OVERWEIGHT, OBESITY AND ASSOCIATED RISK FACTORS IN THE SOUTH AFRICAN AIR FORCE, BLOEMFONTEIN

Submitted by

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Declaration

I declare that the dissertation hereby submitted by me for the MSc Dietetics degree presented by the University of the Free State is my own work and has not previously been submitted by me to another university or faculty. I further cede copyright of this research report in favour of the University of the Free State.

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Table of Contents

ACKNOWLEDGEMENTS I

TABLE OF CONTENTS II

LIST OF TABLES IV

LIST OF ABBREVIATIONS V

SUMMARY VI

CHAPTER 1 INTRODUCTION 1

1.1 INTRODUCTION 4
1.2 PROBLEM STATEMENT 4
1.3 RESEARCH QUESTION 4
1.4 RESEARCH AIM 4
1.5 RESEARCH OBJECTIVES 5
1.6 STRUCTURE OF THE DISSERTATION 5
1.7 REFERENCES 5

CHAPTER 2 LITERATURE REVIEW: OVERWEIGHT AND OBESITY - IT'S CAUSES AND CONSEQUENCES 8

2.1 INTRODUCTION 8
2.2 AETIOLOGY OF OVERWEIGHT AND OBESITY 8
2.2.1 Genetic predisposition 8
2.2.2 Gender 8
2.2.3 Age 10
2.2.4 Hormonal regulation of appetite 11
2.2.4.1 Leptin 12
2.2.4.2 Insulin 12
2.2.4.3 Ghrelin 13
2.2.5 Energy intake and expenditure 13
2.2.6 Physical activity 13
2.2.7 Socio-economic factors 14
2.2.8 Tobacco use 15
2.2.9 Sleep deprivation 16
2.2.10 Alcohol intake 16
2.2.11 Stress 18
2.2.12 Disease Conditions 18
2.3 HEALTH IMPLICATIONS OF OVERWEIGHT AND OBESITY 19
2.3.1 Cardiovascular disease 20
2.3.2 Hypertension 21
2.3.3 Type 2 Diabetes Mellitus 22
2.3.4 Malignancies 23
2.3.5 Obstructive sleep apnoea 24
2.3.6 Osteoarthritis 25
2.4 CONCLUSION 25
2.5 REFERENCES 26

CHAPTER 3 METHODOLOGY 34

3.1 INTRODUCTION 34
3.2 STUDY DESIGN 34
3.3 PARTICIPANTS AND SAMPLE SELECTION 35
3.4 SAMPLING 35
3.4.1 Inclusion criteria 35
3.4.2 Exclusion criteria 35
3.5 STUDY PROCEDURES 37
3.6 TIME SCHEDULE 38
3.7 MEASUREMENTS AND TECHNIQUES 39
3.7.1 Socio-demographic factors 39
3.7.2 Anthropometry 39
3.7.2.1 Weight 39
3.7.2.2 Height 40

3.7.2.3 Waist circumference 40
3.7.2.4 Body mass index 41
3.7.3 Contributing risk factors associated with the development of overweight or obesity 43
3.7.3.1 Dietary intake 43
3.7.3.2 Physical activity 44
3.7.3.3 Sleep deprivation 45
3.7.3.4 Alcohol intake 45
3.7.4 Health conditions associated with overweight and obesity 46
3.7.5 Validity and Reliability 46
3.7.5.1 Validity and reliability of anthropometric measurements 46
3.7.5.2 Validity and reliability of the contributing risk factors associated with the development of overweight or obesity questions 47
3.7.5.3 The validity and reliability of health conditions questions 49
3.8 Ethical considerations 49
3.9 Statistical analysis 50
3.10 Limitations of the study 50
3.11 Conclusion 51
3.12 References 51

CHAPTER 4 OVERWEIGHT, OBESITY AND THE PREVALENCE OF LIFESTYLE DISEASES AT THE AIR FORCE BASE BLOEMSPRUIT 54

4.1 Abstract 54
4.2 Introduction 54
4.3 Methods 55
4.3.1 Study design, sample size and ethical approval 55
4.3.2 Data Collection 56
4.3.3 Statistical Analysis 57
4.4 Results 57
4.5 Discussion 57
4.6 Conclusion 62
4.7 Acknowledgements 66
4.8 References 67

CHAPTER 5 DOES LIFESTYLE CHOICES INFLUENCE THE DEVELOPMENT OF OVERWEIGHT AND OBESITY IN THE SOUTH AFRICAN AIR FORCE? 72

5.1 Abstract 72
5.2 Introduction 72
5.3 Ethical Considerations 74
5.4 Methods 75
5.5 Statistical Analysis 77
5.6 Results 85
5.7 Discussion 89
5.8 Conclusion 90
5.9 Acknowledgements 90
5.10 References 95

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS 95

6.1 Introduction 95
6.2 Overweight, obesity and the prevalence of lifestyle diseases in the South African Air Force 95
6.3 Does lifestyle choices influence the development of obesity in the South African Air Force 96
6.4 Limitations of the study 98
6.5 Research Application 98
6.6 References 99

APPENDIX A APPROVAL LETTER 1 MILITARY RESEARCH ETHICS COMMITTEE 104

APPENDIX B APPROVAL LETTER FROM HEALTH SCIENCES RESEARCH ETHICS COMMITTEE 105

APPENDIX C INFORMATION DOCUMENT AND INFORMED CONSENT 106

APPENDIX D QUESTIONNAIRES 108

APPENDIX E SOUTH AFRICAN JOURNAL OF CLINICAL NUTRITION AUTHOR GUIDELINES 119

APPENDIX F AFRICAN JOURNAL OF PRIMARY HEALTH CARE AND FAMILY MEDICINE AUTHOR GUIDELINES 124

REFERENCE LIST 128

List of Tables

TABLE 3-1: TIME SCHEDULE FOR CONDUCTING THE STUDY 37
TABLE 3-2: GENDER-SPECIFIC WAIST CIRCUMFERENCE AND RISK OF METABOLIC COMPLICATIONS ASSOCIATED WITH OBESITY IN CAUCASIANS (WHO, 2000: 11) 41
TABLE 3-3: CLASSIFICATION OF ADULT WEIGHT STATUS ACCORDING TO BODY MASS INDEX (WHO, 2000:8) 42
TABLE 4-1: BODY MASS INDEX 58
TABLE 4-2: RISK OF METABOLIC COMPLICATIONS ACCORDING TO WAIST CIRCUMFERENCE IN RELATION TO WEIGHT STATUS 58
TABLE 4-3: SOCIO-DEMOGRAPHIC INFORMATION OF PARTICIPANTS IN RELATION TO THEIR WEIGHT STATUS . 59
TABLE 4-4: SELF-REPORTED HEALTH CONDITIONS ACCORDING TO BMI CATEGORIES 61
TABLE 5-1: CLASSIFICATION OF ADULT WEIGHT STATUS ACCORDING TO BMI 75
TABLE 5-2: RISK OF METABOLIC COMPLICATIONS WITH RESPECT TO WAIST CIRCUMFERENCE 76
TABLE 5-3: FREQUENCY OF CONSUMPTION OF DIFFERENT FAT SOURCES IN RELATION TO BMI 78
TABLE 5-4: FREQUENCY OF CONSUMPTION OF SUGARY FOODS AND DRINKS 81
TABLE5-5: MEAL FREQUENCY ACCORDING TO BMI CATEGORIES 82
TABLE 5-6: FRUIT AND VEGETABLE INTAKE ACCORDING TO THE BMI CATEGORIES 83
TABLE 5-7: STRESS, SLEEP AND SMOKE PATTERNS ACCORDING TO BMI 84
TABLE 5-8: PHYSICAL ACTIVITY ACCORDING TO BMI CATEGORIES 85

List of Abbreviations

AgRP	Agouti Related Protein
ARC	Arcuate nucleus (ARC)
BBS	Bardet-Biedl Syndrome
BMI	Body Mass Index
EE	Energy expenditure
FTO	Fat mass and obesity-associated
IL-6	Interleukin-6 (IL-6).
Kg/m^2	Kilogram per meter squared
LPL	Lipoprotein Lipase
MC3R	Melanocortin 3 Receptor
MC4R	Melanocortin 4 Receptor
NCD	Non-Communicable Disease
NPY	Neuropeptide Y
OECD	Organization for Economic and Co-operation Development
PC1	Proprotein convertase 1
POMC	Pro-opiomelanocortin
SAHDS	South African Health and Demographic Survey
SANHANES	South African National Health and Nutrition Examination Survey
Sim-1	Single-Minded 1
SLC6A14	Sodium- and chloride-dependent neutral and basic amino acid transporter B
TNF-Alpha	Tumour Necrosis Factor-Alpha (TNF-alpha)
USA	United States of America
VO2 Max	maximum oxygen uptake
WAGR	Wilms Tumour Aniridia Syndrome
WHO	World Health Organization

Keywords: Overweight, Obesity, Anthropometry, Body Mass Index, Energy intake, Lifestyle diseases, Behaviour, Socio-demographic factors, Physical Activity

Summary

The prevalence of overweight and obesity has grown to epidemic proportions during recent decades, while this increase does not seem to be slowing down. Various factors influence the development of overweight and obesity, including socio-demographic factors, dietary intake and behaviour such as sleep deprivation, alcohol intake and energy expenditure. A strong link between overweight and obesity and the development of numerous chronic conditions has also been clearly demonstrated in the literature. These conditions include cardiovascular disease, hypertension, Type 2 diabetes mellitus, malignancies, obstructive sleep apnoea and osteoarthritis. In this study, the prevalence of overweight and obesity, as well as the association between the above-mentioned risk factors and health consequences of overweight and obesity, was investigated at Air Force Base Bloemspruit, Bloemfontein (AFB Bspt).

A cross-sectional descriptive study, conducted on 166 (136 male and 30 female) uniformed volunteers from AFB Bspt, aged 23 to 59 years, took place at the various units situated at AFB Bspt, including Base Head Quarters, 506 Protection Squadron, 87 Helicopter Flying School, 16 Squadron and 6 Air Support Unit. Participants completed a self-administered questionnaire which reported on socio-demographic-, behavioural-, and dietary factors as well as physical activity. Physical activity was determined by means of the self-administered International Physical Activity Questionnaire (IPAQ) Short Form. Standard measuring techniques were used to determine weight, height and waist circumference. Waist circumference was evaluated by means of the World Health Organization (WHO) gender-specific cut-off points for the evaluation of metabolic complications. Body Mass Index (BMI) was calculated using weight and height and classified, using the WHO BMI cut-off points, as either underweight or normal weight, overweight or obese.

The prevalence of both overweight and obesity was high in the current study, which is in line with national and global trends. As expected, a statistically significant relationship was identified between waist circumference and the different BMI categories. Literature supports a relationship between overweight and obesity and ageing. Although not significant, the median age of participants showed a slight increase from normal weight to overweight and obesity. Socio-demographic factors investigated in this study included gender, ethnicity, rank, marital status and educational attainment. Although the relationship between these factors and overweight and obesity is clearly described in the literature, no statistically significant differences were identified in the current study. Also, no significant differences were identified regarding reported health conditions across BMI categories.

Dietary factors including high intakes of fat and sugar, low intake of fruits and vegetables, meal frequency and number of meals consumed outside the home have been associated with overweight and obesity, however, in the current study, no significant associations were identified. It is concerning

that the majority of participants do not consume the recommended amount of fruit and vegetables daily.

Behavioural aspects including perceived stress, sleeping patterns and tobacco and alcohol use were also investigated. Almost two-fifths of participants identified themselves as moderately stressed, while almost half of the participants identified themselves as highly stressed individuals. Approximately 80% of participants reported more than seven hours of sleep per night. Most respondents were non-smokers. No statistically significant differences were identified between behavioural aspects investigated across BMI categories.

High levels of physical activity were reported. Obese individuals had the highest median for moderate physical activity, while all BMI categories had the same median for vigorous physical activity. The maximum number of hours spent on moderate and vigorous physical activity for one individual was observed in the overweight category, where 42 hours per week was reported for each. No statistically significant differences were identified for physical activity with regard to BMI categories.

Future studies should aim to include a larger number of participants, from different military bases in other geographic areas in South Africa. A more detailed evaluation of anthropometric status, including waist-hip ratio and body composition assessment, should be considered. Questionnaires should be completed through structured, individual interviews by qualified researchers to allow for more in-depth assessment and to ensure that questions are well understood. This study provides valuable information regarding the high prevalence of overweight and obesity in the study sample, as well as low fruit and vegetable intakes that should be addressed in order to improve the health and wellbeing of the military community at AFB Bspt.

Chapter 1

Introduction

1.1 Introduction

Globally, overweight and obesity has increased substantially during recent years (Horaib *et al*., 2013: 402; Organization for Economic Co-operation Development (OECD), 2017: 4) and current projections by the OECD estimates that these statistics will continue to increase until at least 2030 (OECD, 2017: 8). Overweight and obesity are defined by a Body Mass Index (BMI) of equal and more than 25 kg/m^2 and 30 kg/m^2 respectively (World Health Organization (WHO), 2000: 9).

As reported by Stevens *et al*. (2012:4), the global prevalence of obesity has increased from 6.4% in 1980 to 12.0% in 2008. Half of this increase took place between 1980 and 2000 while the rest occurred between 2000 and 2008 (Stevens *et al*., 2012: 4). This indicates that the incidence of overweight and obesity has increased from 572 million adults in 1980 to an alarming 1.46 billion adults in 2008, of whom approximately 508 million were obese (Stevens *et al*., 2012: 4). WHO figures from 2014 show that globally, 39% of adults aged 18 years and older were classified as being overweight, while the prevalence of obesity had nearly doubled between 1980 and 2014 with 11% of men and 15% of women being classified as obese (WHO, 2015: 11). Another study performed by the Non-Communicable Disease (NCD) Risk Factor Collaboration, assessing 1 698 studies which included 19.2 million participants over 200 countries, showed similar trends with the mean BMI in men increasing from 21.7 kg/m^2 in 1975 to 24.2 kg/m^2 in 2014 (NCD Risk Factor Collaboration, 2016: 1379). In women, the mean BMI increased from 21.1 kg/m^2 to 24.4 kg/m^2 during the same time period (NCD Risk Factor Collaboration, 2016: 1379). This study also reported that the increase in obesity has slowed down in high-income countries. The prevalence of obesity has increased in low-income countries, which means that the growth in the global prevalence of obesity has not slowed down after 2000 (NCD Risk Factor Collaboration, 2016: 1389).. More recent figures from the WHO fact sheet on obesity, which was reviewed in February 2018, states that obesity has tripled since 1975 and that the prevalence of overweight has increased to exceed 1.9 billion adults, aged 18 years and older, which constitutes 39% of the global adult population. More than 650 million adults were classified as obese in 2016 which constitutes 13% of the global adult population (WHO, 2018: online). A global increase in the age-standardised prevalence of obesity occurred from 24.6% in 1980 to 34.4%, 28 years later (Stevens *et al*., 2012: 4). This trend was also reported in South Africa between 2008 and 2012, with an increase in BMI of 1.57 kg/m^2 per decade (Cois & Day, 2015: 5), with women showing the highest prevalence of obesity (Stevens *et al*., 2012: 4). Women were also found to have the highest prevalence of obesity in South Africa during 2015 according to the OECD Obesity Update published in June 2017 (OECD, 2017: 5). In South Africa, it is reported from data collected between 2008 and 2012, that women had an increase of 1.82 kg/m^2 in BMI per decade, while men showed an increase of 1.03 kg/m^2 per decade (Cois & Day, 2015: 5). The South African National Health and Nutrition Examination Survey (SANHANES), published in 2013, showed that overweight and obesity has increased significantly in the South African setting.

The prevalence of overweight in females has increased to 24.8% and 39.2% for obesity, while males showed a prevalence of 20.1% for overweight and 10.6% for obesity (Department of Health, 2013: 136). A more recent report from the South African Health and Demographic survey, indicated that the prevalence of overweight and obesity among females has reached an alarming 68%, while the prevalence of overweight and obesity among males has reached 31% (Department of Health, 2016: 45). The increase in BMI that has been observed during the past few decades is still present in the South African setting, where more than 25% of all adults were found to be obese during 2015 (OECD, 2017: 4) and this increase in BMI will possibly have an effect on the mortality associated with non-communicable diseases as well as the prevalence of premature deaths as it is currently estimated that non-communicable diseases cause an equivalent of 71% of all deaths globally (WHO, 2018: online).

When considering the increase in overweight and obesity in the global population (Asfaw, 2006: 250; Stevens *et al*., 2012: 4; WHO, 2015: 11; NCD Risk Factor Collaboration, 2016: 1379; WHO, 2018: online), it can be assumed that these increases would also be reflected in a country's military population. An unhealthy high BMI in a military environment is associated with lowered force readiness, workforce maintenance and productivity, which is of the utmost importance for military service delivery and deployability of military personnel (Peake *et al*., 2012: 451).

In 2015, an analysis of data collected between 1995 and 2008 was performed in the United States Military, to investigate the prevalence of overweight and obesity amongst active duty military personnel. The results showed that the prevalence of overweight and obesity has increased by 10.2% between 1995 and 2008. The most significant increase in body weight occurred amongst females, with an increase in the prevalence of overweight and obesity of 13.8% (from 20.8% to 34.6%) (Reyes-Guzman *et al*., 2015: 148). In the Millennium Cohort study, which was performed on 46 467 military individuals (both active duty and veterans) in the Unites States of America (USA) between 2001 and 2008, it was found that the mean BMI had significantly increased between 2001, when the mean BMI was 26.1 kg/m² to 27.5 kg/m², in 2007. The study also found that 20% of active military individuals were obese in 2007 (Rush *et al*., 2016: 1585). A more recent study performed on 295 active duty military members in Texas and Washington, USA, found that 64% of the respondents had a BMI exceeding 25 kg/m². The study did not differentiate between overweight and obese individuals (Cole *et al*., 2016: 591). It should, however, be noted that the sample size of the study performed by Cole *et al*. (2016: 591) was considerably smaller than the sample size of the study performed by Rush *et al* (2016: 1585).

Another study conducted amongst military personnel in the Kingdom of Saudi Arabia found a prevalence of overweight and obesity of 40.9% in males and 29% in females, with 7.5% of personnel being morbidly obese (Horaib *et al*., 2013). In a study by the Israeli military, amongst 22 671 soldiers at the age of 18 when entering military service and at 22 years of age, when leaving military service, between 1989 to 2003, it was found that 11.9% of males and 7.4% of females were overweight at recruitment, while 19.3% of males and 12% of females were overweight at discharge. The average increase in BMI during their employment at the military service was 1.11 kg/m^2 for males and 1.08 kg/m^2 for females. (Grotto *et al*., 2008: 608). Fat percentage was however not assessed as part of the study and therefore it is not known whether the weight increase was due to muscle or fat mass.

No similar data could be found for any of the four arms of service of the South African National Defence Force, which includes the South African Army, the South African Navy, the South African Military Health Services and the South African Air Force. The high prevalence of overweight and obesity is a cause for concern in many military communities around the world. The investigation into the prevalence of these conditions is therefore warranted for the South African setting. For the purpose of this study, the prevalence of overweight and obesity in the South African Air Force at Air Force Base Bloemspruit, Bloemfontein in the Free State was investigated.

1.2 Problem statement

Obesity is a common problem globally (Stevens *et al*., 2012: 4), and the prevalence of overweight and obesity is showing a definite upwards curve, even in military populations (Reyes-Guzman *et al*., 2015: 148; Horaib *et al*., 2013; Grotto *et al*., 2008: 607–608). Various risk factors are associated with the development of obesity (Cois & Day, 2015: 6–8; Grotto *et al*., 2008: 608–609; West & Jeffery, 2018: 32). Obese individuals are at a higher risk for developing a wide array of chronic diseases (Asfaw, 2006: 255; Crawford *et al*., 2010: 154) and also more likely to get injured and have a higher incidence of illness, which negatively impacts on health care expenditure, as well as productivity (Peake *et al*., 2012: 454).

Very little data are however available with regard to the prevalence of overweight and obesity in the South African Air Force. A knowledge gap, therefore, exists, especially regarding the contributing risk factors associated with the prevalence of obesity and the health implications thereof in this population.

1.3 Research question

To address the knowledge gap regarding the prevalence of overweight and obesity and identifying possible associated contributing risk factors and health implications, the research question in this study was: What is the prevalence, the contributing risk factors and the associated health implications of overweight and obesity amongst military members from the South African Air Force in Bloemfontein, South Africa?

1.4 Research aim

The primary aim of this study was to determine the prevalence, contributing risk factors and health implications of overweight and obesity in military members from the South African Air Force in Bloemfontein, South Africa.

1.5 Research objectives

To reach the research aim, the following objectives were set:

1. To determine the prevalence of overweight and obesity in the study population;
2. To identify known modifiable contributing risk factors associated with the development of overweight or obesity in the study population; and
3. To identify health conditions currently present in the study population that is associated with overweight or obesity.

1.6 Structure of the dissertation

This dissertation has been structured into seven chapters, which are organised as follows:

Chapter 1: The introduction, problem statement, aims and objectives of the study, as well as the structure of the dissertation is explained in this chapter.

Chapter 2: This chapter provides a literature background on obesity as well as an overview with regard to the aetiology and health consequences associated with this condition.

Chapter 3: This chapter explains the methodology used for this study which includes the study design, time frame, ethical considerations and the data collected for the study as well as the statistical methods used to analyse the results of the study.

Chapter 4 and 5: These chapters report on the results of the study and are written in article format. Each of the chapters focuses on the results obtained for each of the objectives set in the study.

Chapter 6: This chapter provides a summary of the results, a conclusion and recommendations from the study and are structured according to the objectives set for the study.

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Chapter 2

Literature Review: Overweight and Obesity - It's causes and consequences

2.1 Introduction

Overweight and obesity, as discussed in Chapter 1, has globally shown a steady increase during recent years. The prevalence of obesity has increased approximately three-fold since 1975 and has been associated with numerous health consequences, as described in the WHO fact sheet on overweight and obesity published in October 2017 and reviewed in February 2018 (WHO, 2018: online). The WHO (2018: online) defines overweight as a BMI equal to or greater than 25 kg/m² and obesity as a BMI equal to or greater than 30 kg/m². This chapter focusses on obesity, especially the aetiology and the associated health consequences thereof.

