acknowledged as the international association that sets the golden standard for U/S. The ISUOG online learning module index for basic U/S training was utilised in Chapter 2 for the development of the first-round questionnaire. During the continuous process of searching for appropriate literature, the researcher incorporated the ISUOG basic U/S training recommendations (ISUOG, 2014) as well as the ISUOG intrapartum guidelines (ISUOG, 2018) in pursuing a complete representation of competency elements. As the experts in Section 4.3.6 indicated that midwifery U/S in South Africa should be equivalent to a level 1 basic U/S, the researcher set off to compare the newly concurred competencies for midwifery U/S in South Africa with the ISUOG basic U/S training recommendations in Addendum H. In addition, the ISUOG Intrapartum guidelines were included in the comparison due to the midwife being the most appropriate SBA to implement the evolving competence. The Likert scale was divided into a set of inclusion elements comprising of the combined consensus of the essential and useful categories. Furthermore, exclusion elements involved the elements pertaining to the potential for inclusion, and not needed on the Likert scale. The consensus levels were re-calculated to ensure the validity of results. In addition, the researcher aimed to identify any gaps in the competencies of midwifery U/S as caused by non-inclusion of the elements in the three questionnaires. The comparison yielded the following report as depicted in Table 4.18. Table 4.18 Comparison of ISUOG basic U/S training and consensus of midwifery U/S education and practice in South Africa ISUOG basic U/S recommendation Competencies for midwifery U/S education and practice in South Africa. Basic physical principles Of 8 elements, 7 were included in competency #1 U/S artefacts were not described in competency #1

34**Theoretical teaching of the basics of diagnostic** U/S Of **the**

6 elements, 4 were included in competency #1 The elements not included referred to informed consent, image recording and storing, quality control and statistical tests to describe screening. First-trimester U/S Of the 9 elements, 8 were included in competency #2. The interpretation of serum human gonadotropin and progesterone in pregnancy of unknown location was not included in the questionnaire. Second and third-trimester U/S All elements were included in competency #3. Intrapartum U/S Of the 8 elements, 4 were included in competency #4 The elements referred to the indications for U/S, and the new generation measurements as indicated in Addendum H. Gynaecological U/S Most elements were not well described in the questionnaire or consensus could not be obtained. General skills Of the 11 elements, 9 elements were included. The elements not included were awareness of consent, and storing of data, as previously mentioned. The triangulation of the expert consensus elements in Chapter 4 created the opportunity for further triangulation of the proposed midwifery U/S competence with the ISUOG's recommendations and guidelines (ISUOG, 2014 & 2018). The comparison allowed for the identification of gaps in the knowledge about the competence of midwifery U/S in South Africa. With minor adjustments to mostly competency #1, which refers to the general principles of sonography, the overview of consensus elements for midwifery U/S in South Africa mostly compares with the international standard for basic U/S. Two grey areas occurred within the boundaries of midwifery U/S in South Africa. The first is the possible addition of intrapartum U/S elements as arguably not part the basic U/S. The second is a stronger inclination toward the exclusion of gynaecological U/S due to the difficulty of reaching competence. 4.6 Concluding remarks The experts reached consensus for the essential inclusion of elements within six competency domains for midwifery U/S education and practice in South Africa. With minor differences, the competency elements that were indicated as essential or useful for inclusion collectively compared with ISUOG's basic U/S training recommendations and could therefore be determined as valid for the use of curriculum development. In Chapter 5, the researcher reflects on the implementation of the research design and technique, identifies gaps in the knowledge, and recommends further research pathways. Chapter 5 Conclusion 5.1 Introduction The conceptual framework set out in Chapter 1 of this study illustrated that SOMSA endorses

7the ICM’s philosophy and model of care. The ICM’ s philosophy and model of

care are more than just the foundation for midwifery care. The ICM is the benchmark for midwifery with regard to education, regulation and practice, which could fill the void of leadership in this regard in many countries. SOMSA not only supports the ICM’s ideology but sets the example for midwives to strive for competence instead of mediocrity in South Africa. For the researcher, as a midwife actively practising her profession as an independent specialist midwife according to the

7ICM’s philosophy and model of care, the

benefits of U/S has been tangible in many situations. In the current age of the 4IR, the appropriate use technology in midwifery care sparked a personal interest. The absence of an accredited and regulated midwifery U/S programme in South Africa became the impetus for this study. As discussed in Chapter 2, a compelling body of knowledge confirms a range of benefits of U/S, its ease and quality of knowledge transfer, as well as the ability of midwives to become competent U/S practitioners. However, U/S education for midwives remains unaccredited and unregulated in South Africa, despite the implementation of midwifery U/S by various provinces in the public health domain. In a bid to ensure quality education, the researcher, also a midwife educator, set out to create an accredited midwifery U/S programme that would be able ensure midwifery competence applicable to the South African context. However, an obstacle to accreditation was the absence of consensus

97on the applicable competencies for the midwifery scope of practice. The discovery of

this crucial gap in knowledge informed the research problem, which

101led to the following research question: What is the

consensus on competencies for midwifery U/S education and practice in South Africa? The objectives that emerged from the research question were the following: • • Identify from literature competencies for midwifery U/S education and practice. Compile a list of competencies for midwifery U/S education and practice in the continuum of female reproductive health. • Describe the competencies for midwifery U/S education and practice as validated by expert opinion. The research question guided the

85research design and technique used to obtain the research objectives. A modified e -Delphi

technique as the best applicable consensus method was utilised to gather data needed for consensus, as discussed in Section 3.3. Within the quantitative design, the consensus level was determined at 70% of the expert opinion on a given element. The sample population was well defined to include the highest obtainable category of experts in South Africa within the field of U/S. The experts represented a national heterogeneous group that included both midwives and traditional healthcare professionals (Section 3.4). As no competencies for midwifery U/S education and practice in South Africa were available, the researcher set forth to compile a comprehensive list of elements from literature related to U/S. The result was a first-round questionnaire that comprised of six competency domains with 91 elements. Two

80open-ended questions that emerged from the literature were included to probe the

experts on how midwifery U/S would fit into the context of South African healthcare. The iterative process of the three rounds with open-ended questions contributed to the addition of 27 questions that increased the number of elements to 118. The modified e-Delphi lent itself to electronic data collection, which in the year of 2020 with the SARS-CoV-2 pandemic was a blessing in disguise. The data collected during the three rounds were analysed, and the findings were presented in Chapter 4. In this chapter, the researcher summarises the research findings and contributions that emerged from seeking expert consensus about midwifery U/S practice and education. The limitations of the study are acknowledged followed by suggestions for future research. The researcher then 167 shares ideas related to dissemination of the findings, and lastly, offers her reflections and concluding remarks about the journey in reaching the aim of this study. 5.2 Summary of findings Consensus was reached on 54 elements included in five of the six competency domains. Although the researcher set out to determine consensus on six domains as was highlighted in the literature, gynaecological U/S reached consensus on only one element (referral of a person with high risk or abnormal findings). Therefore, this domain was excluded from the final consensus competencies for midwifery U/S education and practice in South Africa (refer to Table 5.1). Experts indicated that gynaecological U/S should not form part of midwifery U/S education and practice in South Africa. However, gynaecological U/S is part of the ISUOG's basic U/S recommendations (2014:115). It is noteworthy that experts indicated that only with sufficient clinical practice should competence in gynaecological U/S be reconsidered for midwifery U/S. The current organisation within different levels of health care in South Africa, separate midwifery and gynaecological care and as such could be a possible reason for the exclusion by the experts. The experts indicated that the basic midwife who practices at primary healthcare settings should be able to perform a level 1 U/S. In addition, experts agreed that the specialist midwife should be able to pursue midwifery U/S as an additional competency after their formal training. Furthermore, the experts' opinion was to restrict midwives to the utilisation of transabdominal U/S in the following five competency domains, as