2.2 Aetiology of overweight and obesity

Numerous non-modifiable and modifiable risk factors are associated with the development of overweight, leading to obesity. Non-modifiable risk factors include genetic predisposition (Rolfes et al., 2015: 264; Singh et al., 2017: 94), gender (Cois & Day, 2015: 8; Asfaw, 2006: 254; Department of Health, 2013: 136), age (Pareja-Galeano et al., 2016: 3) and the hormonal regulation of appetite (Singh et al., 2017: 89), while modifiable risk factors include energy intake and expenditure (Webster-Gandy et al, 2006: 408), physical activity, socio-demographic status, tobacco use, sleep deprivation, alcohol intake, stress and disease status.

2.2.1 Genetic predisposition

Obesity is often seen in a family context, where lifestyle factors such as physical activity and food intake, that play an important role in the development of obesity, are similar. Despite lifestyle factors, genetic composition or genotype also plays an important role in the development of obesity (Rolfes *et al*., 2015: 264; Singh *et al*., 2017: 94). Genome-wide association studies have found that one hundred and twenty-seven sites in the human genome are associated with the development of obesity (Singh *et al*., 2017: 87).

Adopted children have also been found to be more likely to share a similar BMI with their biological parents than with their adopted parents (Silventoinen *et al*., 2010: 32), which supports the claim of Wardle *et al.* (2008:403), who stated that excessive weight gain in children should not be attributed to the actions of the parents of these children, but rather to the child's genetic susceptibility and the influence of an obesogenic environment (Wardle *et al*., 2008: 403). Genetic expression is influenced by diet and activity patterns, which interact with metabolic pathways, and influences satiety and energy balance (Rolfes et al., 2015: 264). Individuals have no influence on the genetic material they inherit, but each person can influence the epigenetic changes that take place (Rolfes *et al*., 2015: 264). Diet and physical activity play an important role in influencing gene expression, but genes have the power to determine the extent of the influence on a person's body composition.

Genetic trademarks of obesity might lead to the mutation of certain factors, which play a cardinal role in the control of metabolism and appetite. The genetics of obesity can be expressed in two ways, namely syndromic and non-syndromic forms (Singh et al., 2017: 94–99). The syndromic form can be subdivided into chromosomal rearrangement, which consists of, among others, Prader Willi Syndrome, Wilms tumour-aniridia (WAGR) Syndrome and Single Minded 1 (Sim 1) deficiency, and the pleiotropic forms which include Bardet–Biedl syndrome (BBS) Syndrome, Fragile Syndrome and Cohen syndrome among others(Singh et al., 2017: 94–99). The non-syndromic forms are sub-divided into monogenetic obesity which consists of pro-opiomelanocortin (POMC) and Proprotein convertase 1 (PC1) gene mutations, leptin and leptin receptor gene mutations, Neuropeptide Y (NPY) gene mutations, Ghrelin receptor gene mutations, Melanocortin 3 Receptor (MC3R) gene mutations and Melanocortin 4 Receptor (MC4R) gene mutations as well as fat mass and obesity-associated (FTO) gene mutations and polygenetic obesity which consists of β-adrenergic family gene mutations, mutations of the uncoupling proteins gene family and sodium- and chloride-dependent neutral and basic amino acid transporter B (SLC6A14) gene mutations (Singh *et al*., 2017: 94–99). The expression of these mutated genes will not be discussed for the purpose of this study.

2.2.2 Gender

It has been reported from various studies that females are at a greater risk for developing obesity than males (Cois & Day, 2015: 8; Asfaw, 2006: 254; Department of Health, 2013: 136). Female gender is a significant risk factor for the development of obesity and females have been found to be 3.3% more likely to become overweight and 3% more likely to become morbidly obese than their male counter parts (Hallam *et al.* 2016: 163). This can be explained due to gender differences that exist with regard to the type of foods craved, the frequency and intensity of food cravings and the individuals ability to regulate food cravings (Hallam *et al.* 2016: 163). Women tend to have more cravings for sweet foods while men tend to crave savoury foods (Hallam *et al.* 2016: 163). Women also experience a higher frequency and intensity in food cravings, women also seem to have more trouble controlling their food cravings. Women indicated that they found it easy to withhold from indulging a craving 20% of the time, while men indicated that they found it easy to withstand cravings 50% of the time (Hallam *et al.* 2016: 164). Sex hormones such as testosterone, progesterone and estrogens seem to be the modulating factors driving the gender differences observed in food craving (Hallam *et al.* 2016: 164).

Female gender, as a risk factor for the development of obesity, was also reported among young Israeli adults enrolled for military service (Grotto et al., 2008: 608). In a study performed on 500 randomly selected households to investigate the gender differences in obesity in Khayelitsha in the Western Cape, South Africa, it was reported that more than 75% of females were overweight or obese, while only 30% of men were overweight or obese. Female BMI's were also found to be 5 – 8 units higher than their male counterparts, regardless of age (Case & Menendez, 2010: 277). In another South African study that included a nationally representative sample of South African Households, 10 100 individuals were randomly selected in 2008 and followed up during 2010 and 2012. The male population in this study showed a slower progression of obesity than the female population (Cois & Day, 2015: 8). In the South African study performed by Cois & Day (2015: 8), young women seemed to be at a greater risk for the development of obesity than older women. These findings were supported by the SANHANES-1 survey, which reported that females were significantly heavier in terms of BMI (kg/m^2) than their male counterparts (Department of Health, 2013: 136).

In the study by Case and Mendez (2010: 277) which investigated socio-economic gender differences that could impact the development of overweight and obesity in Khayelitsha in South Africa, women who experienced childhood hunger were found to be 15% more likely to be obese in adulthood than women who did not experience hunger during childhood. No association was found with regard to childhood hunger and the development of obesity in males. While women in higher income households were also significantly more likely to be obese than women in lower income households, there was no association found between income and the development of obesity in males in this study (Case & Menendez, 2010: 278). This is however contradicted by a study performed in Texas, where it was reported that women with higher incomes were less likely to be obese, while men were found to have a higher risk for obesity at higher income levels (Borders *et al*., 2006: 64). Being married and having children were also associated with higher BMI values in the female population (Case & Menendez, 2010: 278).

In a study conducted on 10 healthy men and 10 healthy women between the ages of 21 and 44 years, who were habitually active, it was found that men have a higher percentage of fat-free mass as well as a lower percentage of adipose tissue than their female counterparts (Perreault et al., 2004: 242–247). While maximal oxygen uptake (VO2 Max) were similar for men and women in terms of fat-free mass, the higher muscle mass in men resulted in an overall higher VO_2 Max than in women (Perreault et al., 2004: 242–247). Acute exercise was also found to significantly increase muscle lipoprotein lipase (LPL) activity in men, while there was no change observed in women, this was also found with regard to LPL activity in adipose tissue post exercise (Perreault et al., 2004: 242–247). Women had significantly higher full-body insulin activity than men within 3-4 hours after exercise (Perreault *et al*., 2004: 242–247).

2.2.3 Age

With ageing, an increase in adipose tissue and body fat is reported, with a decrease in lean body mass and bone mineral density (Pareja-Galeano *et al*., 2016: 3). Carbohydrate tolerance also progressively decreases with age due to increased insulin resistance and altered lipolysis (Pareja-Galeano *et al.,* 2016:4). This is typically ascribed to physical activity that tends to decrease with increasing age, which in turn decreases energy expenditure, a known contributor to the development of overweight and obesity. An increase in the prevalence of obesity is therefore observed in older individuals (Ryan *et al*., 2003: 2383). The SANHANES-1 study published in 2013 reports a trend of increasing BMI with age in both genders. A decrease in BMI was however observed in females aged 65 years and older. Individuals aged 45 years and older were also found to have a significantly higher mean BMI than individuals between the ages of 15 – 24 years of age (Department of Health, 2013: 136). It has also been reported that the distribution of body fat tends to become more around the abdominal area with ageing in both males and females, which is associated with an increase in insulin resistance and a higher risk for cardiovascular disease and Type 1 Diabetes Mellitus (Pareja-Galeano *et al*., 2016: 3187).

2.2.4 Hormonal regulation of appetite

The role of the central nervous system and hormonal signalling involved in appetite regulation should also be taken into account when evaluating contributing factors to the development of overweight/obesity, as these mechanisms directly influence energy intake and expenditure. The melanocortin system is crucial in regulating appetite and metabolic responses and includes numerous signalling pathways (Singh *et al*., 2017: 89). These include leptin, insulin, NPY, Agouti-related peptide (AgRP) and POMC (Singh *et al*., 2017: 88). In this review, the role of leptin, insulin and ghrelin will be discussed which are the most important hormones in relation to appetite regulation.

2.2.4.1 Leptin

Leptin is an adipokine that is secreted mainly, but not exclusively, by white adipose tissue in the body and is mediated through the central nervous system (Rostas *et al*., 2016: 119; Singh *et al*., 2017: 88; Park & Ahima, 2015: 24; Suzuki *et al*., 2012: 5). Leptin, which is proportionate to the amount of adipose tissue in the body, inhibits the intake of food by suppressing appetite and stimulating the expenditure of energy by conveying information to the hypothalamus of an individual with regard to the amount of energy that is stored in adipose tissues (Singh *et al*., 2017: 88; Rostas *et al*., 2016: 119; Park & Ahima, 2015: 25). Leptin secretion is stimulated by obesity and overfeeding on glucose, insulin (which is secreted by the beta-cells of the pancreas and has similar functions to that of leptin), and oestrogen as well as by pro-inflammatory cytokines namely Tumor Necrosis Factor-Alpha (TNF-alpha), and Interleukin-6 (IL-6). Severe obesity will be present in cases where leptin levels are low or if there are structural defects to the peptide or its receptors. In some obese individuals, high levels of leptin will be present due to increased levels of adipose tissue but in these cases, leptin will not succeed in reducing body adiposity due to leptin resistance. Exogenous administration of leptin will also not have a significant effect in these obese subjects (Park & Ahima, 2015: 25).

The mechanism of action of leptin in the control of metabolism is complicated and includes interactions with the arcuate nucleus (ARC) where it interacts with complex neurological circuits which includes the activation of anorexigenic neurons that synthesise POMC, cocaine and amphetamine-regulated transcript (CART) as well as by inhibiting orexigenic neurons that synthesise proteins such as AgRP (an appetite stimulant which interacts with the MC3R and the MC4R) and NPY, an appetite stimulant (Park & Ahima, 2015: 25; Singh *et al*., 2017: 90; Suzuki *et al*., 2012: 5). During fasting, lower leptin levels result, which suppresses the anorexigenic neurons and stimulates the orexigenic neurons, which in turn leads to an increase in appetite (Park & Ahima, 2015: 25).

2.2.4.2 Insulin

Insulin is secreted by the beta-cells located in the pancreas and has similar functions to leptin with regard to adiposity signalling (Singh *et al*., 2017: 88). Insulin regulates the uptake of glucose and the deposition of glycogen (Singh *et al*., 2017: 88). Similar to leptin, insulin interacts with the ARC in the hypothalamus to reduce food intake and regulate body weight (Singh *et al*., 2017: 89). A genetic predisposition to higher levels of insulin secretion stimulated by glucose in the blood steam has been found to be obesogenic, this indicates that insulin, which is an anabolic hormone, has a significant influence on the development of obesity in the presence of high blood glucose levels (Astley *et al*., 2018: 197).

2.2.4.3 Ghrelin

Ghrelin, a lipophilic peptide, is released primarily by the mucosa of the stomach but also by the intestine, pancreas, pituitary and colon (Suzuki *et al*., 2012: 4; Klok *et al*., 2007: 25). Ghrelin acts as an indicator of energy insufficiency and rises during fasting. Ghrelin is also the only known orexigenic gut hormone which stimulates appetite and plays a role in improving the use of carbohydrates and decreasing the utilisation of fat (Suzuki *et al*., 2012: 4). Ghrelin concentrations will decrease in individuals with the consumption of a high-fat diet and with obesity (Singh *et al*., 2017: 89) and seem to be dependent on age, gender, BMI, growth hormone, glucose and insulin (Klok *et al*., 2007: 24). Ghrelin also plays a role in enhancing gastric motility and in increasing acid secretion (Singh *et al*., 2017: 89). Ghrelin, which acts as a neurotransmitter, expresses itself in the ARC and the periventricular area of the hypothalamus (Suzuki *et al*., 2012: 4). Ghrelin mediates appetite by the stimulation of NPY and AgRP in the ARC of the hypothalamus (Singh *et al*., 2017: 89).

2.2.5 Energy intake and expenditure

The main modifiable cause of overweight and obesity is a higher energy intake and/or a relatively lower energy expenditure in relation to energy requirements, which results in a positive energy balance (WHO, 1995: 316, Webster-Gandy *et al*, 2006: 408). Social, cultural and behavioural aspects play an important role in energy intake and expenditure (WHO, 1995: 316). Daily energy intakes of only 168kJ more than the required energy intake can theoretically lead to an increase in weight of 15.6kg over a ten-year period. It can, therefore, be said that overweight is a very responsive indicator of chronic overconsumption of energy (WHO, 1995: 331). In contrast, however, it has been reported that the intake of energy in the United Kingdom has decreased during the past 30 years, while the prevalence of obesity has increased. This could possibly be due to underreporting of intake, or the fact that people do not take into account the foods that they consume outside the home (Webster-Gandy *et al*, 2006: 408). The increase in obesity can however also be attributed to the significant decrease in physical activity during recent years (Webster-Gandy *et al*, 2006:408). Food has also become more accessible and affordable, due to improved agricultural practices, industrialisation of food processing and improved storage and transport methods (Webster-Gandy *et al*, 2006: 408). Concentrated sources of energy such as high fat, high sugar foods have also become quickly and easily accessible, which is definitely a contributing factor to the increased prevalence of obesity due to higher energy intake (Webster-Gandy *et al*, 2006: 408).

2.2.6 Physical activity

Physical inactivity also plays an important role in the development of obesity (Webster-Gandy, 2006: 408). The global increase in the prevalence of obesity is mirrored by a decrease in physical activity, which is associated with a decrease in physical labour, the ownership of vehicles for transport, and the time spent doing sedentary activities such as watching television and the increased use of computers (Webster-Gandy: 2006: 408).

A study conducted amongst young Israeli adults found that women who participated in moderate activity had the lowest risk for developing obesity in comparison to women with lower levels of physical activity. Physical activity is viewed as protective against the development of obesity (Grotto *et al*., 2008: 608–609). In a study including 91 volunteers of whom 72 completed 15 weeks of exercise as required by the study at the Department of Physiology at Indira Gandhi Medical College in Chennai, India it was found that both moderate and high intensity exercise significantly improved lean body mass and also caused a significant decrease in both fat mass and fat percentage in participants (Umamaheswari *et al*., 2017: 59–60). Physical activity increases energy output which results in weight loss. Light physical activity has been found to result in an energy expenditure (EE) of 20.9 kilojoules/min (kj/min), while moderate intensity exercise results in the expenditure of 31.4 kj/min and high intensity exercise in an EE of 41.8 kj/min (Jeffery *et al*., 2003: 685). It was also found that exercise over a period of sixteen weeks increased skeletal muscle mitochondria content, -electron transport chain activity and ß-HAD activity in overweight and obese geriatric patients in Pittsburgh while energy restriction did not have the same effect (Menshikova *et al*., 2018: 84). In a study performed on 46 volunteers to assess the effects of strength training on both fat free mass and resting metabolic rate, strength training was found to have a significant effect on both the increase in fat free mass as well as the increase in resting metabolic rate with a median increase of 7% found (Lemmer *et al*., 2001: 357). According to the Obesity Trends and Risk Factors study in the South African population, higher body mass at baseline was observed for individuals who participated in exercise, however, these individuals also showed a lower growth rate in BMI than their counterparts who did not participate in exercise (Cois & Day, 2015: 8). As can be seen from the information given above, physical activity affects the metabolism of energy and fat through the use of numerous pathways, therefore a sedentary lifestyle could lead to the development of overweight and obesity.

2.2.7 Socio-economic factors

In the Obesity Trends and Risk Factors study, conducted between 2000 and 2008, 10 100 South African adults were randomly selected and numerous factors that influence an increase in BMI were investigated. It was reported that white ethnicity, higher income as well as tertiary education played an important contributing role in the observed increase in BMI (Cois & Day, 2015: 5; WHO, 1995: 332). A study by Grotto *et al.* (2008: 608) amongst young adults in the Israeli military, found that the level of paternal education was a significant protective factor in the development of obesity, which contradicts Cois and Day's (2015: 5) claim that higher education might predispose an individual to the development of obesity. Rural populations show a significantly lower baseline BMI, but a greater increase in BMI than urban communities; which could be attributed to urbanisation and a higher intake of processed foods as well as lowered levels of activity (Cois & Day, 2015: 8). There is however other evidence that suggests that income is not associated with the prevalence of obesity, except for in the highest income groups where lower levels of obesity were found (Asfaw, 2006: 255). In a study conducted as part of the South African National Income Dynamics Study, female African women who were married and belonged to the middle to high socio-economic class as well as those who completed tertiary education (both males and females), presented the greatest risk for the development of obesity, which supports the results by Cois and Day (2015: 5). Non-African, wealthy, tertiary educated females were, however, found to no longer be at an increased risk for the development of obesity. Wealthy white males, regardless of their level of education, were found to have a significantly higher risk for the development of obesity, while wealth in African males was a significant risk factor for the development of obesity (Sartorius *et al*., 2015: 3–11). Therefore, it can be said that numerous factors such as wealth, education, marital status and geographic location can either contribute to the development of obesity or prevent the development thereof.

2.2.8 Tobacco use

In general, smokers are less likely to gain weight than their non-smoking counterparts (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608) and Grotto *et al*.(2008: 608) reported that smoking before recruitment into the military protected against the development of obesity, while those who started smoking after recruitment had a significantly higher risk for developing obesity (Grotto *et al*., 2008: 608). Smoking cessation is a significant risk factor for an increase in BMI in those who are underweight or have a normal weight (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608). Overweight and obese individuals who start smoking tend to lose weight, however, only low levels of change were observed. The weight loss observed with smoking initiation was however not seen in underweight and normal weight study participants (Cois & Day, 2015: 6). The effect of smoking on body weight might be attributed to the fact that nicotine plays a role in increasing energy output and suppressing appetite. Further research with regard to all the factors involved is however recommended as psychological aspects might also play a role (Cois & Day, 2015: 8).

2.2.9 Sleep deprivation

A positive association has been found in numerous studies between sleep deprivation and obesity (Shankar *et al*., 2010: 3; Canuto *et al*., 2013: 2620; Benedict *et al*., 2011: 1229). In a study conducted at the Clinical Research Centre of the University of Chicago on 12 healthy men, where sleep was limited to four hours per night on consecutive days, an increase in daytime plasma ghrelin concentrations was found. Ghrelin, a hormone produced by the stomach, increases appetite and decreases energy expenditure. This could lead to an energy shift to a positive energy balance, which could cause weight gain in individuals suffering from chronic sleep deprivation (Kim, 2017: 1). A decrease in leptin levels, an anorexigenic hormone, was also observed in these individuals (Spiegel *et al*., 2004: 847; Kim, 2017: 1).

Metabolic disorders and weight gain have also been observed in individuals who have been exposed to chronic sleep deprivation (Canuto *et al*., 2013: 2622). In a study conducted on 323 men and 414 women involved in phase 1 and 2 of the Quebec Family Study, which investigated the relationship between sleep deprivation, body adiposity and leptin levels, it was found that normal sleepers (average of seven to eight hours per night) had a lower body weight, BMI and percentage body fat as well as a lower waist to hip ratio than short sleepers (average five to six hours per night) (Chaput *et al*., 2007: 255). Leptin levels were found to be significantly lower in individuals who slept five to six hours per night compared to those individuals who averaged seven to eight hours of sleep per night (Chaput *et al*., 2007: 256). These differences however disappeared after statistically adjusting for BMI in these individuals. Sleep may, therefore, have an influence on leptin levels and the prevalence of obesity (Chaput *et al*., 2007: 258). Restricted sleep may result in weight gain due to increased appetite, a decrease in energy expenditure and more time awake available for the consumption of food (Knutson *et al*., 2007: 164; Kim, 2017: 1). Sleep deprivation does not only influence appetite but also has an influence on the sympathetic nervous system as well as increasing the secretion of cortical and growth hormone at night. This may induce insulin resistance and may possibly lead to the development of metabolic syndrome (Kim, 2017: 1). An increase of 1 hour in total sleep duration has been associated with a 14% risk reduction for the development of obesity (Timmermans *et al*., 2017: 30).

2.2.10 Alcohol intake

Numerous studies have found that an individual's risk for the development of obesity is significantly higher when alcohol consumption is increased (Kim & Jeon, 2011: 461; Shelton & Knott, 2014: 629). This can be attributed to the high energy density of alcohol at 29kJ per gram, the pharmacological influence on the nervous system and because it cannot be stored and therefore is given priority in metabolism above energy derived from other sources (Sayon-Orea *et al*., 2011: 420).

Increased adiposity levels remain present in individuals with high alcohol consumption, even when adjusting for socio-demographic and lifestyle factors. An increased risk of obesity, as high as 70%, was found in the Health Survey for England conducted in 2006 (Shelton & Knott, 2014: 629). This finding is supported by a study performed by Kim and Jeon (2011: 461) in South Korea, where it is reported that heavy drinkers tend to have a higher BMI than moderate drinkers and that increased levels of body fat and abdominal fat were found in heavy drinkers compared to light and moderate drinkers. Light drinkers were classified as individuals who consumed one to twelve alcoholic beverages within a thirty day period, while moderate and heavy drinkers were classified as individuals who consumed thirteen to fifty-two drinks or fifty-three or more drinks per thirty day period (Kim & Jeon, 2011: 460). High alcohol intake was also associated with high waist circumference in this study (Kim & Jeon, 2011: 461). Seventy-three percent of the study participants did not participate in any physical activity(Kim & Jeon, 2011: 459).

A study that included 43 093 participants (eighteen years and older) from the United States, District of Columbia, observed an inverse relationship between obesity and alcohol consumption, where obese and morbidly obese individuals were found to have a lower alcohol intake than their normal weight and overweight counterparts (Gearhardt & Corbin, 2009: 222). Another study on 474 participants, supports this finding by reporting that daily drinkers and binge drinkers had a lower likelihood of developing overweight and obesity (Rohrer *et al*., 2005: 2). Due to the contradicting evidence that exists with regard to the relationship between alcohol consumption and body weight, it cannot be concluded that alcohol consumption is a contributing risk factor to the development of obesity under all circumstances.

2.2.11 Stress

In a study performed on 101 women, who had children under the age of five years in North Carolina, USA, it was found that perceived stress had a direct and positive association with severe obesity. This association was found independent of eating behaviours and the quality of the participant’s diet. It was also reported that high levels of perceived stress were associated with unhealthy eating habits. Changes in eating habits and food quality was however not observed in individuals who reported high levels of perceived stress which indicates that other factors such as low physical activity and physiological responses play an important role in the development of severe obesity in individuals (Richardson *et al*., 2015: 5). This relation between stress and activity levels as well as levels of obesity was supported by a study amongst a Mexican Mestizo population where highly stressed individuals were significantly less physically active (56.3%) and had a higher prevalence of obesity (48.3%) (Ortega-Montiel *et al*., 2015: 3).

2.2.12 Disease Conditions

Numerous diseases are associated with changes in body weight and composition, however, for the purpose of this review, Human Immunodeficiency Virus (HIV) infection will be discussed due to the high prevalence reported in Eastern and Southern Africa. The prevalence of HIV infection and Acquired Immune Deficiency Syndrome (AIDS) in Eastern and Southern Africa was estimated at between 16.1 million and 18.5 million in 2015 by the Joint United Nations Programme on HIV/AIDS (UNAIDS) (UNAIDS, 2016: 2). Severe malnutrition and wasting has been described as a common side-effect since the beginning of the AIDS epidemic and was once described as one of the three most common AIDS-defining conditions (Mangili et al., 2006: 837). In the Nutrition for Healthy Living cohort that followed 881 HIV infected adults in the Boston area from 1995 until 2005, it was reported that even with the use of Highly Active Antiretroviral therapy (HAART), 13.9% of 633 participants met the criteria for the diagnosis of wasting at the time of entry into the study (Mangili et al., 2006: 837). In 466 participants with sufficient follow-up data to determine the occurrence of wasting, it was reported that 18% lost 10% or more of their body weight since their baseline visit, while 21% lost more than 15% of their baseline weight. This weight loss was sustained for more than six months. Another 8% of these participants had a BMI below 20 kg/m² (Mangili et al., 2006: 837). In a study by Tate et al. (2012: 1282) performed on 681 patients with a CD4 count below 50 cells/µL found that a total of 44% of the patients were classified as being either overweight or obese before the initiation of ART therapy while only 8% of participants were classified as underweight. After a 24 month follow up the prevalence of overweight had increased from 24% at baseline to 31% at 24 months follow up and the prevalence of obesity had increased from 20% to 25% during this time (Tate et al. 2012: 1284). In another study performed on 1682 HIV+ individuals in a military community between 1985 – 2004 it was found that the prevalence of overweight doubled for patients at diagnosis over the time period while the prevalence of obesity increased four-fold during at diagnosis during this time. The prevalence of underweight had remained low (2%) over the time period (Crum-Cianflone et al. 2010: 2). A later Walter Reid Stage tended to be inversely associated with overweight and obesity and these findings were statistically significant (Crum-Cianflone et al. 2010:3). The inflammation and immune activation associated with HIV infection and the initiation of ART medications in the presence of obesity put HIV+ patients at and increased risk for diseases of lifestyle (Tate et al. 2012: 1285). Obesity must therefore be aggressively managed in individuals with HIV infection (Tate et al. 2012: 1285).

2.3 Health implications of overweight and obesity

The prevalence of chronic diseases of lifestyle is higher amongst obese individuals than in those who are overweight or have a normal weight (Asfaw, 2006: 255; Crawford *et al*., 2010: 154). A study based on the results from the World Health Survey of 2002, which was conducted in South Africa on 1550 individuals and in Senegal on 1640 individuals, found a significantly higher prevalence of conditions such as arthritis, asthma, diabetes mellitus and angina pectoris amongst obese individuals than those not classified as obese (Asfaw, 2006:

258). The Centricity Electronic Medical Record Database also shows a linear relationship between BMI and age and the prevalence of Type 2 diabetes mellitus, hypertension and hyperlipidaemia (Crawford *et al*., 2010: 155). Obese individuals are also more likely to report two or more chronic health conditions than their non-obese counterparts (Asfaw, 2006: 259).

Productivity loss, due to absenteeism from work in the Australian Defence Force, was significantly higher in obese individuals than their normal weight counterparts (Peake *et al*., 2012: 454). The cost of health care was also found to be significantly higher in obese individuals (Peake *et al*., 2012: 454), although medication prescriptions and pathological examinations were equally distributed among the BMI categories (Peake *et al*., 2012: 454). The prevalence of non-chronic illnesses was also found to be higher in obese individuals than in their non-obese counterparts (Peake *et al*., 2012: 457). Overweight and obesity, therefore, seem to have serious health and financial implications that need to be addressed. This is especially of importance in the military setting, as high physical activity levels are required from members and as the South African Military Health Service takes financial responsibility for the medical treatment of all members in the South African Air Force.

2.3.1 Cardiovascular disease

Obesity is a well-known major risk factor in the development of cardiovascular disease (Mirzaei *et al.*, 2017: 65) including acute myocardial infarction and heart failure (Mørkedal *et al*., 2014: 1071). The increase in cardiovascular disease risk is due to the adverse effects of obesity on metabolic components that influence the development of cardiovascular diseases, such as blood pressure, glucose tolerance, and blood lipid levels (Mørkedal *et al*., 2014: 1071). Obesity has also been reported to increase total blood volume as well as cardiac output (Mirzaei *et al.*, 2017: 65; Lavie *et al*., 2009: 1926). The increase in cardiac output in obesity is mainly caused by an increase in stroke volume, but due to sympathetic activation, a slight increase in heart rate can also be observed (Lavie *et al*., 2009: 1926). Hypertension is observed more often in obese patients than in those with a normal weight and an increase in arterial pressure is observed with an increase in weight. The increase in pressure, as well as volume, often leads to the development of left ventricular chamber dilation (Lavie *et al*., 2009: 1926).

Large variability in cardiovascular risk has however been identified, which has led to obese and normal weight individuals being classified in different groups which include metabolically healthy normal weight individuals, metabolically unhealthy normal weight individuals, metabolically healthy obese individuals and metabolically unhealthy obese individuals (Mirzaei *et al*., 2017: 65).

In a study on 1118 patients aged 30 years and older, who underwent coronary computed tomography angiography in the Tehran urban population, it was found that an increase in BMI was significantly associated with the likelihood of coronary artery disease in individuals with metabolic syndrome, who were classified as metabolically unhealthy obese when compared to the metabolically healthy obese group in the absence of metabolic syndrome (Hulten *et al*., 2017: 4). Yet another study performed by Mϕrkedal *et al*. (2014: 1073), reported that metabolically unhealthy individuals throughout the BMI categories, which included normal weight, overweight, and obese individuals, were more susceptible to the development of acute myocardial infarction than those who were classified as metabolically healthy. When the study, however, investigated the presence of heart failure, it was reported that BMI was positively associated with the risk of development of heart failure with the largest risk being found amongst severely obese individuals. There were negligible differences found between metabolically healthy and metabolically unhealthy individuals (Mørkedal *et al*., 2014: 1074). Obesity in the presence of metabolic syndrome seems to hold more risks for the development of coronary artery disease and myocardial infarction; however, the same does not seem to apply to the occurrence of heart failure in obese individuals.

2.3.2 Hypertension

Hypertension is one of the leading contributing factors to global mortality with between 13.5% (Hedner *et al*., 2012: 1) and 17.8% (Campbell *et al*., 2015: 165) of all premature deaths being attributed to hypertension (Almeida *et al*., 2016: 2; Gao *et al*., 2016: 2; Hedner *et al*., 2012: 1), and approximately one billion or 25% of individuals worldwide suffering from either diagnosed or undiagnosed hypertension. This number is expected to increase to 1.5 billion or 29% by the year 2025 (Gao *et al*., 2016: 3; Hedner *et al*., 2012: 1; Kearney *et al*., 2005). Various studies have shown a positive association between overweight/obesity and the development of hypertension, which included abdominal and general obesity (Gao *et al*., 2016: 7; Almeida *et al*., 2016: 6; Bushara *et al*., 2016: 609; Ren *et al.*, 2016: 4).

In a study performed amongst 362 women in Midwest Brazil, aged 20 – 59 years (Almeida *et al*., 2016: 4), it was reported that women diagnosed with overweight and obesity had a 50% higher prevalence of hypertension than their normal weight counterparts (Almeida *et al*., 2016: 6). This study was supported by a study on 1275 individuals from Yuzhong county, Lanzhou, aged 35 years and older, that found a significant association between the prevalence of hypertension and obesity in both males and females (Gao *et al*., 2016: 7). In females, the prevalence of hypertension increased by 37% while the prevalence of hypertension in males only increased by 23% with obesity (Gao *et al*., 2016: 7). In the same study, a significant relationship between the prevalence of central obesity and hypertension was also found, while general overweight and obesity was not significantly associated with the prevalence of hypertension. Central obesity found in normal- and underweight individuals was also not associated with the prevalence of hypertension (Gao *et al*., 2016: 7). This association between blood pressure and body weight was also confirmed by a study on 954 individuals from North Sudan that reported the highest prevalence of hypertension amongst individuals with class 2 obesity (Bushara *et al*., 2016: 609).

2.3.3 Type 2 Diabetes Mellitus

Type 2 diabetes mellitus is globally recognised as an important public health problem and is increasing in prevalence with the condition also associated with cardiovascular disease and renal disease (Katchunga *et al*., 2016: 2). A strong positive association between overweight and obesity and the development of Type 2 diabetes has been reported in numerous studies (Xiao *et al*., 2015: 387; Pîrcălăboiu, 2011: 49; Katchunga *et al*., 2016: 6). It is also acknowledged that obese individuals are more prone to presenting with impaired fasting glucose and impairment of glucose tolerance (Pîrcălăboiu, 2011: 49), while weight loss has been found to decrease an individual's risk for developing Type 2 diabetes mellitus (Xiao *et al*., 2015: 388). Studies have also shown a stronger correlation between abdominal obesity and the development of Type 2 diabetes than with general obesity and the development of Type 2 diabetes (Katchunga *et al*., 2016: 6; Xue *et al*., 2016: 194).

The metabolic health of an individual also seems to play an important role in the development of Type 2 diabetes mellitus. Individuals classified as being metabolically unhealthy showed an increased risk for the development of Type 2 diabetes mellitus, regardless of their weight category in comparison to their metabolically healthy counterparts (Wu *et al*., 2016: 6; Janghorbani *et al*., 2017: 3). Wu *et al*. (2016: 2) define metabolic health as the presence of less than two metabolic abnormalities such as abnormal systolic or diastolic blood pressure, high triglyceride- or high-density lipoprotein cholesterol levels and insulin resistance. When the risk for the development of Type 2 diabetes in metabolically healthy normal weight and metabolically healthy overweight individuals were evaluated, it was found that metabolically healthy overweight individuals still had a significantly increased risk for the development of Type 2 diabetes regardless of their metabolic health (Janghorbani *et al*., 2017: 4). It can, therefore, be said that both obesity and poor metabolic health increases an individual's risk for the development of Type 2 diabetes (Wu *et al*., 2016: 6; Janghorbani *et al*., 2017: 3).

2.3.4 Malignancies

Cancer is one of the leading causes of death in both developed and developing countries (Vucenik & Stains, 2012: 37) and according to the Global Cancer Statistics 18.1 million new cancer cases and 9.6 million cancer deaths will have taken place during 2018 (Bray *et al.*, 2018: 398). Epidemiological evidence suggests a strong link between the development of cancers of the colon, oesophagus, rectum, kidney, pancreas, gallbladder, liver, thyroid, breast, ovaries and endometrial cancers and the presence of obesity (Donohoe *et al*., 2017: 46; Vucenik & Stains, 2012: 38; Byers & Sedjo, 2015: R125). It has also been reported that the presence of excess adiposity causes approximately 17% of obesity-related cancers in Great Britain and 13% and 11% in Brazil and China respectively (Byers & Sedjo, 2015: R125). Evidence shows an increase of 1.05 – 1.62 in the risk of cancer development with a weight gain of 5 kg/m² in BMI (Donohoe *et al*., 2017: 46).

The mechanisms associated with the development and progression of cancer in obese individuals are complicated and not well understood and include obesity-related hormones, growth factors, modulation of energy balance and energy restriction as well as multiple signalling pathways and inflammatory processes (Vucenik & Stains, 2012: 38). Individuals with a BMI exceeding 40 kg/m² have a higher mortality risk related to cancer when compared to individuals with a normal body weight (Vucenik & Stains, 2012: 38; Donohoe *et al*., 2017: 46), this can however also be attributed to an increase in the prevalence of heart disease associated with obesity in these individuals (Donohoe *et al*., 2017: 46). Risk factors related to the development of obesity such as physical inactivity, dietary intake and energy balance has also been linked to the development of cancer. The effect of these factors have however not been adequately researched (Donohoe *et al*., 2017: 46).

2.3.5 Obstructive sleep apnoea

Obstructive sleep apnoea is characterised by the repeated collapse of the upper airway of an individual during sleep, which leads to low oxygen saturation of the individual's haemoglobin and repeated arousals from sleep throughout the night (Lam *et al*., 2012: 223; Lain *et al*., 2010: 165). The development of obstructive sleep apnoea is mainly due to a decrease in pharyngeal lumen diameter mainly due to the deposition of fatty tissue in the walls of the airway and decreased airway muscle strength due to the deposition of fat in the muscles surrounding the airway as well as the pressure caused by fat in the abdomen and chest (Ünlü *et al*., 2014: 14). Obstructive sleep apnoea is one of the most common sleep disorders (Lam *et al*., 2012: 223; Ünlü *et al.*, 2014: 13) and obesity has been found to be one of the main causes of obstructive sleep apnoea (Ünlü *et al*., 2014: 13; Lain *et al*., 2010: 165). It has been reported that individuals with obstructive sleep apnoea have an increased BMI, waist circumference, systolic blood pressure, fasting glucose levels as well as fasting insulin when compared to individuals who do not suffer from obstructive sleep apnoea (Gruber *et al*., 2006: 3).

For this reason, metabolic syndrome has also been strongly associated with the development of obstructive sleep apnoea (Gruber *et al*., 2006: 3), while metabolic syndrome is also closely associated with the epidemic of obesity (Lam *et al.*, 2012: 224). Obstructive sleep apnoea has also been associated with the development of diseases such as ischemic heart disease, hypertension, diabetes mellitus and stroke, increasing the global health burden (Lain *et al*., 2010: 168).

The risk of developing obstructive sleep apnoea is reported to be greater in males than in females (Ünlü *et al*., 2014: 14; Oztura *et al*., 2013: 41; Jeler & Mihaltan, 2016: 156; Lam *et al*., 2012: 225; Lain *et al*., 2010: 166). It is estimated that the global prevalence of obstructive sleep apnoea is approximately 3 – 7% in men while the prevalence in women is slightly less at approximately 2 – 5% (Lain *et al.*, 2010: 166). In addition, anthropometric markers in predicting the disease were also found to differ between genders. Waist circumference and BMI were found to be the most useful anthropometric markers to assess the risk for the development of obstructive sleep apnoea in men, while only hip circumference and neck circumference to height ratio were significant markers in women when considering multiple regressions (Mazzuca *et al*., 2014: 19).

2.3.6 Osteoarthritis

A strong relationship exists between obesity and the development of musculoskeletal diseases (Anandacoomarasamy *et al*., 2008: 217). The level of obesity also plays an important role in the development of these diseases; and it was found that obese individuals have a 15% higher reporting rate of diagnosed osteoarthritis than their normal weight counterparts (Anandacoomarasamy *et al*., 2008: 211). The role of the level of obesity in the development of osteoarthritis was also observed in studies that reported that the level of obesity is an important factor to take into account, as it seems that obese individuals have a much higher risk for the development of osteoarthritis than their normal weight counterparts (Anandacoomarasamy *et al*., 2008: 212; Coggon *et al*., 2001: 623; Pal *et al*., 2016: 520). In a study conducted by Coggon *et al.,* it was found that obese individuals who lowered their weight into the normal ranges would halve the number of reported cases; and modest weight loss of only 5 kg could reduce the number of osteoarthritis cases by a quarter (Coggon *et al*., 2001: 624).

The association between obesity and the development of osteoarthritis was found especially linked to knee, hand and hip osteoarthritis (Lee *et al*., 2016: 4; Anandacoomarasamy *et al*., 2008: 212; Mazzuca *et al*., 2014; Pal *et al*., 2016: 520; Reyes *et al*., 2016: 1872), with the most significant influence of obesity on the development of osteoarthritis found in the knee joint (Reyes *et al*., 2016: 1872). However, a study conducted by Maddah and Mahdizadeh (2014: 745) that focused on the association between metabolic syndrome and the development of knee osteoarthritis, found that there was no significant difference in BMI between the osteoarthritis group and non-osteoarthritis group in men, but a significant difference was present in women. The relationship between the development of osteoarthritis and obesity seems to be multi-factorial which includes mechanical as well as metabolic causes (Anandacoomarasamy *et al*., 2008: 213). Associations with different components of metabolic disease and the development of osteoarthritis were also reported (Maddah & Mahdizadeh, 2014: 745).

2.4 Conclusion

The development of overweight and obesity can be attributed to various factors which include non-modifiable risk factors such as age, gender, genetic predisposition and hormonal regulation as well as modifiable risk factors such as environment, lifestyle and dietary patterns. Overweight and obesity causes a chronic inflammatory state which predisposes individuals to the development of lifestyle diseases, which can be life-threatening. The prevention and treatment of overweight and obesity are therefore of utmost importance to ensure long term health and wellness for all.

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Chapter 3
Methodology

3.1 Introduction

This chapter includes a description of the methodology followed in conducting this study, with a focus on the study design, the population being studied, the methods used for sample selection as well as the data collection process that was followed, the time frame of the study, measurements and techniques implemented to perform the measurements, the validity and reliability of the measurements collected, ethical considerations that were taken into account, the statistical analysis of the data and limitations of the study.

3.2 Study design

A descriptive, cross-sectional study design was applied in the current study.

3.3 Participants and sample selection

The study population included members of the South African Air Force, based at Air Force Base Bloemspruit, in Bloemfontein. According to the unit, there are 707 uniformed members administratively allocated to Air Force Base Bloemspruit. Of these, 601 members were physically present at the base during the study, due to external deployments, course attendance, and vacation leave, which excluded 106 members from the study.

For the purpose of this study, the commanding officer of Air Force Base Bloemspruit was approached to advertise and promote the study amongst the members of the unit. All members who were willing to participate in the study were included, with the exception of those who did not meet the inclusion criteria. There were 166 volunteers who agreed to participate in the study.

The 166 participants represented 27.6% of the 601 individuals stationed at Air Force Base Bloemspruit, Bloemfontein during the study.

3.4 Sampling

The following inclusion and exclusion criteria were used for the purpose of this study:

3.4.1 Inclusion criteria

Participants were included in the study as follows:

1. All air force employees, currently in active military service (permanent employment or medium-term employment);
2. Aged between 18 and 60 years; who
3. Provided informed consent to participate in this study.

3.4.2 Exclusion criteria

Reserve force members and members who did not wish to participate were excluded from this study as well as members who were on deployment and detached duty. This accounted for 74 members in total of which 40 members were on deployment and 34 members were attending a course during this time. During the data collection period, 32 members were on leave, which reduced the number of possible participants to 601 members physically present at Air Force Base Bloemspruit during the study.

3.5 Study procedures

The study was conducted in the following manner:

The protocol was drafted and submitted for approval to an evaluation committee of the School for Allied Health Professions, Faculty of Health Sciences, as well as the Health Sciences Research Ethics Committee from the Faculty of Health Sciences, University of the Free State and conditional approval, was granted in November 2016, pending approval from the 1 Military Ethics Committee.

After conditional approval was obtained from the Health Sciences Research Ethics Committee of the University of the Free State, permission to perform the study was obtained from the Directorate Ancillary Health of the South African Military Health Service, after which the protocol was submitted to the Military Medical Ethics Committee situated at 1 Military Hospital, Pretoria, Gauteng (Appendix A). Ethical approval was granted during July 2017 and approval for the study was obtained from Defence intelligence on 23 August 2017. Final approval for the study was granted on 30 August 2017 by the Health Sciences Research Ethics Committee from the Faculty of Health Sciences, University of the Free State (Appendix B). Final approval from the Officer Commanding Area Military Health Unit Free State was obtained on 3 October 2017, after which approval from the Officer Commanding of Air Force Base Bloemspruit was sought. Approval was granted on 10 October 2017.

A pilot study was conducted on the 7th of November 2017 on 10 participants that were randomly selected from Air Force Base Bloemspruit to test the logistics, measurement procedures and techniques as well as the questionnaires that were used to conduct the study. No changes were made to the study design or questionnaires after the pilot study was performed and therefore the data gathered during the pilot study were included in the main study.

Participants for the study were recruited by requesting the Officer Commanding of Air Force Base Bloemspruit to advertise the study to the members of Air Force Base Bloemspruit. The members from the different units were asked to volunteer to participate in the study. This was done with the support of the Officers Commanding of the various units situated on Air Force Base Bloemspruit, which includes the Base Head Quarters, 506 Protection Squadron, 87 Helicopter Flying School, 16 Squadron and 6 Air Support Unit.

Before commencing the study in a specific unit, individuals were invited to participate in the study and orientation was done by the researcher to inform the individuals about the aims, goals and procedures of the study. An information document (Appendix C) was given to each of the prospective participants and informed consent was obtained from individuals that were willing to participate in the study. All of the questionnaires were assigned a file number to ensure the anonymity of the members participating in the study. English was used to communicate with the members, as this is the official language used in the South African Air Force in all correspondence and communication.