153**summarised in Table 5.1. Table 5.1 Summary of**

midwifery U/S competency domains for education and practice in South Africa Five midwifery U/S competency domains Summary of elements #1 General principles for sonography • • Principles of knobology, basic maintenance of U/S equipment, safety and infection control. Related normal and abnormal maternal, embryonic and fetal anatomy and physiology #2 Early and first trimester U/S • • • Evaluation of normal and abnormal morphology of an in-utero positioned single/multiple embryo or fetus (including pregnancy viability) Fetometry to determine embryonic/fetal age. Timely and appropriate referral of a high risk or abnormal finding. #3 Second and third- trimester U/S • • • • • Evaluation of basic fetal anatomy screening. Evaluate fetal age and growth Examine placental, umbilical cord, amniotic fluid and adnexa. Ethical issues related to prenatal diagnosis Timely and appropriate referral of a high risk or abnormal finding. #4 Intrapartum U/S • • Confirm fetal heartbeat, position, lie and attitude Evaluate placental, umbilical cord and amniotic fluid for position and pathological appearance #5 Postpartum U/S • • Identify normal involution of reproductive organs after childbirth. Timely and appropriate referral of high risk or abnormal finding. The general principles, early and first-trimester, and second and third-trimester U/S as midwifery competency domains are included in the internationally recognised ISUOG's basic U/S training (2014:113-116). The postpartum midwifery U/S competency is not necessarily described within intrapartum U/S, and an inclination towards inclusion as part of gynaecological U/S screening seems to be more appropriate. However, intrapartum U/S is described in ISUOG's basic U/S training (2014:114) as an extension of the competence into the birth room. It is only with the ISUOG's guidelines to intrapartum U/S (2018:128-139) where the specific competency elements are described. In this study, it became clear that intrapartum U/S elements have evolved far beyond the general identification of fetal, placental and amniotic features. The inclusion of transperineal measurements, such as AOP and SHD, would have a remarkable impact on the way midwives implement care during labour. Transperineal progression of labour is supported by the ICM's philosophical principle of technologically appropriate and non-intervention of midwifery care. More importantly, compelling evidence indicates that transperineal progression of labour is preferred by the childbearer. The midwife is the most appropriate care provider to render care during the childbearing period, (WHO, 2018[b]:2) and the ICM (2014:1). In addition to being the only healthcare professional continuously present for intrapartum progression of labour in all birth settings, the midwife can effectively utilise the full spectrum of intrapartum U/S as described by ISUOG (2018). The use of intrapartum U/S should be in the hands of the most appropriate care provider during childbirth, where the highest access of care will ensure the greatest benefit for the childbearing family. As discussed in Section 2.3.1 the systemic disempowerment of midwives and midwifery most probably contributed to the global underutilisation of intrapartum U/S, to the detriment of all involved. The same systemic injustice spilled over into the South African healthcare system, from where midwives and woman were excluded from the benefit of intrapartum U/S as a non-intrusive modality. Figure 5.1 depicts a synopsis of the research and the findings. Figure 5.1 Synoptic representation of the research and findings. Figure 5.1 represents an overview of the process that

56**led to the** discovery **of the research** findings. As discussed **in Section**

4.5, and indicated in a comprehensive comparison in Addendum H, the ISUOG basic U/S training recommendations and intrapartum U/S guidelines are comparable to the competencies for midwifery U/S education and practice in South Africa. The implication would be a midwifery U/S curriculum that is of international standard for a low-to-middle income country, such as South Africa. 5.3 Summary of contributions This research established five competencies for midwifery U/S education and practice that can be instrumental in curricular development in South Africa. In addition, with minor additions to the elements contained in the five competency domains, the competencies for midwifery U/S education and practice are comparable to ISUOG's internationally recognised basic U/S and intrapartum U/S training programme. Therefore, it is possible for other low-to-middle income countries to adapt the South African midwifery U/S competencies in their healthcare context. As the five midwifery U/S competencies are the first of its kind in South Africa, it could be adjusted into a quality-control instrument to measure the standard of midwifery U/S education and practice. The instrument could be used for self-evaluation or for determining of the proficiency level of competence.

9**Although it was not the aim of the study to determine**

the landscape in which midwives should practice U/S in South Africa, the additional questions on which the experts offered their opinion gave a sense of direction for further research. Expert opinion on the level of midwifery U/S education and practice is reported in the findings. This study's generation of new knowledge may serve the planning of curricular development and may contribute to further research on the subject. Another contribution of the research findings was the consideration of the potential increased workload for midwives. Intrapartum midwifery U/S as a diagnostic tool, fits perfectly in intrapartum midwifery care. As U/S has only been introduced to selected midwives during the last two decades as an unregulated and unaccredited skills set, the majority of midwives might not be aware of the benefit of transperineal U/S during labour. This study was able to show the benefit of a known intrapartum U/S skills set, and highlight the additional measures that could benefit intrapartum care for women congruent with the ICM