The participants were requested to complete a self-administered questionnaire (Addendum B) which included questions regarding modifiable known contributing risk factors associated with the development of overweight or obesity as well as health conditions associated with overweight or obesity. Medical records could not be utilised as the documentation was not completely accurate as a capturing backlog exists. The researcher also could not obtain access to the documents on the system mainframe due to the confidentiality of these documents. The researcher guided the members through the questions by reading and explaining the questions while the questionnaire was being completed and the researcher was available to answer any questions during the completion of the questionnaire as well as to ensure that all questions were answered in full.

Anthropometric measurements were taken by the researcher in a private consultation room and recorded on the numbered questionnaire. These measurements included weight, height and waist circumference of the participants and was taken in duplicate. If the measurement deviated by more than 0.01 m, a third measurement was performed. Standard measuring techniques were used by the researcher as discussed later in this chapter.

The data collected were captured on two separate Microsoft Excel data sheets as soon as the questionnaires and the measurements were completed. Data were electronically compared in order to identify and eliminate possible errors with data recording. In the instance where input errors were detected, the original questionnaire was used to correct the mistake. The data were managed confidentially and in a secure environment.

The statistical analysis of the data was performed by the Department of Biostatistics of the Faculty of Health Sciences at the University of the Free State and interpreted after analysis.

The results obtained from the study are presented as a dissertation in the article format as approved by the University of the Free State.

3.6 Time schedule

The time schedule for conducting the study indicates the tasks that were performed as well as the target date for each task as depicted in Table 3.1 below:

Table 3-1: Time schedule for conducting the study

The task to be completed:	**Time allocated to perform the task:**	**Target dates for completion of the task:**

Planning the study and writing the research protocol	7 months	February - October 2016
Evaluation Committee meeting		November 2016
Ethics committee approval and funding application	2 months	June 2016
Conditional approval from the Health Sciences Research Ethics Committee	8 months	February 2017
1 Military Hospital Research Ethics Committee approval	4 months	July 2017
Approval from Defence Intelligence SANDF	1 month	August 2017
Final approval from the Health Sciences Research Ethics Committee	1 month	August 2017
Approval from Officer Commanding Area Military Health Unit Free State	2 months	October 2017
Performing a pilot study	1 day	November 2017
Data collection for the study	1 month	November 2017
Checking of data and capturing of data onto data sheets	1 month	December 2017
Analysis of data by biostatistician	2 months	January – February 2018
Writing of research report	10 months	March – December 2018

3.7 Measurements and techniques

In this study, socio-demographic information was collected by means of a questionnaire (Appendix D), while anthropometric data were collected by the researcher using standardised measuring techniques set forth in this chapter. Information regarding health status, dietary intake, physical activity, sleep and alcohol intake were collected through the use of a questionnaire and evaluated according to the parameters set forth in this study. The questionnaires were compiled based on information gathered through the use of academic articles,journals and handbooks as well as through the use of the researchers knowledge of the community gathered through working in the study population for nine years. .

3.7.1 Socio-demographic factors

In this study, socio-economic data were collected by making use of a socio-demographic questionnaire. The questionnaire collected data on rank, age, marital status, educational attainment and race and ethnicity. The socio-demographic questionnaire was self-administered in a group format. Data were analysed to investigate associations between social characteristics and the prevalence of overweight or obesity in the population. Rank was classified into three groupings, namely Non-commissioned officer, Warrant Officer and Officer. Rank is closely associated with income in the South African Air Force. The age of the individuals was determined by including questions on the date of birth as well as the actual age of the participants. Marital status was divided into seven categories which consisted of single; in a relationship, not living with a partner; in a relationship, living with a partner; married, not living with a partner; married and living with a partner; divorced and widowed. Educational attainment was categorized into three categories namely high school or less, trade or skill attained after the completion of high school and college or university qualification.

3.7.2 Anthropometry

In this study anthropometrical measurements (Appendix D) included weight height, from which Body Mass Index (BMI) was calculated; as well as waist circumference.

3.7.2.1 Weight

Weight was measured using an ADAM MDW 250-L scale, with a valid and recent calibration certificate. Weight was measured in kilograms (kg) to the value of one decimal point. For the measurement of weight, participants were asked to remove heavy outer clothing and shoes. The weight of participants was measured with the participant standing up straight in the middle of the scale, facing away from the digital screen located on the scale (National

Health and Nutrition Examination Survey, 2000: online). The study participant was facing away from the digital screen of the scale to enable the examiner to measure the height of the participant at the same time. The examiner waited for the measurement to settle at a two decimal point value, which was recorded on the study participant's data form and used in the calculation of the BMI. All measurement were performed in duplicate and repeated for a third time if the measurements differed with more than 0.1kg.

3.7.2.2 Height

Height was measured with an ADAM MDW 250-L scale with an attached stadiometer and was measured in cm to one decimal point. The study participant's head and hair were free of objects (National Health and Nutrition Examination Survey, 2007: online). The study participant stood with his/her arms at his/her sides, shoulders relaxed and knees straight and together. The study participant's heels, buttocks and upper back were touching the stadiometer while standing up straight in the middle of the scale, facing away from the digital screen located on the scale (National Health and Nutrition Examination Survey, 2000: online). The toes were pointing slightly outwards at approximately a 60° angle. The head of the participant was in the Frankfort plain (National Health and Nutrition Examination Survey, 2007: online).

The headpiece of the stadiometer was lowered until it rested firmly on the participant's head. The participant was asked to take a deep breath at the end of which the height measurement was taken. The measurements were taken twice on all participants. If the measurements differed with more than 0.1cm from the previous measurement, a third measurement was taken and the average value of the three measurements was used (Lee & Nieman, 2013: 186).

3.7.2.3 Waist circumference

To increase the validity of using BMI as a method to evaluate body weight, it is necessary to consider other techniques, when accurate identification of overweight or obesity is required. One of these techniques, which is also cost-effective, is measuring waist circumference, to indicate the abdominal distribution of fat, also known as android adiposity. Android adiposity in individuals can vary greatly within a certain weight- and BMI category and waist circumference are therefore useful for determining an individual's risk for developing certain lifestyle diseases. Waist circumference is an inexpensive and relatively easily performed method for the determination of android adiposity (World Health Organization (WHO), 2000: 11).

Waist circumference however also seems to underestimate obesity compared to using bioelectrical impedance analysis for determining body fat percentage (Heinrich *et al*., 2008: 71). In support of using these simple and affordable techniques to evaluate body adiposity, a study conducted on 1667 individuals between 1996 and 2008 found that waist circumference and BMI showed a stronger correlation with fat mass and abdominal subcutaneous fat than with visceral abdominal tissue (Camhi *et al*., 2011: 403–404). The study also reported that waist circumference and BMI showed the same correlations across gender by race groups when White and African American males and females were investigated (Camhi *et al*., 2011: 404).

For the current study, waist circumference was measured by using a non-elastic Seca measuring tape. Waist circumference was measured at the midpoint between the lower edge of the ribcage and the upper edge of the iliac crest. Measurements were taken to the nearest 0.1cm and were repeated in each participant to ensure accuracy in measurement (Lee & Nieman, 2013: 186).

Table 3.2 shows the gender-specific cut-off points that are associated with increased risk and high risk for the development of metabolic complications that can be associated with overweight and obesity as set forth by the World Health Organization (WHO, 2000: 11).

Table 3-2: Gender-specific waist circumference and risk of metabolic complications associated with obesity in Caucasians (WHO, 2000: 11)

Risk of metabolic complications	**Waist circumference (cm)**	
	Men	Women
Increased	≥94cm	≥80cm
Substantially increased	≥102cm	≥88cm

3.7.2.4 Body mass index

Previous studies conducted on military personnel, mainly used BMI as an indicator of overweight and obesity and this is also the most frequently used indicator of body weight in population-based studies due to its low cost and convenience (Reyes-Guzman *et al*., 2015: 146; Horaib *et al*., 2013: 404; Grotto *et al*., 2008: 608; Heinrich *et al*., 2008: 68) . The use of BMI as a diagnostic tool and an indicator of overweight and obesity has however been questioned, due to the fact that it does not distinguish between fat- and muscle mass, which becomes an important factor to keep in mind when evaluating active individuals such as athletes and military personnel (Reyes-Guzman *et al*., 2015: 152).

Military personnel or athletes can easily be misclassified as being obese, resulting from a high muscle mass and/or short body stature, while having a low body fat percentage, whereas individuals with a lower BMI can be mistakenly viewed as having a healthy weight while having a high body fat percentage (Reyes-Guzman et al., 2015: 152). In a study by Heinrich *et al*. (2008: 71), it was however found that this was not the case. Their study on 451 individuals investigated the relationship between body fat percentage as determined by bioelectrical impedance, BMI and waist circumference. It was found that BMI underestimated obesity in comparison with bioelectrical impedance (Heinrich *et al*., 2008: 71).

For the current study, BMI was calculated by making use of the weight and height of the participants measured in this study. BMI is a simple way of quantifying weight for length and is frequently used to classify individuals as either underweight, overweight or obese. BMI is calculated as weight in kilograms divided by height in meters squared (kg/m^2) (WHO, 2000: 8). The classification of adult weight status according to BMI is indicated in Table 3-3 (WHO, 2000: 8)

Table 3-3: Classification of adult weight status according to Body Mass Index (WHO, 2000:8)

Classification	**Body Mass Index**	**Risk of co-morbidities**
Underweight	<18.5 kg/m^2	Low (but the risk of other clinical problems increased
Normal range	18.5 – 24.9 kg/m^2	Average
Overweight	25.0 – 29.9 kg/m^2	Increased
Obesity class 1	30.0 – 34.9 kg/m^2	Moderate
Obesity class 2	35.0 – 39.9 kg/m^2	Severe
Obesity class 3	≥40.0 kg/m^2	Very severe

3.7.3 Contributing risk factors associated with the development of overweight or obesity

3.7.3.1 Dietary intake

Food frequency questionnaires estimate the nutrient intake of an individual by determining how frequently a person consumes a certain pre-determined group of foods. These foods are chosen based on their contribution to the average intake of the population. The participants indicate the frequency of their intake of a certain food within a specified time period (Gibson, 2005: 46). Intake can be measured as daily, weekly, monthly or yearly (Lee & Nieman, 2013: 88; Gibson, 2005: 47). For the purpose of this study, a self-administered food frequency questionnaire was used. The foods included in the questionnaire were chosen through the use of the researcher's knowledge of the intake of the study participants gathered through nine years of experience with the study population. A tested questionnaire was not used due to the fact that dietary intake is very specific to the community in question and questionnaires compiled for a different community might not have been applicable to the community in question. Additional data can be obtained by adding portion sizes to the food frequency questionnaire and it has been found that the frequency in which the food is consumed gives a better indication of the nutrients consumed in this type of questionnaire (Johnson & Hankin, 2003: 231). The food frequency questionnaire is useful in determining the relationship between the intake of certain food and a variable such as the incidence of obesity in a population (Lee & Nieman, 2013: 83; Johnson & Hankin, 2003: 231). Recall bias takes place when the study participant cannot accurately remember the type of food consumed or the frequency in which the food is consumed. This error can be reduced by including the foods most frequently consumed by the study population in the food frequency questionnaire to encourage study participants to recall the intake of a specific food. Study participants also tend to over-report the intake of healthy foods and underreport the intake of unhealthy foods due to the fact that participants want to please the interviewer (Johnson & Hankin, 2003: 232). This was avoided as far as possible by conducting the interview in a group setting where individuals completed their own Food Frequency Questionnaire. The researcher was present during the completion of the questionnaire and members were asked not to discuss their answers during the completion of the questionnaires. The researcher read and explained each question before the study participants completed the question. Any further questions regarding the questionnaire was answered by the researcher to ensure that all questions were well understood and completed correctly.

3.7.3.2 Physical activity

In this study, physical activity was determined by making use of the short International Physical Activity Questionnaire (IPAQ), developed by the IPAQ Research Committee, which was formed in Geneva in 1998 (Craig *et al*., 2003: 1381). The April 2004 IPAQ Short form was used for the purpose of this study. The questionnaire was self-administered in a group format. The questionnaire was developed to measure self-reported physical activity at the population level (Craig *et al*., 2003: 1381). The short IPAQ questionnaire has relatively good levels of repeatability (Craig *et al*., 2003: 1385). IPAQ measures physical activity in different categories. These categories include leisure time activity, domestic and gardening activity and any exercise associated with exercise during work or work and transport related activities (IPAQ Research Committee, 2004: 2). Activities are measured in terms of Metabolic Equivalent Task-minutes (MET-minutes) which reflects three different levels of activity. These levels are walking, moderate activity and vigorous activity or Health-Enhancing Physical Activity (HEPA) (IPAQ Research Committee, 2004: 1). These scores are calculated separately by multiplying the days in which the activity was performed by minutes per day. These scores are then rated according to MET-minutes which enables the researcher to divide the study population into three different groups. These groups are as follows (IPAQ Research Committee, 2004:3):

a. Inactive activity is classified as a score that does not meet the criteria for moderate activity or vigorous activity.

b. Minimal activity should comply with one of the following criteria:
   i. Three days per week of vigorous intensity activity or more than 20 minutes of walking per day.
   ii. Five days of moderate intensity activity or walking for more than 30 minutes daily for more than ten minutes at a time.
   iii. Five days of any combination of walking or moderate intensity activity or 3 days per week of high-intensity exercise with a MET score exceeding 600 MET-minutes per week.

c. HEPA is classified as:
   i. Vigorous intensity activity exceeding 3 days per week with a MET-minutes score exceeding 1500 MET-minutes per week.

ii. More than 7 days a week of walking, moderate intensity exercise or high-intensity exercise with a MET-minutes score exceeding 3000 MET-minutes per week.

The following formulas were used to calculate MET-minutes for each of the three groups of activity:

a. Walking MET-minutes/week = 3.3 x (walking minutes) x (walking days)
b. Moderate MET-minutes/week = 4.0 x (moderate intensity activity minutes) x (moderate days)
c. Vigorous MET-minutes/week = 8.0 x (vigorous-intensity activity minutes) x (vigorous-intensity days)

The physical activity results for this study were evaluated according to the current recommendations for physical activity from the American Cancer Association, which is 150 minutes or 2 hours and 30 minutes per week of moderate intensity physical activity or 75 minutes or 1 hour and 15 minutes or vigorous physical activity spread throughout the week (Kushi *et al*., 2012: 32).

3.7.3.3 Sleep deprivation

In this study, sleep deprivation was determined by including a question regarding sleep duration in the self-administered questionnaire. The question provided data on the number of hours of sleep a participant gets in 24 hours. Adequate sleep was defined as 7 or more hours of sleep per day while sleep deprivation was classified as 6 or fewer hours of sleep per day (Chaput *et al.*, 2007: 255).

3.7.3.4 Alcohol intake

In this study, alcohol intake was determined by including two questions regarding the frequency and quantity of alcohol consumed. Reported alcohol consumption was then classified into three different categories namely no alcohol consumption, low alcohol consumption (which is less or equal to two units of alcohol per day for men and less than one unit of alcohol per day for women) and high alcohol consumption (which was defined as more than two units of alcohol per day for men and more than one unit of alcohol per day for women) (Vorster *et al*., 2013: S118). For the purpose of this study, one unit of alcohol was defined as 150ml wine, 25ml spirits or 330ml fermented alcoholic beverages. No distinction was made between original and lite alcoholic beverages.

3.7.4 Health conditions associated with overweight and obesity

In this study, health conditions associated with overweight and obesity was determined by making use of a self-reporting health questionnaire. The questionnaire was self-administered in a group setting. The questionnaire aided in identifying the health conditions most frequently experienced by members of the South African Air Force. The health conditions listed in the study were hypertension, hypercholesterolemia, Type 2 diabetes mellitus, gout, heart disease, sleep apnoea, osteoarthritis, and cancer.

3.7.5 Validity and Reliability

3.7.5.1 Validity and reliability of anthropometric measurements

For the purpose of this study, the validity of anthropometric measurements was ensured by making use of recently calibrated scales and measuring instruments, the measurements were performed by a registered dietician and standardised techniques were used. The researcher took the weight and height measurements according to the standard techniques described in the protocol to ensure accuracy.

The reliability of anthropometric measurements was ensured by repeating the measurements.

Systematic error in measurement occurs when the instrument used to perform a certain measurement differs systematically from the true value. This type of error occurs when the measuring instrument is not properly calibrated to obtain valid results (Aldous *et al*., 2012: 31). For this reason, valid and reliable tools with a current and valid calibration certificate were used when the measurements were performed.

Inter-observer error occurs when the measurement taken by two different observers on the same study participant of the same characteristic differs from each other (Aldous *et al*., 2012: 31). Inter-observer bias was avoided in this study due to the fact that all measurements were taken by the researcher.

3.7.5.2 Validity and reliability of the contributing risk factors associated with the development of overweight or obesity questions

The contributing risk factors associated with the development of overweight and obesity were recorded by using a self-reported questionnaire. The validity and reliability of the contributing risk factors associated with the development of overweight or obesity questionnaire were insured by making use of the following methods:

a. The validity of the food frequency questions was ensured by testing the validity of the questions in a representative sample of the study population during the pilot study. A method evaluated in another population could not be implemented in the study population due to the fact that structured food frequency questions should be tailored to reflect the eating habits of the study population in question to ensure valid results (Johnson & Hankin, 2003: 223). The food frequency questions required relatively little time and energy to complete and generated estimations of food and nutrient intake (Lee & Nieman, 2013: 88; Gibson, 2005: 49). Food frequency questions is known to provide a reliable indication of food intake over an extended time period (Gibson, 2005: 48; Johnson & Hankin, 2003: 231), it is suited for large scale studies and it is economical to use (Lee & Nieman, 2013: 88; Johnson & Hankin, 2003: 231).

   There are however questions regarding the ability of the food frequency questionnaire to estimate food intake in groups and individuals as stated by Lee and Nieman, (2013: 88) especially when evaluated using weighed food records, however when the food frequency questionnaire was evaluated using weighed food records it was found that nutrient intake results correlated strongly between these two methods with the exception of vitamin A and polyunsaturated fat (Gibson, 2005: 158). The relationship correlated especially strongly when nutrient densities were evaluated (Gibson, 2005: 158). It was also found to be useful when ranking groups of people according to low, medium and high energy intakes (Lee & Nieman, 2013: 88).

   Food frequency questions are used frequently in large population studies, regardless of its limitations. It is also the most frequently used method when correlations between dietary intake and disease are being investigated (Lee & Nieman, 2013: 89; Johnson & Hankin, 2003: 234).

b. The validity of data on physical activity was ensured by making use of the validated IPAQ which has been shown to be an acceptable instrument for the measurement of physical performance in adults (Craig *et al*., 2003: 1388).

The IPAQ was developed by making use of various stages of development which lead to a multi-country reliability and validity study (Craig *et al*., 2003: 1388). The results of the IPAQ: Validity and reliability study shows that the IPAQ showed the same amount of reliability and validity as other well-known physical activity instruments based on self-reported data. The review study to which the IPAQ was compared included 14 different studies of seven methods for evaluating self-reported physical activity in adults (Craig *et al*., 2003: 1388). The reported reliability correlations for these studies ranged between 0.34 and 0.89 with a median of 0.80 which correlates very well with the IPAQ study which also showed a reported reliability correlation of 0.80 (Craig *et al*., 2003: 1388). The criterion validity of the seven self-reported methods ranged between 0.14 and 0.53 with a median of 0.30 which also correlates very well with the IPAQ criterion validity which was also found to be 0.30 (Craig *et al*., 2003: 1388). When taking into account that the IPAQ instrument was measured in twelve different countries, including developed and developing countries, it can be said that the IPAQ is an acceptable method of measuring physical performance especially if it is taken into account that most of the other measuring instruments were only evaluated in developed countries (Craig *et al*., 2003: 1388).

c. The validity and reliability of the socio-economic, tobacco use, sleep deprivation and alcohol use questions were tested with the food frequency questions and physical activity questions in a representative sample of the study population. The questions were carefully explained by the researcher to ensure that the study participants understand what is expected of them. The questionnaires were as short as possible and only solicited information that was essential to meeting the requirements of the study objectives (Leedy & Omrod, 2010: 194). The questions asked were kept as simple as possible and clear instructions regarding the completion of the questionnaire were given by the researcher.

3.7.5.3 The validity and reliability of health conditions questions

All the questions on the questionnaire were thoroughly explained by the researcher to ensure that the study participants understood what was expected. The questionnaire was as short as possible and only information that was essential to meeting the requirements of the study objectives (Leedy & Omrod, 2010: 194) were asked.

3.8 Ethical considerations

Approval to conduct the study was obtained from the Officer Commanding of Area Military Health Unit Free State, the Officer Commanding of Air Force Base Bloemspruit, the Ancillary Health Directorate of the South African Military Health Service as well as the Directorate of Defence Intelligence. Ethical approval for conducting this study was obtained from the Health Sciences Research Ethics Committee (HSREC) of the Faculty of Health Sciences, the University of the Free State with reference number REC-230408-011 and study reference number HSREC189/2016 (UFS-HSD2016/1516). Ethical approval was also obtained from the Ethics Committee of the South African Military Health Services situated in Pretoria, Gauteng, with reference number REC-111208-019-RA with study reference number 02.05.2017: "Overweight, obesity and associated risk factors in the South African Air Force, Bloemfontein."

The study was explained in detail in clear understandable language to study participants after which voluntary informed consent was obtained from each participant. The fact that participation in the study was voluntary and that individuals were under no obligation to participate in the study was reiterated. The participants were also informed of their right to withdraw from the study at any time, without any discrimination following the withdrawal. Consenting participants received an information document regarding the study and a copy of the consent form. The forms were administered in English, as this is the official language used in the South African Air Force. The information gathered during the study was handled confidentially and the rights of each participant were respected throughout the study.

Correct and scientifically acceptable methods were used in conducting this study according to the approved protocol. Each study participant received a 24g chocolate to the value of three rands to thank them for participation in the study.

Results from the research conducted were made available to the SAMHS to assist in the development of health policies and procedures, this will also aid in the development of intervention strategies as well as aiding in identifying target groups for intervention. The results of the study also identified the most common health issues experienced by the study community which will aid in the development of health and nutrition education programs.

3.9 Statistical analysis

Data collected in the study were entered in duplicate in two Excel spreadsheets by the researcher. The information gathered during the study was electronically checked through the comparison of the two excel sheets, to identify possible errors and missing information in the data sheets. The original data sheets were stored numerically to ensure that captured data could be checked with ease. Any errors on the questionnaires that could not be corrected by tracking it to its original source were regarded as missing information. Statistical analysis was performed by the Department of Biostatistics from the Faculty of Health Sciences, University of the Free State. Statistical Analyses Software (SAS 9.4) was used during the analysis. Continuous variables are reported as medians, minimum, maximum and percentiles. Categorical variables are summarised as frequencies and percentages. Differences between groups were evaluated using the Chi-square test or the Fisher's Exact Test for unpaired data.

3.10 Limitations of the study

The main limitation of the study was the fact that the questionnaire was self-reported and completed in a group setting. The researcher, however, was present during each data collection session and all the questions were explained to the members as the questionnaire was completed, to ensure that members understood the questions asked. Members also had the opportunity to ask for further clarification during the completion of the questionnaires.

Other limitations of the study were the availability of members to participate in the study due to work obligations. In the South African Air Force Setting the majority of members are shift workers, which include the members working at the food service units well as the members from 506 Protection Squadron, who are stationed at the gates as guards. These members were unable to leave their area of responsibility. Of the 707 members employed at the unit, only 601 were available as possible research participants due to deployments, courses and vacation leave.

3.11 Conclusion

This chapter discussed the methodology used in conducting this study as well as the ethical considerations as well as the limitations of this study. The methodology was followed according to the objectives of the study as discussed in the first chapter of this dissertation.

3.12 References

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Chapter 4
Overweight, obesity and the prevalence of lifestyle diseases at the Air Force base Bloemspruit

This chapter is written in article format and reports on the findings of data collected for this study according to the first and third objectives of this study, which includes reporting on the prevalence of overweight and obesity in the South African Air Force as well as on the lifestyle factors that influence the development of obesity in the study population. This article has been written with the goal of submission to the South African Journal of Clinical Nutrition (SAJCN) and therefore the author guidelines of the SAJCN have been followed with the exception of the referencing style which is done according to the requirements of the Department of Nutrition and Dietetics, University of the Free State.

4.1 Abstract

Objective: The study aim was to determine the prevalence of overweight and obesity of military members employed at the AFB, Bloemspruit; the associated socio-demographic determinants of obesity and the prevalence of self-reported health conditions associated with overweight and obesity.

Design: A cross-sectional descriptive study was performed.

Setting: Participants were recruited from different units from the AF B Bloemspruit in Bloemfontein, Free State.

Subjects: A convenience sample of 166 uniformed, active duty personnel between the ages of 18 and 60 years were recruited as voluntary participants.

Outcome measures: Data on age, weight, height and waist circumference were collected and Body Mass Index (BMI) calculated. A structured questionnaire was used to collect socio-demographic and health information.

Results: A high prevalence of overweight (38.5%) and obesity (36.1%) was observed in this sample. An unhealthy waist circumference was identified as a prevalent risk factor for the development of metabolic complications, with 42.9% of overweight women at risk and 28.6%

at high risk, 30.4% of obese men at moderate risk and 58.7% at high risk; and 14.3% of obese women at risk and 78.6% at high risk. Despite the high prevalence of overweight/obesity, relatively low levels of lifestyle diseases were reported in this sample. The highest disease prevalence was reported for hypertension (23.3%) with no association found between overweight/obesity and reported lifestyle diseases. No significant associations were found between socio-demographic factors and overweight/obesity.

Conclusion: The high prevalence of overweight and obesity in the study population is concerning. No associations were found between socio-demographic factors or the prevalence of lifestyle diseases and overweight and obesity, possibly due to the young age of participants.

Keywords: Overweight, obesity, waist circumference, socio-demographic, lifestyle diseases,

4.2 Introduction

The global prevalence of overweight and obesity has shown a rapid increase during the past three to four decades (Stevens *et al*., 2012: 4; WHO, 2015: 11; NCD Risk Factor Collaboration, 2016: 1379). The World Health Organization states that the prevalence of obesity has tripled since 1975, which indicates that more than 1.9 billion adults were overweight and more than 650 million adults were classified as obese in 2016 (WHO, 2018: online). The increase in the prevalence of overweight and obesity observed in South Africa has been in line with global trends (Cois & Day, 2015: 5; Department of Health, 2016: 136). The most recent report from the South African Health and Demographic survey indicated that an alarming 68% of females included in the study were overweight or obese while 31% of males were classified as either overweight or obese (Department of Health, 2016: 45). Internationally, numerous studies have been performed on military communities to investigate the prevalence of overweight and obesity, with all these studies reporting either a high prevalence of overweight and obesity or an alarming increase in its prevalence (Reyes-Guzman *et al*., 2015: 148; Rush *et al*., 2016: 1585; Cole *et al*., 2016: 591; Horaib *et al*., 2013; Grotto *et al*., 2008: 608). In South Africa, similar data is however not available for the South African Air Force.

Various factors, including socio-demographic risk factors, such as age (Ryan *et al*., 2003: 2383; Pareja-Galeano *et al*., 2016: 3187), gender (Cois & Day, 2015: 8; Asfaw, 2006: 254; Department of Health, 2013: 136), ethnicity, income, marital status (Case & Menendez, 2010: 278), and educational attainment (Sartorius *et al*., 2015: 10 - 11; Horaib *et al*., 2013: 406) are often linked to the development of overweight and obesity.

The prevalence of chronic diseases have been found to be higher in obese individuals than amongst those who are overweight or have a normal weight (Asfaw, 2006: 255; Crawford *et al*., 2010: 154). A positive association is described between BMI and the risk of developing heart failure, with a greater risk amongst severely obese individuals (Mørkedal *et al*., 2014: 1074). Various studies have shown a strong association between overweight and obesity and the development of hypertension in both abdominal and general obesity (Gao *et al*., 2016: 7; Almeida *et al*., 2016: 6; Bushara *et al*., 2016: 609; Ren *et al.*, 2016: 4). The development of Type 2 diabetes has also been shown to have a strong positive association with overweight and obesity (Xiao *et al*., 2015: 387; Pîrcălăboiu, 2011: 49; Katchunga *et al*., 2016: 6), while metabolic health was another factor that was found to be a strong indicator with regard to the development of Type 2 diabetes, regardless of weight class (Wu *et al*., 2016: 6; Janghorbani *et al*., 2017: 3). The development of cancer is also strongly linked to obesity in numerous studies (Donohoe *et al*., 2017: 46; Vucenik & Stains, 2012: 38; Byers & Sedjo, 2015: R125). Adiposity has been found to be the cause of approximately 17% of obesity-related cancers in Great Britain as well as 13% and 11% respectively in Brazil and China (Byers & Sedjo, 2015: R125). Obesity has also been identified as one of the leading causes of obstructive sleep apnoea (Ünlü *et al*., 2014: 13; Lain *et al*., 2010: 165). In terms of musculoskeletal diseases, obese individuals have a 15% higher prevalence of osteoarthritis than individuals with a normal weight (Anandacoomarasamy *et al*., 2008: 211).

Research clearly shows the detrimental effects of obesity in any population and is, therefore, a reason for concern, especially in a military population where physically laborious tasks are frequently executed. In this study, the prevalence of overweight and obesity at the Air Force Base Bloemspruit, socio-demographic factors as well as the prevalence of health conditions associated with overweight and obesity were investigated.

4.3 Methods

4.3.1 Study design, sample size and ethical approval

This descriptive study was performed by making use of a cross-sectional study design. The study sample included 166 male and female, uniformed members from the Air Force Base Bloemspruit, Bloemfontein between the ages of 18 and 60 years. Ethical approval for this study was obtained from the Health Sciences Research Ethics Committee, University of the Free State (UFS) (Ethical Clearance number: HSREC189/2016 (UFS-HSD2016/1516). Ethical approval was also obtained from the Ethics Committee of the South African Military Health Services situated at 1 Military Hospital in Pretoria, Gauteng, with reference number REC-111208-019-RA. Written informed consent for participation in the study was obtained from all participants who volunteered to participate in the study. Participation was voluntary and participants could withdraw from the study at any time.

4.3.2 Data Collection

Data were collected at the various units situated at Air Force Base Bloemspruit, Bloemfontein during November 2017. Data collected included socio-demographic data, anthropometric measurements and self-reported health history. Socio-demographic information was collected through the use of a self-administered socio-demographic questionnaire, which was completed in a group setting. Socio-demographic data included questions on gender, ethnicity, rank, marital status, and educational attainment.

Anthropometric measurements were taken by the researcher and included weight, height and waist circumference; and Body Mass Index (BMI) was calculated. An ADAM MDW 250-L scale and stadiometer were used to measure weight and height. Standard anthropometric techniques were used and weight was measured to one decimal value, while height was taken to the nearest 0.1cm (National Health and Nutrition Examination Survey, 2007: online). Waist circumference was measured using a non-elastic Seca measuring tape and was taken to the nearest 0.1cm (Lee & Nieman, 2013: 186). Waist circumference was evaluated by making use of gender-specific cut-off values for evaluating metabolic complications (WHO, 2000: 11). BMI was calculated, and the WHO classification used for interpretation. Underweight was classified as a BMI below 18.5 kg/m^2, normal weight was classified as a BMI between 18.5 kg/m^2 and 24.9 kg/m^2. Overweight was defined as a BMI between 25 kg/m^2 and 29.9 kg/m^2 and obesity as a BMI greater or equal to 30 kg/m^2 (WHO, 2000: 8).

Data on health conditions associated with overweight and obesity, including hypertension, hypercholesterolemia, Type 2 diabetes mellitus, gout, heart disease, sleep apnoea, osteoarthritis, and cancer, were collected by making use of a self-reported health history questionnaire to identify current health conditions. All questionnaires were tested during the pilot study which preceded the data collection phase.

4.3.3 Statistical Analysis

Data were captured by the researcher on two Microsoft Excel (2007) spreadsheets and electronically checked by the Department of Biostatistics, Faculty of Health Sciences, University of the Free State in order to identify possible errors. Statistical analysis was also performed by the Department of Biostatistics and SAS software (SAS 9.4) was used to do the analysis. Continuous variables were summarised as medians, minimums, maximums or percentiles. Categorical variables were summarised as means of frequencies and percentages. Differences between groups were evaluated using the Chi-square test or the Fisher's Exact Test for unpaired data. A P-value below or equal to 0.05 was considered statistically significant.

4.4 Results

This study included 136 male and 30 female participants between the ages of 21 and 59 years. The sample included mainly participants with a Black ethnicity (45.8%), followed by White participants (32.5%) and mixed-race ethnicity participants (17.5%). Indian participants made up 1.2% of the population (n=2), while 0.6% (n=1) of the participants indicated their ethnicity as 'other'. The sample included mostly non-commissioned officers (NCO) (n=113) including ranks from Private to Flight Sergeant; Warrant Officers (WO) (n=17) which includes rank groupings from class 1 WO to senior WO; as well as officers (n=36), which includes rank groupings from Lieutenant to Lieutenant Colonel. Most of the participants included in the sample were married and living with their partner (50.7%). Most of the participants obtained a skill or trade after high school (41%) or a college or university degree (24.1%) with 34.9% of the participants who completed high school or less.

BMI values as an interpretation of weight status were divided into three categories namely underweight and normal weight, overweight and obese. As summarised in Table 4.1, 25.3% (n=42/166) of participants were underweight or normal weight, 38.6% (n=64/166) were overweight and 36.1% (n=60/166) were obese according to BMI classification. Of the 133 male participants, 42.8% were overweight and 33. 8% obese, while in the female population of 30 participants, 23.3% were overweight and 46.7% were obese. The median age for underweight and normal weight participants was 33 years, ranging between 23 and 59 years, for overweight 35 years (ranging between 21 and 59 years) and 41 years (ranging between 25 and 58 years) for obese participants. The median age shows an increase from normal and underweight to overweight and obese. Table 4.1 summarises the BMI distribution of participants.

Table 4-1: Body Mass Index

	Body Mass Index Group		
	Under- and Normal Weight BMI <18.5 -24.9 kg/m²	**Overweight** **BMI: 25 – 29.9 kg/m²**	**Obese** **BMI: ≥30 kg/m²**
Risk of Co-morbidities	Low with a BMI <18.5 kg/m² and average at a BMI between 18.5 – 24.9 kg/m²	Increased	Moderate to severe
Prevalence in study population	42 (25.3%) Male: 33 Female: 9	64 (38.6%) Male: 57 Female: 7	60 (36.1%) Male: 46 Female: 14

Waist circumference data were divided into three categories based on the gender-specific cut off points for the evaluation of metabolic complications (WHO, 2000: 11). Amongst males (n=136), 77 were classified as low risk, 29 were classified in the increased risk category and 30 were classified with a substantially increased risk of metabolic complications. Of the female participants (n= 30), 11 were classified with a low risk, 6 with an increased risk and 13 with a high risk for metabolic complications. Table 4.2 provides a summary of waist circumference in terms of BMI.

Table 4-2: Risk of metabolic complications according to waist circumference in relation to weight status

Risk of metabolic complications according to waist circumference	Under and Normal weight		Overweight		Obese		Total	
	n	%	n	%	n	%	n	%
Male								
Low risk (< 94cm)	32	97.0	40	70.2	5	10.9	77	46.4
Increased risk (≥94cm)	1	3.0	14	24.6	14	30.4	29	17.5
Substantially increased risk (≥102cm)	0	0.0	3	5.3	27	58.7	30	18.1
Total	33	19.8	57	34.3	46	27.7	136	81.9
Female								
Low risk (<80cm)	8	88.9	2	28.6	1	7.1	11	6.6
Increased risk (≥80cm)	1	11.1	3	42.9	2	14.3	6	3.6
Substantially increased risk (≥88cm)	0	0.0	2	28.6	11	78.6	13	7.8
Total	9	5.4	7	4.2	14	8.4	30	18.0

In Table 4-3, the demographic information of the participants in relation to their weight status is presented.

Table 4-3: Socio-demographic information of participants in relation to their weight status

Socio-Demographic Factor	Under and Normal weight		Overweight		Obese		P-value
	n	%	n	%	n	%	
Gender							
Male (n=136)	33	24.3	57	41.9	46	33.8	0.5131
Female (n=30)	9	30.0	7	23.3	14	46.7	
Ethnicity (n=162)							
Black or African (n=76)	27	35.5	29	38.2	20	26.3	0.1025
Coloured (n=29)	7	24.1	11	37.9	11	37.9	
White (n=54)	8	14.8	21	38.9	25	46.3	
Indian (n=2)	0	0.0	1	50.0	1	50.0	
Other (n=1)	0	0.0	1	100.0	0	0.0	
Rank							
Non-Commissioned Officer (n=113)	32	28.3	38	33.6	43	38.0	0.0719
Warrant Officer (n=17)	2	11.8	6	35.2	9	52.9	
Officer (n=36)	8	22.2	20	55.6	8	22.2	
Marital Status:							
Single (n=29)	10	34.5	11	37.9	8	27.6	0.2567
In a relationship, not living with a partner (n=26)	7	26.9	11	42.3	8	30.8	
In a relationship, living with a partner (n=11)	4	36.4	5	45.5	2	18.1	
Married, not living with a partner (n=5)	1	20.0	2	40.0	2	40.0	
Married, living with a partner (n=84)	17	20.2	29	34.5	38	45.2	
Divorced (n=8)	1	12.5	5	62.5	2	25.0	
Widow/widower (n=3)	2	66.7	1	33.3	0	0.0	
Educational Attainment							
High school of less (n=58)	14	24.1	19	32.8	25	43.1	0.2228
Trade/skill after high school (n=68)	18	26.5	24	35.3	26	38.2	
College/university degree (n=40)	10	25.0	21	52.5	9	22.5	

Participants reported a total of 69 diagnosed cases of health conditions typically associated with overweight and obesity. A large percentage of members (70.5%) reported no lifestyle diseases, 21.1% reported one diagnosed lifestyle disease, and 8.4% of participants reported that they suffer from more than one lifestyle disease. The highest number of lifestyle diseases reported was four and only one individual was categorised in this group. There was no statistically significant difference (P = 0.1090) with regard to the BMI groupings and the number of lifestyle diseases reported. The health condition with the highest reported prevalence was hypertension (19.3%), followed by hypercholesterolemia (9.6%), and gout (3.6%). Four or fewer participants indicated having other health conditions typically linked to obesity. These conditions included Type 2 diabetes mellitus, heart disease, sleep apnoea, osteoarthritis and cancer. The self-reported health conditions generally associated with obesity are categorised according to BMI and are reported in Table 4.4.

Table 4-4: Self-reported health conditions according to BMI categories

BMI Category	Health condition present		Health condition absent		P-value
Hypertension					
	n	%	n	%	
Underweight and Normal weight (n=42)	6	14.3	36	85.7	0.5246
Overweight (n=64)	12	18.75	52	81.25	
Obese (n=60)	14	23.33	46	76.67	
Hypercholesterolemia					
	n	%	n	%	
Underweight and Normal weight (n=42)	2	4.8	40	95.2	0.0934
Overweight (n=64)	4	6.25	60	93.75	
Obese (n=60)	10	16.7	50	83.3	
Type 2 Diabetes Mellitus					
	n	%	n	%	
Underweight and Normal weight (n=42)	1	2.3	41	97.6	0.7674
Overweight (n=64)	2	3.1	62	96.9	
Obese (n=60)	3	5.0	57	95.0	
Gout					
	n	%	n	%	
Underweight and Normal weight (n=42)	0	0.0	42	100.0	0.4455
Overweight (n=64)	3	4.7	61	95.3	
Obese (n=60)	3	5.0	57	95.0	
Heart Disease					
	n	%	n	%	
Underweight and Normal weight (n=42)	0	0.0	42	100.0	0.6145
Overweight (n=64)	0	0.0	64	100.0	
Obese (n=60)	1	1.7	59	98.3	
Sleep Apnoea					
	n	%	n	%	
Underweight and Normal weight (n=42)	1	2.4	41	97.6	0.3586
Overweight (n=64)	0	0.0	64	100.0	
Obese (n=60)	2	3.3	58	96.7	
Osteoarthritis					
	n	%	n	%	
Underweight and Normal weight (n=42)	1	2.4	41	97.6	0.8335
Overweight (n=64)	1	1.6	63	98.4	
Obese (n=60)	2	3.3	58	96.7	
Cancer					
	n	%	n	%	
Underweight and Normal weight (n=42)	0	0.0	42	100.0	0.6145
Overweight (n=64)	0	0.0	64	100.0	
Obese (n=60)	1	1.7	59	98.3	

4.5 Discussion

A high prevalence of overweight and obesity according to BMI has been identified in recent years in the South African population (Cois & Day, 2015: 5; Department of Health, 2013: 139; Department of Health, 2016: 45–46; Kruger *et al*., 2005: 492) which is also confirmed in this study, where a high prevalence of both overweight (38.5%) and obesity (36.1%) was identified. When the current findings are compared to the prevalence of overweight and obesity in the Free State, where the prevalence of overweight was 19.5% and the prevalence of obesity at 5.8%, and South Africa where the prevalence of overweight of was 20.1% and a prevalence of obesity was 10.6%, the current study showed a higher prevalence of both overweight and obesity in relation to reported percentages in the rest of the Free State and South Africa (Department of Health, 2013: 139). Numerous South African studies have indicated that the prevalence of overweight and obesity is higher in females than in males (Department of Health, 2016: 45–46; Sartorius *et al*., 2015: 13; Asfaw, 2006: 254), and this seems to be the case in numerous other countries based on the Organization of Economic and Co-operation Development (OECD) analysis of national health survey data, however according to this analysis male obesity seems to be showing a more rapid increase in recent years (OECD, 2017: 9). No statistically significant differences with regard to gender and prevalence of obesity were found in the current study, possibly due to the low number of female compared to male participants.

No significant differences were found between the socio-demographic factors investigated in the current study which included gender, ethnicity, rank, marital status and educational attainment and the prevalence of overweight and obesity, however. wealth, higher levels of education, and being married has, in other studies, been reported to be associated with the development of obesity in both males and females (Sartorius *et al*., 2015: 10 - 11; Horaib *et al*., 2013: 406). In a study performed by Sartorius *et al.* between 2008 and 2012 in South Africa, wealth was found to be one of the highest significant risks for the development of obesity in both males and females (Sartorius *et al*., 2015: 12). This was supported by the South African Health and Demographic Survey where the prevalence of obesity increased from 12% to 29% for females and from less than one to 10% in men from the lowest to the highest income groups (Department of Health, 2016: 47). It is however interesting to note that the two studies have significantly different findings with regard to the increase of wealth and obesity between males and females.

In an analysis of eight countries (Korea, Spain, Italy, France, England, Hungary, USA and Canada) worldwide, women with a lower level of education were found to be two to three times more likely to develop obesity in four of the eight countries than their higher educated counterparts (OECD, 2017: 9). Smaller differences were found in men, but these disparities were growing. These findings were contradicted by Horaib *et al.* in a study performed on Saudi Arabian military personnel, where a higher level of education was positively associated with the development of obesity. This study also investigated the effect of military rank, which is closely tied to income and found that higher ranking individuals were less likely to be obese (Horaib *et al*., 2013: 405). These findings were supported by a study performed in the United States where the largest growth of obesity has been taking place amongst highly educated individuals (OECD, 2017: 9). Another study, however, found that tertiary educated individuals did not have a statistically higher risk for the development of obesity than individuals with no schooling (Sartorius *et al*., 2015: 15). The effect of educational level on the development of overweight and obesity is contradictory in the literature, with some evidence stating a positive association between education and the development of overweight and obesity and others finding a negative association. This could explain why no statistically significant differences were found with regard to the prevalence of overweight and obesity and education in this study. Being married was found to have a greater influence on the development of obesity in men than in women in a study performed by Sartorius *et al.* based on findings between 2008 and 2012 (Sartorius *et al*., 2015: 12).

The risk for the development of metabolic complications due to increased waist circumference is well described in the literature (Janssen *et al*., 2004: 381; Klein *et al*., 2007: 1064–1065; Zhu *et al*., 2002: 747). More than 63.3% of the female population and about 43.3% of the male participants in the current study had either an increased risk or a substantially increased risk for the development of metabolic complications based on waist circumference. The male participants in the overweight BMI group had a relatively low risk for metabolic complications when evaluating waist circumference (WHO, 2000: 11).