6**Philosophy and Model of Care (ICM, 2014:1-**

2). 5.4 Limitations The questionnaire was developed on a four-level Likert scale with the third level descriptor as a potential for inclusion. Although the data analysis did not yield any evidence that the level descriptors influenced the consensus, the researcher questioned the likelihood of experts choosing the third descriptor if it had been described with a stronger negative connotation, for example, 'potential for exclusion'. A descriptive study using a Delphi technique could be considered by some critics as a reduced level of research (Grove & Gray, 2019:43; Hohmann et al., 2018:3281). Descriptive studies provide appropriate knowledge and serve as the basis for generating further research. Despite the criticism against the Delphi technique, the modified e-Delphi technique is a flexible and adaptable method (Hsu & Sandford, 2007:6) which served the research with the best possible outcome in a time where national lock-down and quarantine measures could have disrupted data collection. The iterative rounds as a key feature of the Delphi technique were arguably the main contributor to the depth of data that was collected regarding task shifting, level of U/S training and the workload distribution. Furthermore, in the South African context where no agreement was existed, the egalitarian solution was the use of an online meeting of experts, such as the modified e-Delphi. The researcher identified a gap in the knowledge related to gynaecological U/S competence. However, the first round questionnaire was not comprehensive in capturing the essence of the gynaecological U/S. Due to the elements of gynaecological U/S competence that was not well defined, the question arose whether the opinion of the experts relating to the exclusion of gynaecological U/S would have been altered. 5.5 Future research pathways The current research is one step on the road to the accreditation and regulation of midwifery U/S in South Africa. Apart from establishing the five competencies for midwifery U/S, several research pathways emerged from the study that may strengthen midwifery U/S education and practice. Future research pathways are: • • Determine the landscape in which midwives should be able to practice U/S in South Africa. Determine the inclusion of postpartum and gynaecological U/S as part of midwifery U/S education and practice in South Africa. • Describe the midwives' opinion regarding the inclusion of U/S as an addition to the midwifery care skills set. • Compare the competence of midwifery U/S to that of traditional healthcare professionals in South Africa. • • • • • Determine the integration of midwifery U/S in the workload of the different levels of care. Compare the findings of vaginal examination and intrapartum midwifery U/S during labour. Determine the barriers to intrapartum midwifery U/S in South Africa. Evaluate the implementation of intrapartum midwifery U/S in South Africa. Determine the impact of intrapartum midwifery U/S on referral, identification of obstetrical emergencies and the perinatal mortality rate. • • • • Determine the childbearer's and midwife's experience of intrapartum U/S. Evaluate the diagnostic accuracy of midwives U/S fetal morphology evaluation. Develop an accredited midwifery U/S curriculum and programme. Critique the contribution of midwifery U/S competence to

6**maternal and** child **health in South Africa** Intrapartum midwifery care **is**

the personal driving force and passion of the researcher. Ensuring a positive childbirth experience while rendering individualised, sensitive and culturally congruent care has been a lifelong passion and learning curve for the researcher. Therefore, midwifery intrapartum U/S as an addition to midwifery U/S competence is a personal calling for further research. 5.6 Suggestions for dissemination of research findings The research findings will be shared with SANC

50**as the regulatory body for** midwifery **and** a stakeholder in **midwifery education**

in South Africa. As midwifery U/S was identified as a mandate within the strategic objectives of SOMSA, with a working group allocated to it, the research findings will be shared with the professional association. The NCCEMD, as a ministerial committee, advises the Minister of Health on issues related to maternal health. Therefore, in the interest of effecting change to the regulation of midwifery U/S in South Africa, the researcher will direct feedback via the National Department of Health and SOMSA to the NCCEMD. The