The absence of significant differences in the prevalence of lifestyle diseases between the different BMI categories was surprising, due to the fact that many studies indicate a significant increase in the prevalence of the health conditions, evaluated in the current study, and overweight and obesity. In a study performed by Almeida *et al.,* the prevalence of hypertension was found to be 50% higher in overweight and obese individuals than in their normal weight counterparts (Almeida *et al*., 2016: 4). The ages of the individuals included in this study ranged between 20 – 59 years and a mean age of 35.5 years (Almeida *et al.*, 2016: 3) , which is similar to the ages in the current study which ranges between 21 – 59 years with a mean age of 36 years. Another study performed on 1275 individuals aged 35 years and more with an average age of 55 years from Yuzhong county Lanzhou supported the findings of Almeida *et al* where a significant association between obesity and the development of hypertension was also identified (Gao *et al*., 2016: 7), while yet another study which included 954 individuals aged between 18 and 90 years and a mean age of 39.5 years further supported these findings where the highest prevalence of hypertension was identified in individuals with a BMI exceeding 35 kg/m² (Bushara *et al*., 2016: 609). When prevalence of hypertension (19.3%) evaluated in the study sample throughout the BMI categories were compared with statistics from the South African Health and Demographic Survey of 2016, the prevalence of hypertension was found to be significantly lower in the current study than that reported for the South African population where a prevalence of approximately 45% was identified (Department of Health, 2016: 48). This may indicate that possible under-reporting of hypertension took place in the current study, especially in the light of the fact that the reported prevalence of overweight and obesity was much lower in the Demographic Health and Nutrition Survey than that of the current study population.

Obesity is a well-known major risk factor in the development of cardiovascular disease (Mirzaei *et al.*, 2017: 65), however large variability with regard to the prevalence of cardiovascular disease has been identified in normal weight, overweight and obese individuals (Mirzaei *et al*., 2017: 65). This necessitated the classification of individuals throughout the BMI groups as either metabolically healthy or metabolically unhealthy (where metabolically unhealthy refers to an individual diagnosed with metabolic syndrome). An increased BMI in the presence of metabolic syndrome was significantly associated with a higher prevalence in coronary artery disease (Hulten *et al*., 2017: 4), while another study found that metabolic syndrome regardless of BMI rendered individuals at a greater risk for the development of acute myocardial infarction (Mørkedal *et al*., 2014: 1073). The same study investigated the risk for the development of heart failure and found that severely obese individuals had a significantly higher risk for the development of heart failure than their normal weight counterparts, regardless of metabolic health (Mørkedal *et al*., 2014: 1074). The reported prevalence for hypercholesterolemia and heart disease in the SANHANES was 4.2% and 7.6% respectively regardless of BMI categories and the prevalence of hypercholesterolemia increased with age, with the highest prevalence amongst individuals aged 55 – 64 years (Department of Health, 2013: 74–75) , while the current study reported a 9.6% prevalence of hypercholesterolemia and a 0.6% prevalence of heart disease in the study sample. The differences observed between the reported prevalence hypercholesterolemia of the current study and that of the SANHANES can not be explained by the prevalence of metabolic syndrome, as only 8.4% of the study population reported more than one health condition No statistically significant differences were found in the current study for the BMI categories and hypercholesterolemia or heart disease in the study sample.

A strong positive association between overweight and obesity and the development of type 2 diabetes mellitus has been widely reported on (Xiao *et al*., 2015: 387; Pîrcălăboiu, 2011: 49; Katchunga *et al*., 2016: 6), while weight loss has been found to cause significant decreases in the risk for the development of type 2 diabetes mellitus (Xiao *et al*., 2015: 388). However, there is evidence that metabolic health does play an important role in the increased development of Type 2 diabetes mellitus throughout the BMI classes (Wu *et al*., 2016: 6; Janghorbani *et al*., 2017: 3). The prevalence of diabetes mellitus as reported in the SANHANES-1 was 5%, compared to the current study where a prevalence of 3.6% was reported. These findings are interesting in light of the above-mentioned evidence, due to the fact that the prevalence of both overweight and obesity was reported in the current study were much higher. No statistically significant differences were however identified between the Type 2 diabetes mellitus across the three BMI categories.

The relative risk for gout in men has been shown to increase with BMI, with a relative risk of 1.40 at a BMI of 21 – 22.9 kg/m² compared to a relative risk of gout of 3.26 at a BMI of 30 – 34.9 kg/m². A BMI exceeding 35 kg/m² is associated with a relative risk of 4.41 for the development of gout (Choi *et al*., 2005: 744). These findings were supported by another study performed on both males and females where the age-adjusted relative risk for gout increased from 1.87 and 1.67 respectively in overweight individuals to 3.50 and 3.52 respectively for individuals exceeding 30 kg/m² (Bhole *et al*., 2010: 1073). It can, therefore, be said that a strong increase in the risk for the development of gout can be seen with an increase in BMI. No significant association was however found between overweight or obesity and gout in the current study.

Obstructive sleep apnoea develops due to an increase in fatty tissue in the walls of the pharyngeal lumen, decreased airway muscle strength due to the deposition of fat in the muscles surrounding the airway as well as the pressure caused by fat in the abdomen and chest (Ünlü *et al*., 2014: 14). Obesity has been classified as one of the main causative factors in the development of obstructive sleep apnoea (Ünlü *et al*., 2014: 13; Lain *et al*., 2010: 165). In the current study, no significant differences were identified between the three BMI categories and the presence of obstructive sleep apnoea.

Cancer is one of the leading causes of death in both developed and developing countries (Vucenik & Stains, 2012: 37). The development of many malignancies has been strongly associated with the presence of obesity in epidemiological studies (Donohoe *et al*., 2017: 46; Vucenik & Stains, 2012: 38; Byers & Sedjo, 2015: R125). In the current study, only one respondent indicated the presence of cancer. This respondent was classified as obese, however again no statistically significant differences were found between the presence of cancer across the BMI categories investigated.

The absence of statistically significant differences across the BMI categories could possibly be due to the inherent disadvantage of using BMI as an indicator of body fat status, with especially males with a high muscle mass being classified as being overweight, which is supported by the relatively low risk in terms of waist circumference identified in this group. Another possible reason for the low prevalence of health conditions can however also be attributed to the relatively young age of the participants as well as the possibility of undiagnosed or unreported health conditions. No associations were found between the lifestyle diseases reported in this study and overweight or obesity.

4.6 Conclusion

In this study, as in the rest of South Africa, a high prevalence of overweight and obesity was identified. The high prevalence of overweight and obesity in this population, however, demands attention, especially due to the active nature of service performed by military personnel. A low prevalence of lifestyle diseases was identified in the study population; however, this could be due to numerous factors including the age of participants, possible underreporting of disease conditions and undiagnosed conditions. Further investigation into the socio-demographic factors associated with the development of overweight and obesity as well as the long-term effect of overweight/obesity on the development of lifestyle diseases is warranted. Future research could include data from medical records to obtain risk factors for lifestyle diseases and prevent underreporting of diseases. The current study did not utilise medical records as captured on the medical mainframe system due to access control as well as the possible inaccuracy of the records due to a capturing backlog.

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Chapter 5

Does lifestyle choices influence the development of overweight and obesity in the South African Air Force?

The data in this chapter is presented in article format according to the Author Guidelines of the African Journal of Primary Health Care and Family Medicine (Appendix D). This chapter focuses on the first and second objective of this study which includes the prevalence of overweight and obesity as well as the dietary and lifestyle factors that influence the development of overweight and obesity at Air Force Base Bloemspruit, Bloemfontein. The referencing of this article is, however, done according to the requirements as set by the Department of Nutrition and Dietetics, University of the Free State.

5.1 Abstract

Background: A global increase in the prevalence of overweight and obesity has been observed in both the global and military populations around the world. No information with regard to the prevalence of overweight and obesity as well as the lifestyle choices that influence its development are available for the South African Military Population.

Aim: To determine the prevalence of overweight and obesity at Air Force Base Bloemspruit in Bloemfontein, Free State, South Africa as well as the factors associated with the development thereof.

Setting: The study sample included 166 volunteers from five units situated on Air Force Base Bloemspruit.

Methods: A descriptive cross-sectional study was performed which included data gathered from active military personnel by means of anthropometric measurements and lifestyle questionnaire.

Results: A high prevalence of overweight (38.6%) and obesity (36.1%) was identified in the study population. No associations could, however, be identified between lifestyle factors or physical activity and body mass index. Most of the participants (59.6%) consumed three meals per day. Only 3.6% of participants consumed less than two meals per day. Meal frequency did not differ between the Body Mass Index categories and no associations were found between meal frequency and overweight or obesity. A very low intake of fruit and vegetables was identified in the study population. With regard to physical activity, some participants reported as much as 42 hours of moderate or vigorous physical activity per week.

Conclusion: A high prevalence of overweight and obesity was observed in the study population. No associations were however found with regard to lifestyle factors and the presence of overweight and/or obesity. Further investigation is required with regard to the prevalence of overweight and obesity as well as predisposing lifestyle factors.

Keywords: Overweight, Obesity, Dietary Intake, Physical Activity, Behavioural Factors

5.2 Introduction

The prevalence of overweight and obesity has shown a strong upward trend in the global population during recent years (Asfaw, 2006: 250; Stevens *et al*., 2012: 4; WHO, 2015: 11; Non Communicable Disease (NCD): Risk Factor Collaboration, 2016: 1379; World Health Organization (WHO), 2018: online). This trend has also been observed in numerous military communities around the world (Reyes-Guzman *et al*., 2015: 148; Cole *et al*., 2016: 591; Rush *et al*., 2016: 1585; Horaib *et al*., 2013; Grotto *et al*., 2008: 608). The increase in the prevalence of overweight and obesity in these communities is of great concern, as an unhealthy high BMI has been associated with a decrease in force readiness, workforce maintenance as well as a decrease in productivity (Peake *et al*., 2012: 2).

Numerous factors have been associated with the development of overweight and obesity. These include factors such as energy balance (WHO, 1995: 316, Webster-Gandy *et al*, 2006: 408), stress (Richardson *et al*., 2015: 5; Ortega-Montiel *et al*., 2015: 3) sleep deprivation (Shankar *et al*., 2010: 3; Canuto *et al*., 2013: 2620; Benedict *et al*., 2011: 1229; Spiegel *et al*., 2004: 847; Timmermans *et al*., 2017: 30), smoking (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608), as well as alcohol intake (Kim & Jeon, 2011: 461; Shelton & Knott, 2014: 629).

The main modifiable risk factor for the development of obesity is undoubtedly a high energy intake which leads to a positive energy balance (WHO, 1995: 316, Webster-Gandy *et al*, 2006: 408). Physical inactivity, which can also lead to the development of a positive energy balance, has been associated with the development of obesity (Jeffery *et al*., 2003: 685). A short sleep duration seems to have an impact on energy consumption and an increase in sleep duration of as little as one hour has showed a 14% reduction in the odds for the development of obesity (Timmermans *et al*., 2017: 27). Smoking has been negatively associated with the development of obesity (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608) and has even been identified as a protective factor with regard to the development of obesity (Grotto *et al*., 2008: 608). Smoking cessation, however, has been shown to have a positive association with regard to the development of obesity (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608). Increased alcohol intake contributes to the development of obesity, most likely due to the high energy density of alcohol and the fact that energy from alcohol takes priority above other sources of energy, leading to these sources being stored in the body as fat (Sayon-Orea *et al*., 2011: 420). Contradicting evidence with regard to alcohol consumption and the development of obesity has however also been documented (Gearhardt & Corbin, 2009: 222; Rohrer *et al*., 2005: 2). Information regarding the prevalence of overweight and obesity and the associated lifestyle factors in the South African military population is not available. This study aims to describe the prevalence of overweight and obesity in Air Force Base Bloemspruit as well as the associated risk factors contributing to the development of overweight or obesity.

Air Force Base Bloemspruit is located approximately 15km outside of Bloemfontein in the Free State province, South Africa. The study population included active duty military personnel from different ethnic groups performing military duties at Air Force Base Bloemspruit which consists of administrative activities as well as physically laborious activities. AFB Bspt is made up of five different units including the main base personnel, 87 Helicopter Flying School, 16 Squadron, 6 Air Support Unit and 506 Protection Squadron. A military medical clinic is also situated on the base, which provides medical services such as primary health care, nursing, dietetics and social work services to the members on the base.

5.3 Ethical Considerations

Ethical approval for conducting this study was obtained from the Health Sciences Research Ethics Committee, University of the Free State (UFS) (Ethical Clearance number: HSREC189/2016 (UFS-HSD2016/1516). Ethical approval was also obtained from the Ethics Committee of the South African Military Health Services situated at 1 Military Hospital in Pretoria, Gauteng, with reference number REC-111208-019-RA. Voluntary written informed consent was obtained from all participants. Participants could withdraw from the study at any time. All documentation was handled in a confidential manner.

5.4 Methods

A cross-sectional study design was used to conduct this study. The study included 166 active duty military personnel (136 males and 30 females) between the ages of 21 and 59 years. A convenience sample of members who volunteered to participate in the study was taken. Only members between the ages of 18 years and 60 years were invited to participate in the study. This study was conducted at the five different units situated at Air Force Base Bloemspruit during November 2017. The aim of the study was to determine the dietary and lifestyle factors associated with the development of overweight and obesity at Air Force Base Bloemspruit.

Overweight and obesity was determined by the use of body mass index (BMI) and waist circumference (WC). Anthropometric data collected included weight, height and waist circumference. Weight was measured by means of an ADAM MDW 250-L scale with a current and valid calibration certificate. Weight was measured in kilograms (kg) to the nearest 0.1 kg, by using standard methods (National Health and Nutrition Examination Survey, 2007: online). The height of the participants was measured using an ADAM MDW 250L stadiometer which is fixed to the scale. Height measurements were recorded to the nearest 0.1 cm using standardised techniques (National Health and Nutrition Examination Survey, 2007: online). BMI is defined as weight in kg divided by height in meters squared (kg/m²) (WHO, 2000: 8). The WHO (2000: 8) cut off points for the evaluation of BMI, as indicated in Table 5.1, were used to interpret BMI.

Table 5-1: Classification of adult weight status according to BMI

Classification	Body Mass Index	Risk of co-morbidities
Underweight	<18.5 kg/m^2	Low (but the risk of other clinical problems increases)
Normal range	18.5 – 24.9 kg/m^2	Average
Overweight	25.0 – 29.9 kg/m^2	Increased
Obesity class 1	30.0 – 34.9 kg/m^2	Moderate
Obesity class 2	35.0 – 39.9 kg/m^2	Severe

Obesity class 3	≥40.0 kg/m^2	Very severe

In order to increase the reliability of the BMI method being used, WC was taken by making use of a non-elastic Seca measuring tape. WC was measured between the lower edge of the ribcage and the upper edge of the iliac crest and measurements were recorded to the nearest 0.1cm (Lee & Nieman, 2013: 186). Waist circumference was interpreted by making use of the WHO (2000:11) cut off points as shown in Table 5.2.

Table 5-2: Risk of metabolic complications with respect to waist circumference

Risk of metabolic complications	**Waist circumference (cm)**	
	Men	Women
Increased	≥94cm	≥80cm
Substantially increased	≥102cm	≥88cm

Food frequency questionnaires are used to estimate food intake in terms of pre-determined food groups. Participants usually indicate their intake of the different foods as stipulated on the questionnaire in terms of frequency of intake in a specified period (Gibson, 2005: 46). The intake can be measured as daily, weekly, monthly or yearly intakes (Lee & Nieman, 2013: 88; Gibson, 2005: 47). For the purpose of this study, a self-administered food frequency questionnaire was used in a group setting and measured food intake on a weekly or daily basis.

Lifestyle factors such as stress, sleep, tobacco use and alcohol intake were determined by making use of a self-administered lifestyle questionnaire completed in a group setting. Physical Activity was determined by making use of the International Physical Activity Questionnaire (IPAQ) developed by the IPAQ Research Committee (Craig *et al*., 2003: 1381). The April 2004 IPAQ Short form was used for the purpose of this study. Physical activity results were classified according to the current recommendations for physical activity from the American Cancer Association which are 150 minutes or 2 hours and 30 minutes per week of moderate intensity physical activity or 75 minutes or 1 hour and 15 minutes of vigorous physical activity spread throughout the week (Kushi *et al*., 2012: 32).

5.5 Statistical Analysis

Data were captured by the researcher on two Microsoft Excel (2007) spreadsheets and electronically checked by the Department of Biostatistics, Faculty of Health Sciences, University of the Free State in order to identify possible errors. Statistical analysis was also performed by the Department of Biostatistics and SAS software (SAS 9.4) was used to do the analysis. Continuous variables were summarised as medians, minimums, maximums or percentiles. Categorical variables were summarised as means of frequencies and percentages. Differences between groups were evaluated using the Chi-square test or the Fisher's Exact Test for unpaired data. A P-value below or equal to 0.05 was considered statistically significant.

5.6 Results

One hundred and thirty-six male and thirty female participants, ranging between the age of 21 and 59 years, volunteered to participate in the current study. The median age of the underweight and normal weight group was 33 years, while the median age for the overweight group was 35 years and that of the obese group was 41 years. This shows a slight increase in age with the increase in BMI; however, these findings were not statistically significant. Most of the participants were classified as being either overweight (38.6%) or obese (36.1%), while a quarter (25.3%) were classified in the underweight and normal weight group.

Regarding waist circumference, 97% of the normal and underweight male, as well as 70% of the overweight male participants, had a low risk for the development of metabolic complications according to their waist circumference. As expected, the majority of male participants (58.7%) in the obese category presented with a high risk of developing metabolic complications according to their waist circumference. These differences were statistically significant ($P<0.0001$), which indicates that obese individuals had a higher waist circumference and are at a higher risk for the development of metabolic complications, as could be expected. In the female underweight and normal weight group, 88.9% of participants were classified as low risk. In the overweight category, the largest prevalence was in the medium risk category at 42.9% of the participants. Most of the obese female participants (78.6%) were categorised as high-risk individuals. These differences were also statistically significant ($p<0.0003$).

Most of the participants (75.9%) used full cream milk, with a slightly higher percentage (83.3%) of participants using full cream milk in the underweight and normal weight category. The intake of processed meats (once or twice weekly) was more than double in the overweight and obese group with 40.8% and 40.9% compared to the 18.3% of participants in the underweight and normal weight category. However, intakes of processed meats consumed three or more times a week showed a similar distribution across the weight classes. The number of individuals who made use of margarine or butter on bread and rolls at least once per day in the obese group was double that of the underweight and normal weight or overweight group. Most of the underweight and normal weight (64.2%) and overweight (67.2%) and obese individuals consumed "vetkoek" and "slap chips" only once or twice a week. Most of the participants (69.0%) did not make use of coffee creamers in their tea or coffee. A relatively similar distribution with regard to the frequency of use of fat during cooking was seen in all of the weight categories. The food frequency questions relating to fat intake are shown in Table 5.3.

Table 5-3: Frequency of consumption of different fat sources in relation to BMI

Fat Intake Questions	Under and Normal weight		Overweight		Obese		P-value
	n	%	n	%	n	%	
Do you use full cream milk, 2% fat milk or fat-free milk at home?							
Full cream milk (n=126)	35	27.8	49	38.9	42	33.3	0.3604
2% fat milk (n=23)	3	13.0	7	30.4	13	56.6	
Fat-free milk (n=10)	3	30.0	5	50.0	2	20.0	
I do not use milk (n=7)	1	14.4	3	42.8	3	42.8	
How often do you eat foods cooked in margarine, butter, or oil?							
Never (n=6)	1	16.7	2	33.3	3	50.0	
1 – 2 times per week (n=58)	13	22.4	21	36.2	24	41.4	0.9496
3 – 4 times per week (n=49)	14	28.6	21	42.8	14	28.6	
5 – 6 times per week (n=20)	6	30.0	7	35.0	7	35.0	
At least once per day (n=33)	8	24.2	13	39.4	12	36.4	
How often do you use margarine or butter on bread or rolls?							
Never (n=38)	10	26.3	17	44.7	11	28.9	
1 – 2 times per week (n=39)	6	15.4	20	51.3	13	33.3	0.2557
3 – 4 times per week (n=36)	10	27.8	14	38.9	12	33.3	
5 – 6 times per week (n=21)	8	38.1	5	23.8	8	38.1	
At least once per day (n=32)	8	25.0	8	25.0	16	50.0	
How often do you add margarine, butter or oil to vegetables when cooking?							0.4521

Fat Intake Questions	Under and Normal weight		Overweight		Obese		P-value
	n	%	n	%	n	%	
Never (n=34)	10	29.4	12	35.3	12	35.3	
1 – 2 times per week (n=70)	15	21.4	29	41.4	26	37.1	
3 – 4 times per week (n=33)	9	27.3	11	33.3	13	39.4	
5 – 6 times per week (n=15)	5	33.3	3	20.0	7	46.7	
At least once per day (n=14)	3	21.4	9	64.3	2	14.3	
How often do you eat sausage, ham, salami, viennas, Russians, polony or bacon?							0.3324
Never (n=14)	6	42.9	5	35.7	3	21.4	
1 – 2 times per week (n=93)	17	18.3	38	40.8	38	40.9	
3 – 4 times per week (n=36)	13	36.1	12	33.3	11	30.6	
5 – 6 times per week (n=9)	3	33.3	2	22.2	4	44.4	
At least once per day (n=14)	3	21.4	7	50.0	4	28.6	
How often do you eat "slap" chips or "vetkoek"?							0.8709
Never (n=33)	7	21.2	13	38.2	13	39.4	
1 – 2 times per week ((n=107)	27	25.2	43	40.2	37	34.6	
3 – 4 times per week (n=15)	4	26.7	5	33.3	6	40.0	
5 – 6 times per week (n=3)	2	66.6	0	0.0	1	33.3	
At least once per day (n=8)	2	25.0	3	37.5	3	37.5	
How often do you use cheese or cheese spread?							0.1788
Never (n=32)	10	31.2	10	31.2	12	37.5	
1 – 2 times per week (n=78)	13	16.7	38	48.7	27	34.6	
3 – 4 times per week (n=37)	14	37.8	11	29.7	12	32.4	
5 – 6 times per week (n=10)	2	20.0	2	20.0	6	60.0	
At least once per day (n=9)	3	33.3	3	33.3	3	33.3	
How often do you use mayonnaise, salad dressing or salad cream?							0.6848
Never (n=34)	9	26.4	14	41.2	11	32.4	
1 – 2 times per week (n=96)	21	21.8	39	40.6	36	37.5	
3 – 4 times per week (n=25)	8	32.0	7	28.0	10	40.0	
5 – 6 times per week (n=5)	3	60.0	1	20.0	1	20.0	
At least once per day (n=6)	1	16.7	3	50.0	2	33.3	
How often do you use sauces or gravy on rice, samp, or pasta?							0.4872
Never (n=21)	4	19.0	8	38.1	9	42.8	
1 – 2 times per week (n=70)	17	24.3	26	37.1	27	58.7	
3 – 4 times per week (n=46)	11	23.9	20	43.5	15	32.6	
5 – 6 times per week (n=17)	7	41.2	3	17.6	7	41.2	
At least once per day (n=12)	3	25.0	7	58.3	2	16.7	
When you eat meat or chicken do you cut the fat from the meat or take the skin off the chicken?							0.7301
Yes, I cut it off before cooking (n=53)	12	48.0	18	34.0	23	43.4	
Yes, I cut it off after cooking (n=41)	12	29.3	16	39.0	13	31.7	
No, I don't remove it at all (n=72)	18	25.0	30	41.7	24	33.3	
How many times a week do you use frying as a cooking method when preparing food?							0.3406

Fat Intake Questions	Under and Normal weight		Overweight		Obese		P-value
	n	%	n	%	n	%	
Never (n=25)	6	24.0	11	44.0	8	32.0	
1 – 2 times per week (n=88)	21	23.9	37	42.0	30	34.1	
3 – 4 times per week (n=39)	9	23.1	11	28.2	19	48.7	
5 – 6 times per week (n=9)	5	55.6	2	22.2	2	22.2	
At least once per day (n=5)	1	20.0	3	60.0	1	20.0	
How many times a week do you use coffee creamers such as Ellis Brown or Cremora?							
Never (n=116)	25	21.5	46	39.7	45	38.8	0.4870
1 – 2 times per week (n=19)	6	31.6	7	36.8	6	31.6	
3 – 4 times per week (n=14)	6	42.8	3	21.4	5	35.7	
5 – 6 times per week (n=5)	2	40.0	1	20.0	2	40.0	
At least once per day (n=12)	3	25.0	7	58.3	2	16.7	
How often do you eat baked products such as pies, cakes, muffins, rusks and cookies?							
Never (n=27)	4	14.8	14	51.9	9	33.3	0.2778
1 – 2 times per week (n=110)	28	25.4	43	39.1	39	35.5	
3 – 4 times per week (n=20)	5	25.0	5	25.0	10	50.0	
5 – 6 times per week (n=3)	2	66.7	0	0.0	1	33.3	
At least once per day (n=6)	3	50.0	2	33.3	1	16.7	

The intake of sugary cold drinks was relatively low in all the weight categories, with 10.2% of the study population consuming sugar sweetend cold drinks on a daily basis. Most of the participants (63.2%) consumed sweets and chocolates only once or twice a week and the distribution of consumption was similar across the different BMI categories. Caffeine-containing energy drinks were consumed by 35.6% of the participants in this study. The sugar-related food frequency questions are indicated in Table 5.4.