12research findings will be presented at conferences and

congresses such as the Perinatal Priorities, SOMSA, ICM, and the Sensitive Midwifery Symposium. In addition, the researcher, in association with the supervisors of this research has planned various articles for possible publication. In addition to publications, the researcher has planned to embark on further research to support midwifery U/S education and practice in South Africa. 5.7 Critique As an adult midwifery scholar, the researcher has embraced lifelong learning. The journey of completing this research empowered the researcher in her personal and professional development which started as a novice and has evolved to a multilevel classification of competence. At the beginning of the process, experienced researchers attempted to motivate the researcher by indicating that the aim of a Magister degree is not to change the world, but merely to demonstrate the ability to perform research. On a personal level, it was a passion for midwifery and belief in the change that the findings may hold that led to the completion of the study. Indeed, we need to change the world of midwifery in the changing world, to the benefit of the childbearing family. During the evolving personal and professional development throughout the journey, the researcher became more aware of the impact of the systemic disempowerment of women and midwives. This was most eminent in the underutilisation of midwifery U/S, more specifically intrapartum U/S. Retrospective reflection illuminated the confounding importance of advocacy for the ICM's core elements of midwifery care to the benefit of the childbearing family. Hence, the inclusion of an opportunity for experts to give their opinion on the barriers brought by the systemic disempowerment, would have provided insight to enhance utilisation of midwifery U/S in South Africa. The researcher started the journey with the notion of employing the help of a biostatistician for data management and analysis. However, working side by side with an independent statistical expert instead of the biostatistician abled the researcher to engage with the data with greater awareness and a deeper understanding of the descriptive statistics applied to this study. If allowed the opportunity to continue with research, the same route for data analysis would be preferable. Although sometimes a daunting task, the process was an enriching experience. 5.8 Conclusion This study yielded a comprehensive set of five midwifery U/S competencies – a first for South Africa. The competencies could be used as the foundation for curricular development or as a catalyst for further research and implementation on the topic. The WHO (2018[b]:2) urges stakeholders to plan for the introduction of the U/S during antenatal care. Policymakers should provide a conducive environment for the exploration of U/S to ensure universal access for the benefit of reducing maternal and child morbidity and mortality (Luntsi et al. 2020:5). As a passionate midwifery scholar, the researcher, through this research journey arrived at an absolute credence that childbearing families are disadvantaged by the exclusion of midwifery U/S from maternal health care. This reality is even more atrocious in the changing world we live in. With the 4IR, the world of midwifery care could be revolutionised for the childbearing family. By using a diagnostic tool such as U/S we as midwives can contribute to non-intrusive midwifery care and thereby respect the confounds of the profession and women. Ultimately, U/S belongs to the women. The findings of this research have surpassed any possible expectations that the researcher could have foreseen. The journey of completing this study has taken the researcher on long winding roads, high peaks of expectation and dark places of despair. One clear and consistent truth remained: The LORD is my shepherd; He supplied all my needs. When my mind and body could not carry me any further, He made me rest in pastures green, to walk beside still waters. Today I can rejoice for He has restored my soul. The paths on which I walked and the steps I plan to take is only in His name's sake. I am not afraid; my Father comforts me. Even in the presence of enemies, He has kept not only me, but also my loved ones safe. He anointed my head with oil and has filled my cup with measures I cannot contain. My Father's ways are kind and true. His goodness and mercy follow me, always. My prayer is to dwell in the house of my Father, forevermore. – Adapted from Psalm 23 Reference list Abramowicz, J.S. 2013. Benefits and risks of ultrasound in pregnancy. Seminars in Perinatology, Vol.37(5):295-300. 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Passport / Passeport

REPUBLIC OF SOUTH AFRICA / REPUBLIQUE D'AFRIQUE DU SUD

Type / Type: PA

Country code / Code du pays: ZAF

Passport No / No du passeport: A08637255

Surname / Nom: HUMAN

Given names / Prénoms: CHARNÉ ELOISE

Nationality / Nationalité: ZAF

Date of birth / Date de naissance: 23 OCT 1979

Sex / Sexe: F

Place of birth / Lieu de naissance: ZAF

Date of issue / Date de délivrance: 08 JUL 2019

Date of expiry / Date d'expiration: 07 JUL 2029

Identity No / No d'identité: 7910230014089

Authority / Autorité: DEPT OF HOME AFFAIRS

Holder's signature / Signature du titulaire

ZAF SA 68453

PAZAFHUMAN<<CHARNE<ELOISE<<<<<<<<<<<<<<<<<<<
A086372550ZAF7910236F29070777910230014089<60

REPUBLIC OF SOUTH AFRICA
NATIONAL IDENTITY CARD

Surname: HUMAN

Names: CHARNÉ ELOISE

Sex: F

Nationality: RSA

Identity Number: 7910230014089

Date of Birth: **23 OCT 1979**

Country of Birth: RSA

Status: CITIZEN

Signature:

DRIVING LICENCE
BESTUURSLISENSIE
CARTA DE CONDUCAO

SADC ZA

SOUTH AFRICA

CE HUMAN

ID No.: 02/7910230014089 FEMALE

Birth/Geboorte: 23/10/1979 ZA Restr./Beperk.: 0,0

Lic. No./Lisensienr.: 30040008T8XJ No.: 1

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