Table 5-4: Frequency of consumption of sugary foods and drinks

Sugar intake questions	Under and Normal weight		Overweight		Obese		P-value
	n	%	n	%	n	%	
How often do you drink sugary drinks or soft drinks such as coke, Fanta, Stoney, Iron Brew or flavoured water or ice teas?							
Never (n=13)	3	23.1	7	53.8	3	23.1	
1 – 2 times per week (n=72)	13	18.1	28	38.9	31	43.0	0.1128
3 – 4 times per week (n=31)	14	45.2	9	29.0	8	25.8	
5 – 6 times per week (n=17)	2	11.8	9	52.9	6	35.3	
At least one glass (250ml) per day (n=17)	6	35.3	7	41.2	4	23.5	
More than one glass (250ml) per day (n=16)	4	25.0	4	25.0	8	50.0	
How often do you eat sweets or chocolates?							
Never (n=25)	3	12.0	12	48.0	10	40.0	
1 – 2 times per week (n=105)	25	23.8	44	41.9	36	34.3	0.3151
3 – 4 times per week (n=20)	7	35.0	4	20.0	9	45.0	
5 – 6 times per week (n=8)	4	50.0	2	25.0	2	25.0	
At least once per day (n=8)	3	37.5	2	25.0	3	37.5	
How many times per week do you drink caffeine-containing energy drinks such as Red Bull, Monster or Play?							
Never (n=107)	28	26.2	35	32.7	44	41.1	0.4671
1 – 2 times per week (n=40)	11	27.5	18	45.0	11	27.5	
3 – 4 times per week (n=12)	2	16.7	7	58.3	3	25.0	
5 – 6 times per week (n=4)	0	0.0	3	75.0	1	25.0	
At least once per day (n=3)	1	33.3	1	33.3	1	33.3	
How many teaspoons of sugar do you drink in your coffee or tea?							
None (n=45)	8	17.8	20	44.4	17	37.8	
One teaspoon (n=25)	7	28.0	10	40.0	8	32.0	0.8376
Two teaspoons (n=41)	10	24.4	16	39.0	15	36.5	
Three teaspoons (n=46)	13	28.3	15	32.6	18	39.1	
More than three teaspoons (n=9)	4	44.4	3	33.3	2	22.2	

Table 5.5 shows the results for questions related to meal frequency and meals consumed outside of the home for the week, including weekends. Most of the participants (59.6%) consumed three meals per day, followed by those who consumed only two meals per day (28.9%). Only 3.6% of participants consumed less than two meals per day, while 7.8% consumed more than three meals per day. Overall, 45.8% of participants indicated that they snacked only once a day. The distribution of snacking was similar across BMI categories.

Meals consumed outside of the home were determined by including questions relating to take-away meals and restaurants. Most of the participants (70.5%) consumed take away meals only once per month. No significant differences could be identified with regard to the intake of takeaway meals across the weight categories. Participants seemed to dine at restaurants more frequently than they consumed take away meals. The distribution was similar across BMI categories.

Table5-5: Meal Frequency according to BMI categories

Meal Frequency Questions	Under and Normal weight (n=42)		Overweight (n=64)		Obese (n=60)		P-value
	n	%	n	%	n	%	
How many meals do you consume per day?							0.7269
One meal per day (n=6)	2	33.3	2	33.3	2	33.3	
Two meals per day (n=48)	10	20.8	20	41.7	18	37.5	
Three meals per day (n=99)	25	25.3	36	36.4	38	38.4	
More than three meals per day (n=13)	5	38.5	6	45.2	2	15.4	
How often do you eat breakfast during the week?							0.4099
Never (n=14)	3	21.4	6	42.9	5	35.7	
Once per week (n=10)	5	50.0	4	40.0	1	10.0	
Twice per week (n=18)	4	22.2	9	50.0	5	27.8	
Three times per week (n=20)	2	10.0	7	35.0	11	55.0	
Four times per week (n=14)	5	35.7	4	28.6	5	35.7	
Five or more times per week (n=90)	23	25.6	34	37.8	33	36.7	
How often do you eat lunch during the week?							0.4493
Never (n=4)	1	25.0	1	25.0	2	50.0	
Once per week (n=5)	3	60.0	1	20.0	1	20.0	
Twice per week (n=7)	0	0.0	5	71.4	2	28.6	
Three times per week (n=15)	3	20.0	5	33.3	7	46.7	
Four times per week (n=20)	3	15.0	8	40.0	9	45.0	
Five or more times per week (n=115)	32	27.8	44	38.3	39	33.9	
How often do you eat supper during the week?							0.4213
Never (n=0)	0	0.0	0	0.0	0	0.0	
Once per week (n=2)	1	50.0	0	0.0	1	50.0	
Twice per week (n=3)	2	66.7	0	0.0	1	33,3	
Three times per week (n=2)	0	0.0	2	100	0	0.0	

Meal Frequency Questions	Under and Normal weight (n=42)		Overweight (n=64)		Obese (n=60)		P-value
	n	%	n	%	n	%	
Four times per week (n=7)	2	28.6	2	28.6	3	42.8	
Five or more times per week (n=152)	37	24.3	60	39.5	55	36.2	
How many times per day do you eat anything in between meals?							
Never (n=21)	5	23.8	8	38.1	8	38.1	0.9770
Once per day (n=76)	17	22.4	29	38.2	30	39.5	
Twice per day (n=33)	9	27.3	14	42.4	10	30.3	
Three times per day (n=17)	6	35.3	5	29.4	6	35.3	
Four times per day (n=8)	3	37.5	3	37.5	2	25.0	
Five or more times per day (n=11)	2	18.2	5	45.5	4	36.4	
How often do you eat takeaways or fast food?							
Never (n=25)	8	32.0	6	24.0	11	44.0	0.2623
Once per month (n=117)	26	22.2	46	39.3	45	38.5	
Twice per month (n=18)	7	38.9	8	44.4	3	16.7	
1 – 2 times per week (n=4)	0	0.0	3	75.0	1	25.0	
3 – 4 times per week (n=2)	1	50.0	1	50.0	0	0.0	
How often do you eat in a restaurant?							
Once per month (n=30)	11	36.7	13	43.3	6	20.0	0.3143
Twice per month (n=69)	14	20.3	24	34.8	31	44.9	
1 – 2 times per week (n=41)	10	24.4	16	39.0	15	36.6	
3 – 4 times per week (n=22)	7	31.9	8	36.4	7	31.8	
5 – 6 times per week (n=4)	0	0.0	3	75.0	1	25.0	

A low intake of fruits and vegetables was observed across the BMI categories in this study. Most of the participants consumed fruit only once daily, while vegetable intake was also limited to once per day for most participants. Table 5.6 shows the results from questions relating to fruit and vegetable consumption.

Table 5-6: Fruit and vegetable intake according to the BMI categories

Fruit and vegetables	Under and Normal weight (n=42)		Overweight (n=64)		Obese (n=60)		P-value
	n	%	n	%	n	%	
How many fruits do you consume in a day?							
One fruit per day (n=109)	30	27.5	35	32.1	44	40.4	0.2815
Two fruits per day (n=42)	9	21.4	21	50.0	12	28.6	
Three fruits per day (n=11)	2	18.2	5	45.5	4	36.4	
Four fruits per day (n=4)	1	25.0	3	75.0	0	0.0	
How many vegetables do you consume in a day?							0.3650
One vegetable per day (n=71)	19	26.8	32	45.1	20	28.2	

Two vegetables per day (n=58)	12	20.7	17	29.3	29	50.0	
Three vegetables per day (n=25)	7	28.0	11	44.0	7	28.0	
Four vegetables per day (n=5)	2	40.0	1	20.0	2	40.0	
Five or more vegetables per day (n=7)	2	28.6	3	42.8	2	28.6	

Most of the participants regarded themselves as either moderately or highly stressed individuals. The distribution of stress levels was again found to be similar throughout the weight classes. Most of the participants obtained adequate sleep (more than seven hours of sleep per day). Most of the participants were non-smokers (68.1%) regardless of their BMI categories. No statistically significant differences were found for any of the behaviour questions with regard to the presence of overweight and obesity. Table 5.7 indicates the response regarding the behaviour questions.

Table 5-7: Stress, sleep and smoke patterns according to BMI

Behavioural information	Under and Normal weight (n=42)		Overweight (n=64)		Obese (n=60)		P-Value
	n	%	n	%	n	%	
On a scale from 1 – 10 how stressed would you say you normally are?							0.5076
1 – 3 (Low stress levels) (n=23)	6	26.1	6	26.1	11	47.8	
4 – 6 (Medium stress levels) (n=66)	17	25.8	26	39.4	23	34.8	
7 – 10 (High stress levels) (n=77)	19	24.7	32	41.5	26	33.8	
On average how many hours of sleep do you get in a 24-h period?							0.9123
Less than 7 hours of sleep per day (n=33)	7	21.2	11	33.3	15	45.5	
Equal to or more than 7 hours of sleep per day (n=133)	35	26.3	53	39.8	45	33.8	
Do you currently smoke (n=165)							0.6308
Yes (n=52)	15	28.8	21	40.4	16	30.8	
No (n=113)	27	24.0	43	38.0	43	38.0	

Alcohol intake was also determined and compared, with regard to the distribution of intake, between the three BMI categories, however, no significant difference (p = 0.3624) was found for alcohol intake between the different BMI categories.

Physical activity was classified as moderate and vigorous activity. Most of the participants reported engaging in moderate physical activity (68.0%), while 31.9% of the participants reported no moderate physical activity. The minimum time spent on moderate physical activity was ten minutes, while the maximum was 2520 minutes (42 hours) per week. This indicates that the participant who reported this level of activity participated in six hours of moderate physical activity per day for seven days in a week. No statistically significant difference was found with regard to moderate physical activity duration across the three BMI groups. Most of the participants (64.4%) reported taking part in vigorous physical activity, while (35.5%) of the participants reported no vigorous physical activity. The minimum time spent engaging in vigorous physical activity was also 10 minutes, while the maximum reported for vigorous physical activity was again 2520 minutes (42 hours) per week of vigorous physical activity. The median for vigorous physical activity was 180 minutes for all the groups and no statistically significant difference (p = 0.9879) was found with regard to vigorous physical activity across the three BMI groups. Table 5.8 provides a summary of the median, minimum and maximum exercise duration as reported for each BMI category.

Table 5-8: Physical Activity according to BMI categories

Moderate Physical Activity in minutes per week					
BMI Category	N	Median	Minimum	Maximum	P-value
Under and normal weight	29	120	10	840	
Overweight	46	127	15	2520	0.4891
Obese	38	202	10	1440	
Vigorous physical activity in minutes per week					
BMI Category	N	Median	Minimum	Maximum	P-value
Under and normal weight	27	180	10	720	
Overweight	44	180	30	2520	0.9879
Obese	36	180	10	840	

5.7 Discussion

This study shows that most of the participants were classified as being either overweight (38.6%) or obese (36.1%) according to BMI. A high prevalence of overweight and obesity was also identified in the United States Army in a study conducted on 12 756 military individuals in 2002 where 57.2% of individuals were found to be overweight or obese and 60.5% of individuals were either overweight or obese in 2005 (Smith *et al*., 2012: 1535). A study conducted in the Saudi Arabian Military on 10 229 individuals found that 40.9% of individuals were overweight, while 29% obese (Horaib *et al*., 2013: 403–404). The prevalence of overweight and obesity (40.4%) in the Nigerian military is lower than that seen in Air Force Base Bloemspruit, the United States Army or Saudi Arabian Military, however a prevalence of 40.4% for overweight and obesity is also considered high (Adebayo *et al*., 2011: 314).

In the current study, it was observed that most of the obese individuals had a high risk for the development of metabolic complications according to the WHO waist circumference cut off points in both the male and female groups, while most of the male overweight participants were classified as low risk. In the National Health and Nutrition Examination Survey III (NHANES III) conducted in Atlanta, the USA which included 33 199 participants, both male (84.8%) and female (97.5%) obese participants were classified as high-risk individuals which supports the findings of the current study. A relatively low prevalence of high-risk waist circumference was also observed in the male overweight category, which also supports the findings in the current study (Janssen *et al*., 2002: 2076). Waist circumference is a good indicator of android adiposity (WHO, 2000: 11), which might indicate that the overweight males in the current study had lower levels of android adiposity and possibly higher levels of lean body mass, therefore resulting in a higher BMI.

Increased dietary energy intake has been significantly associated with an increase in body weight according to a WHO global analysis performed on 56 countries (Vandevijvere *et al*., 2015: 450). Fat contains 37.6 kJ/gram, which is more than double that of carbohydrate or protein. This suggests that foods that are high in fat are generally also high in energy, which can lead to an increase in body weight (Rolls, 2000: 268). In the current study, however, the distribution of the intake of fatty foods was similar in all the BMI groups, which may suggest that the quantity of intake instead of the frequency should be considered as a risk factor for the development of obesity. The members of Air Force Base Bloemspruit have also had the opportunity to participate in numerous dietary intake education sessions presented at the base by a qualified dietitian. Members are required to undergo yearly health assessments and are referred for dietary treatment for obesity if identified in an individual, which could have resulted in members reporting intake according to the guidelines that they have received instead of a true reflection of their actual intake.

The intake of energy containing sweeteners has increased significantly (21%) between 1962 and 2000 (Popkin & Nielsen, 2003: 1327–1328) which has been mirrored by a significant increase in the prevalence of overweight and obesity during the last three to four decades (Stevens *et al*., 2012: 4; WHO, 2015: 11; NCD Risk Factor Collaboration, 2016: 1379). The increase in caloric sweetener intake may have played a role in the development of overweight and obesity. No significant differences were however found in the current study with regard to sugar intake across the three BMI groups.

The consumption of smaller, more regular meals (4 or more meals per day) has been shown to have an inverse relationship with the development of obesity, while a higher risk of obesity was observed in individuals who did not eat breakfast on a regular basis (Ma *et al*., 2003: 87). Irregular meal patterns were also associated with a decrease in postprandial energy expenditure as well as a decrease in the thermogenic effect of food in comparison to regular meal frequency in a study performed on ten healthy obese women (Farshchi *et al*., 2005: 22). These studies were however contradicted by a study performed on 16 male and female subjects which found that there were no differences with regard to weight loss between two groups on an energy-restricted diet with regard to meal frequency (Cameron *et al*., 2010: 1099). Most of the participants in the current study consumed three meals per day and the largest percentage of participants consumed one or more snacks per day. No difference with regard to meal frequency could, however, be identified. The frequent consumption of meals consumed outside the home also has a significant association with the development of obesity in a study performed by Ma *et al.* (2003: 90). A low frequency of eating away from home was however observed in the current study with no significant differences observed with regard to the intake of meals outside the home across BMI categories.

Fruit and vegetable intake in the current study did not meet the recommendations according to the South African Food-Based Dietary Guidelines where intake of a minimum of 5 fruits and vegetables or 400g of fruit and vegetables are recommended (Love & Sayed, 2001: s29). Most of the participants consumed only one fruit per day and one to two vegetables per day. This could lead to a low intake of fibre, vitamins and minerals, which could lead to an increase in disease risk (Love & Sayed, 2001: s26). No significant differences were observed for fruit and vegetable intake across BMI groups.A study based on data gathered during the Nurses' Health Study, where 74 063 female nurses were followed up during a twelve year period, found that individuals with a higher consumption of fruit and vegetables had a significantly lower risk for the development of obesity (He *et al*., 2004: 1571), therefore an increase in fruit and vegetable consumption may be advantageous in the current study population.

High levels of perceived stress were found to be causative in the development of obesity, independent of eating behaviours, however high levels of perceived stress was also positively associated with unhealthy eating behaviours (Richardson *et al*., 2015: 5). This was supported by a study conducted on the Mexican Mestizo population where highly stressed individuals had a significantly higher rate of physical inactivity (56.3%) and a higher prevalence of obesity (48.3%) (Ortega-Montiel *et al*., 2015: 3). It can, therefore, be said that the development of obesity can be positively associated with increased levels of perceived stress. In the current study, however, stress levels were equally high in all the individuals investigated regardless of their BMI categories.

Sleep deprivation has been positively associated with the development of obesity in numerous studies (Shankar *et al*., 2010: 3; Canuto *et al*., 2013: 2620; Benedict *et al*., 2011: 1229). Sleep deprivation has been found to increase daytime ghrelin concentrations, which are responsible for an increase in appetite and decreases in energy expenditure, which may lead to a positive energy balance (Kim, 2017: 1). With this, a decrease in the anorexigenic hormone, leptin, has also been observed which may lead to the development of a positive energy balance (Spiegel *et al*., 2004: 847; Kim, 2017: 1). In the current study, 133 (80.1%) of the participants reported that they slept for seven hours or more than seven hours per night. This means that 19.9% of the study population could be classified as being sleep deprived. No statistically significant differences were found with regard to hours of sleep between the BMI categories.

Smokers are generally less likely to experience weight gain than their non-smoking counterparts (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608). In a study performed by Grotto *et al.* (2008:608), it was reported that military members who were smokers prior to recruitment into the military were less likely to develop obesity than those who initiated smoking after recruitment. Smoking cessation has also been associated with a significant increase in BMI in underweight and normal weight individuals (Grotto *et al*., 2008: 608). Smoking cessation is a significant risk factor for an increase in BMI in those who are underweight or have a normal weight (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608). However, individuals who initiate smoking tend to lose weight, but only small changes in weight status were observed (Cois & Day, 2015: 6). In the current study, 31.3% of the population indicated that they smoke. No statistically significant differences were however observed between smokers or non-smokers across BMI groups.

Alcohol consumption has been associated with the development of obesity in numerous studies (Kim & Jeon, 2011: 461; Shelton & Knott, 2014: 629). This can be attributed to the high energy density of alcohol at 29kJ per gram, its pharmacological influence on the nervous system and because it cannot be stored and is therefore given priority over energy derived from other sources (Sayon-Orea *et al*., 2011: 420). In the current study, alcohol consumption across the different BMI groups was analysed and no statistically significant difference was observed.

Various studies have proven a strong association between the development of obesity and physical inactivity (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608–609; Umamaheswari *et al*., 2017: 59–60). Physical activity increases energy output, which in turn results in a negative energy balance and therefore weight loss (Jeffery *et al*., 2003: 685; Lemmer *et al*., 2001: 357). Regardless of the strong evidence to support the association between lower body weight and physical activity, no significant differences could be identified between the BMI groups and physical activity in the current study. Due to abnormally high levels of activity reported, a possibility of over-reporting does exist in this study population.

5.8 Conclusion

A high prevalence of overweight and obesity was identified in the current study, however, no associations were found between any of the risk factors, which have been shown to influence the development of overweight and obesity in the literature, across the BMI groups. It is, however, important to note that the study population has free access to medical care, which includes nutritional counselling by registered dieticians. Most of the members have received some form of nutrition counselling during their time in the military due to numerous preventative projects that are in place to ensure the health and wellbeing of the military community. Therefore, it can be assumed that some under-reporting did take place during the completion of the questionnaires. These findings may also suggest that a more in-depth analysis of anthropometric indicators, such as fat percentage, hip circumference as well as waist-hip ratio, is needed to provide more insight into the body composition of the study participants as part of their routine screening. Making use of structured interviews and 24-hour recall food intake analysis might provide a better indication of the energy and nutrient content of the study participants. Further research with regard to the causes of obesity in the study population is recommended.

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Chapter 6
Conclusions and recommendations

6.1 Introduction

The main aim of this descriptive cross-sectional study was to determine the prevalence of overweight and obesity at Air Force Base Bloemspruit, as well as to identify the lifestyle factors and health consequences associated with overweight and obesity in the study population. This chapter provides the conclusions and recommendations with regard to the findings of this study as presented in chapter four and five of this dissertation.

6.2 Overweight, obesity and the prevalence of lifestyle diseases in the South African Air Force

A high prevalence of overweight and obesity is present in South Africa (Cois & Day, 2015: 5; Department of Health, 2013: 139; Department of Health, 2016: 45–46; Kruger *et al*., 2005: 492). The tendency of an increased BMI and a high prevalence of overweight and obesity was also identified in the current study population. The prevalence of overweight and obesity in Air Force Base Bloemspruit was however higher than reported for the Free State in the South African National Health and Nutrition Examination Survey (SANHANES) study (Department of Health, 2013: 139). This could be due to body composition as a result of high physical activity, however body composition was not evaluated in the current study. Socio-demographic factors such as wealth, higher levels of education and being married have been positively associated with the development of obesity in other studies (Sartorius *et al*., 2015: 10 - 11; Horaib *et al*., 2013: 406). In this study, no associations were however found between these variables and the presence of overweight and obesity.

The study participants reported a relatively low prevalence of lifestyle diseases, regardless of the fact that a high number of participants had a waist circumference above the cut off points for either an increased risk or substantially increased risk for the development of metabolic complications. Strong associations between large waist circumference and the development of lifestyle diseases have however been described in the literature (Janssen *et al*., 2004: 381; Klein *et al*., 2007: 1064–1065; Zhu *et al*., 2002: 747). An interesting finding of the current study was the fact that many of the male overweight candidates had a waist circumference which categorised them as having a low risk for the development of metabolic complications, where one would expect these individuals to have an increased waist circumference. No association was found between the presence of reported lifestyle diseases and overweight and obesity. Under-reporting of or undiagnosed lifestyle diseases is however possible in the current study. High levels of physical activity and the young age of the participants may be protective against the development of lifestyle diseases in the stud population.

This study provides valuable information regarding the prevalence of overweight and obesity in the study population, and from these findings, it is clear that urgent intervention is necessary. The study could however not identify socio-demographic factors associated with the presence of overweight/obesity. No associations were found between lifestyle diseases and overweight and obesity in the study population. Further investigation with the aim of identifying causative factors in the development of overweight and obesity are warranted.

6.3 Does lifestyle choices influence the development of obesity in the South African Air Force

Approximately three quarters (74.7%) of the study sample were classified as being either overweight or obese according to BMI. A high prevalence of overweight and obesity has also been identified in other military communities (Smith *et al*., 2012: 1535; Horaib *et al*., 2013: 403–404; Adebayo *et al*., 2011: 314). Most of the obese individuals, as well as most of the overweight female participants, demonstrated a high risk for the development of metabolic complications due to high waist circumference measurements. Interestingly, almost two thirds (70.2%) of males in the overweight category were classified as having a low risk for the development of metabolic complications according to their waist circumference measurements. A statistically significant association was found between obesity and risk for metabolic complications according to waist circumference in this study. These findings are supported by the NHANES III findings where both male and female obese individuals had a high risk for the development of metabolic complications.

Overweight males also demonstrated a relatively low risk in this study population (Janssen *et al*., 2002: 2076).

An increase in dietary energy intake has been shown to have a significant association with an increase in body weight (Vandevijvere *et al*., 2015: 450). In the current study, fat and sugar intake was investigated as an indication of energy intake. Fat has a high energy density, which could lead to an increase in energy intake and therefore body weight (Rolls, 2000: 268). In this study, however, a similar distribution with regard to the intake of fatty foods were observed in all the BMI categories and no significant differences were found between fat intake in overweight and obese categories An increase in sugar intake has been observed in recent years (Popkin & Nielsen, 2003: 1327–1328) which may lead to a higher energy intake and therefore an increase in body weight. However again a similar distribution with regard to the intake of sugar was found in all the BMI categories and no associations were found between self-reported sugar intake and the prevalence of overweight or obesity.

A greater frequency in meal consumption and the inclusion of breakfast have been found to be protective against the development of obesity (Ma *et al*., 2003: 87). Most of the study population consumed three meals and at least one snack per day. However, no association was found between meal frequency and overweight or obesity in this study. Frequent consumption of meals outside of the home has also been positively associated with the development of overweight and obesity (Ma *et al*., 2003: 90), however, there was no statistically significant differences with regard to the consumption of meals outside the home found between the three BMI categories.

A very low intake of fruit and vegetables was observed in the study population. Most of the participants in this study consumed only one fruit and one or two vegetables per day. The recommendations for fruit and vegetable intake according to the food-based dietary guidelines of South Africa is a minimum of 5 portions or 400g per day (Love & Sayed, 2001: s29). This low intake of fruit and vegetables is concerning as it is associated with decrease fibres, vitamin and mineral intakes, which has been linked to an increase in disease risk associated with low fruit and vegetable consumption (Love & Sayed, 2001: s26). Fruit and vegetable intake was evenly distributed across the various BMI categories and no associations were found with regard to fruit and vegetable intake and the presence of overweight or obesity.

Lifestyle factors such as stress, sleep deprivation (Shankar *et al*., 2010: 3; Canuto *et al*., 2013: 2620; Benedict *et al*., 2011: 1229), smoking (Cois & Day, 2015: 8; Grotto *et al*., 2008: 608) and alcohol consumption (Kim & Jeon, 2011: 461; Shelton & Knott, 2014: 629) has been associated with the development of overweight and obesity. In this study, however, no associations between these factors and overweight and obesity could be identified.

6.4 Limitations of the study

The main limitation of this study was the small number of respondents included in the study as a result of unit activities and work obligations of members working at Air Force Base Bloemspruit. Since the questionnaires were self-administered, some of the questions may have been misunderstood by the participants, which could have led to under- or overreporting of information. This study did not identify a relationship between socio-demographic-, dietary-, or lifestyle factors and the presence of overweight and obesity. No relationships were identified between the presence of lifestyle diseases and overweight and obesity in the study population. Future researchers are advised to make use of structured individual interviews and a detailed diet history that can be analysed to obtain the total energy intake of the individual, physical examinations, including weight, height, waist- and hip circumferences, body composition and hormone levels as well asmedical records to identify lifestyle factors and health consequences associated with overweight and obesity. The sample size of the study must be increased to include more military units and bases, as nutrition and lifestyle behaviours can differ with regard to geographical placement.

6.5 Research Application

Although no significant associations between overweight and obesity and lifestyle factors or health consequences were identified in the study population, a high prevalence of both overweight and obesity was identified. This study is therefore of value as findings may suggest that the current health and nutrition strategies being implemented by the South African Military Health Service may not be effective. Therefore this study identifies the need for the development of new and interesting healthy lifestyle strategies which will inspire members to make lifestyle adjustments and will, therefore, improve the health and wellbeing of the military community at Air Force Base Bloemspruit. Awareness campaigns with regard to risks associated with overweight and obesity should be implemented to ensure that members are frequently reminded of the importance and impact of good nutritional choices. A low intake of fruit and vegetables is a particularly important issue that demands attention due to the health implications resulting from low intakes.

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Appendix A

Approval letter 1 Military Research Ethics Committee

RESTRICTED

1MH/302/6/02.05.2017

sa military health service
Department:
Defence
REPUBLIC OF SOUTH AFRICA

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12 June 2017

CLINICAL TRIAL APPROVAL: 02.05.2017: "OVERWEIGHT, OBESITY AND ASSOCIATED RISK FACTORS IN THE SOUTH AFRICAN NATIONAL DEFENCE FORCE, BLOEMFONTEIN"

1. The 1 Military Hospital Research Ethics Committee (1MHREC) registered in South Africa with the National Health Research Ethics Council (NHREC) (REC-111208-019-RA) adhering to GCP/ICH and SA Clinical Trial guidelines, evaluated the above-mentioned protocol and additional documents.

2. The following members approved the study:

    a. Lt Col M.K. Baker: Neurologist, male, chairman 1 MHREC.
    b. Lt Col C.S.J. Duvenage: Specialist physician, female, member 1 MHREC.
    c. Lt Col D. Mahapa: Dermatologist, female, member 1 MHREC.
    d. Lt Col A.D. Moselane: Urologist, male, member 1 MHREC.
    e. Lt Col E.J. Venter: Periodontist, male, member 1 MHREC.
    f. Maj M.L. Kekana: Specialist physician, female, member 1 MHREC.
    g. DR T.J. Marè: Advocate, independent of the organization, male, member 1 MHREC.
    h. Mrs. C. Jackson: Layperson, independent of the organization, female, member 1 MHREC.
    i. Maj. M.M.M. Ledwaba: Specialist physician, female, member 1 MHREC

3. The following documents were evaluated:

    a. Personalised covering letter from investigator
    b. Research proposal
    c. Informed Consent Document
    d. Questionnaire
    e. Letter of permission to conduct research within the Military
    f. University of Free State Approval Letter
    g. Updated Curricula Vitae:

        i. C. Haasbroek
        ii. R. Lategan-Potgieter
        iii. E. van der Westhuizen

Health Warriors Serving the Brave
RESTRICTED

4. The recommendations are: The study was ethically approved on 12 June 2017. The principal investigator, Capt. C. Haasbroek, will be supervised by Dr. R. Lategan-Potgieter. Report backs are to be made to the 1MHREC six monthly, in the event of any serious adverse events and on completion or termination of the study. Should publications result from the study the relevant manuscripts will also need to be approved by Military Counter Intelligence. All funds generated through this research study should be paid into an approved Regimental fund account.

The 1 MHREC wishes you success with the study.

M.K Baker

(M.K BAKER)
CHAIRMAN 1 MILITARY HOSPITAL RESEARCH ETHICS COMMITTEE:
LT COL / PROF

DIST

For Action

Capt. C. Haasbroek

Appendix B

Approval letter from Health Sciences Research Ethics Committee

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UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

28 July 2017

MRS C HAASBROEK
DEPT OF NUTRITION AND DIETETICS
FACULTY OF HEALTH SCIENCES
UFS

Dear Mrs C Haasbroek

HSREC 189/2016 (UFS-HSD2016/1516)
PROJECT TITLE: OVERWEIGHT, OBESITY AND ASSOCIATED RISK FACTORS IN THE SOUTH AFRICAN NATIONAL DEFENCE FORCE, BLOEMFONTEIN

APPROVED

1. You are hereby kindly informed that the Health Sciences Research Ethics Committee (HSREC) approved this protocol after all conditions were met. This decision will be ratified at the next meeting to be held on 29 August 2017.

2. The Committee must be informed of any serious adverse event and/or termination of the study.

3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.

4. A progress report should be submitted within one year of approval and annually for long term studies.

5. A final report should be submitted at the completion of the study.

6. Kindly use the **HSREC NR** as reference in correspondence to the HSREC Secretariat.

7. 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.

Yours faithfully

....
DR SM LE GRANGE
CHAIR: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE

Cc R Lategan-Potgieter

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Appendix C

Information document and informed consent

OVERWEIGHT, OBESITY AND ASSOCIATED RISK FACTORS IN THE SOUTH AFRICAN AIR FORCE, BLOEMFONTEIN

INFORMATION SHEET

Thank you for participating in this study. This study is being conducted with the aim of improving the health of the members in military service with regard to obesity and the associated risk factors in the South African Air Force, Bloemfontein. The researcher is conducting this study as part of her thesis with the purpose of obtaining an M.Sc in Dietetics.

The study is being conducted to determine the factors involved in causing obesity in military individuals as well as identifying the most common health problems associated with obesity in individuals. Research is conducted with the purpose of answering a question. In this study, the aim is to determine the causative factors when developing obesity and identifying treatment programs and interventions to limit the prevalence of obesity in the South African Air Force, Bloemfontein.

What is the study about? The aim of this study is to gather information with regard to the prevalence of obesity and the associated risk factors and chronic diseases that accompany obesity. The diseases that will be evaluated include high blood pressure, high cholesterol, Type 2 Diabetes Mellitus, gout, heart disease, sleep apnoea, and osteoarthritis. The information obtained will be used to develop nutrition intervention programs for persons diagnosed with obesity in the South African Air Force, Bloemfontein.

For this study, members will be recruited to participate in the study from Air Force Base Bloemspruit. The information will be collected during November 2017 at the various units situated at Air Force Base Bloemspruit. After completion of the study intervention programs will be implemented in the military community of Air Force Base Bloemspruit.

All questionnaires will be completed after which the measurements which include weight, height and waist circumference will be taken. The questionnaires will be completed within a group format which will be led by a qualified registered dietician. Respondents who have provided informed consent will be required to complete a questionnaire to determine the following:

Socio-demographic and household questions
Health and behaviour questions
Eating habits questions
Physical activity questions

As indicated above the measurements such as weight, height, waist circumference will then be taken. It is of the utmost importance that the information gathered is truthful and of high quality. Obesity is a serious health concern which could lead to morbidity and mortality if not corrected. You will be measured to determine whether you are underweight, normal weight, overweight or obese. Intervention programs will be implemented in a timely manner to address the risk factors as well as health concerns identified in this study.

The results of this study will benefit or eventually benefit individuals with regard to the prevention and treatment of obesity in the South African Air Force Bloemfontein.

You are free to refuse participation in this study and will not be required to provide reasons for your refusal. Your privacy will be insured by the fact that all information gathered will be done anonymously. The information will also be safely locked away to further ensure the confidentiality of the information gathered.

The researcher will endeavour to provide information about the outcome of the research. Your information will not be released for other uses without consent unless required by law.

Risks of being involved in the study: All procedures will be conducted with safety principles and regulations in mind to ensure the safety of all participants included in the study. The study is not likely to hold any risks.

Benefits of being in the study: By participating in this study you are contributing to the development of health and nutrition strategies for the prevention and treatment of obesity in the South African Air Force, Bloemfontein. The results of the study will be communicated to the relevant authorities to ensure that the issues identified received the attention required.

Participation is voluntary and refusing participation will not involve any penalty or loss of benefits to which you are entitled. You can discontinue your participation in the study at any given time without penalty or loss of benefits.

Confidentiality: Efforts will be made to keep personal information confidential. All data sheets will be coded and de-identified to ensure that absolute confidentiality is maintained. Personal information may be disclosed if required by law. Organizations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as the Ethics Committee for Medical Research and the Medicines Control Council.

Kind regards

CARINA HAASBROEK

Contact details: 072 630 0293 / 051 405 6264(W)

OVERWEIGHT, OBESITY AND CONTRIBUTING RISK FACTORS AND ASSOCIATED CONSEQUENCES IN THE SOUTH AFRICAN AIR FORCE, BLOEMFONTEIN

CONSENT FORM

You have been asked to participate in a research study and have been informed about the study by Carina Haasbroek

You may contact Carina Haasbroek at 072 630 0293 at any time if you have questions about the research.

You may contact the Secretariat of the Health Research Ethics Committee (HREC) of the Faculty of Health Sciences; UFS at telephone number (051) 405 2812 if you have questions about your rights as a research subject.

Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to terminate participation.

If you agree to participate, you will be given a signed and dated copy of this document as well as the participant information sheet, which is a written summary of the research.

The research study, including the above information, has been verbally described to me. I understand what my involvement in the study means and I voluntarily agree to participate.

______________________ ___________________

Signature of Participant Date

_____________________ ____________________

Signature of researcher Date

Appendix D

Questionnaires

OVERWEIGHT, OBESITY AND ASSOCIATED RISK FACTORS IN THE SOUTH AFRICAN AIR FORCE, BLOEMFONTEIN

OVERWEIGHT, OBESITY AND ASSOCIATED RISK FACTORS IN THE SOUTH AFRICAN AIR FORCE, BLOEMFONTEIN

Please complete the following questionnaire honestly and in full, according to the explanation that will be provided to you.

Respondent number: | | | |

Interview date:

Y	Y	Y	Y	M	M	D	D

Socio-demographic questions

1. What is your rank: ____________________
2. What is your mustering (occupation): ____________________

3. What is your date of birth:

Y	Y	Y	Y	M	M	D	D

4. Please state your age: ____________________

5. What is your gender: | M | F |

Marital Status:

Tick the applicable block:

6. Please indicate your marital status with an X below

1	Single, not living with a partner:	
2	In a relationship, not living with a partner	
3	In a relationship, living with a partner	
4	Married not living with a partner	
5	Married, living with a partner:	
6	Divorced:	
7	Widow/widower:	

Education completed:

Tick the applicable block:

7. Please indicate your level of education with an X in the blocks below

1	High school or less	
2	Trade/Skill after high school	
3	College/university degree	

Race/ ethnicity:

Tick the applicable block:

8. Please indicate your race with an X

1	Black or African	
2	Coloured	
3	White	
4	Indian	
5	Other (specify):	

Health questions:

1. Please indicate with an X if you are suffering from or using medication for any of the following health conditions?

	Yes	No
High blood pressure		
High cholesterol		
Type 2 diabetes mellitus		
Gout		
Heart disease		
Sleep apnoea		
Osteoarthritis		
HIV / AIDS		
Cancer		

Behaviour questions

1. On average, how many hours of sleep do you get in a 24-hour period?

____

2. Do you currently smoke (smoked within the last month)?

1	Yes
2	No, if no skip question 4

3. If yes how many cigarettes do you smoke per day?

____

4. During the past 30 days, how many days did you have at least one drink of any alcoholic beverage such as beer, wine, a malt beverage or liquor? (indicate one)

1	____days per week
2	____days in the past 30 days
3	No drinks in the past 30 days
4	Don't know

5. During the past 30 days when you drank, about how many drinks did you drink on the average? One drink is equivalent to one 330ml beer, 150ml of wine or a drink with one shot of liquor.

1	1 – 2 drinks
2	3 – 4 drinks
3	5 – 6 drinks
4	More than 6 drinks

Eating habits questions

Fat intake

Think about your eating habits over the past 12 months. About how often did you eat or drink each of the following foods? Remember breakfast, lunch, dinner, and eating out or takeaways. Mark the applicable block.

1. Do you use full cream milk, 2% fat milk or fat-free milk at home?

1	Full cream milk
2	2% fat milk
3	Fat-free milk
4	I do not use milk

2. How often do you eat foods cooked in margarine, butter, or oil?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

3. How often do you eat sausage, ham, salami, viennas, russians, polony or bacon?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

4. How often do you use margarine or butter on bread or rolls?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

5. How often do you use cheese or cheese spread?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

6. How often do you eat “slap” chips or “vetkoek”

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

7. How often do you add margarine, butter or oil to vegetables when cooking?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

8. How often do you use mayonnaise, salad dressing or salad cream?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

9. How often do you use sauces or gravy on rice, samp, or pasta?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

10. When you eat meat or chicken do you cut the fat from the meat or take the skin off the chicken?

1	Yes, I cut it off before cooking
2	Yes, I cut it off after cooking
3	No, I don't remove it at all

11. How many times a week do you use frying as a cooking method when preparing food?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

12. How many times a week do you use coffee creamers such as Ellis Brown or Cremora?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

13. How often do you eat baked products such as pies, cakes, muffins, rusks and cookies?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

Sugar and sweetener intake

14. How often do you drink sugary drinks of soft drinks such as Coke, Fanta, Stoney, Iron Brew or flavoured water or ice teas?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least one glass (250ml) per day
6	More than one glass (250ml) per day

15. How often do you eat sweets or chocolates?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

16. How many times per week do you drink caffeine-containing energy drinks such as Red Bull, Monster or Play?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

17. How many cups of coffee or tea do you drink in a day?

1	One per day
2	Two per day
3	Three per day
4	Four per day
5	Five per day
6	More than five per day

18. How many teaspoons of sugar do you drink in your coffee or tea?

1	None
2	One teaspoon
3	Two teaspoons
4	Three teaspoons
5	More than three teaspoons

Meal frequency

19. How many meals do you consume per day?

1	One meal per day
2	Two meals per day
3	Three meals per day
4	More than three meals per day

20. How often do you eat breakfast during the week?

1	Never
2	Once per week
3	Twice per week
4	3 times per week
5	4 times per week
6	5 or more times per week

21. How often do you eat lunch during the week?

1	Never
2	Once per week
3	Twice per week
4	3 times per week
5	4 times per week
6	5 or more times per week

22. How often do you eat supper during the week?

1	Never
2	Once per week
3	Twice per week
4	3 times per week
5	4 times per week
6	5 or more times per week

23. How many times per day do you eat anything in between meals?

1	Never
2	Once per day
3	Twice per day
4	3 times per day
5	4 times per day
6	5 or more times per day

Takeaway meals and eating out

24. How often do you eat takeaways or fast food?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

25. How often do you eat in a restaurant?

1	Never
2	1 – 2 times per week
3	3 – 4 times per week
4	5 – 6 times per week
5	At least once per day

Fruit and Vegetable consumption

26. How many fruits do you consume in a day?

1	One fruit per day
2	Two fruits per day
3	Three fruits per day
4	Four fruits per day
5	Five or more fruits per day

27. How many vegetables do you consume in a day?

1	One vegetable per day
2	Two vegetables per day
3	Three vegetables per day
4	Four vegetables per day
5	Five or more vegetables per day

Perceived stress

28. On a scale from 1 – 10 how stressed would you say you normally are?
One is not stressed at all and ten being very stressed.

1	2	3	4	5	6	7	8	9	10

IPAQ (August 2002) Short last 7 days self-administered

1. During the last 7 days on how many days did you do vigorous physical activities, like heavy lifting, digging, aerobics or fast bicycling?

1	1 day per week
2	2 days per week
3	3 days per week
4	4 days per week
5	5 days per week
6	6 days per week
7	7 days per week
8	**No vigorous physical activities skip to question 3**

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

1	How many hours per day?	1	2	3	4	5	6	7	8	9	10
	or										
2	How many minutes per day?	10	15	20	25	30	35	40	45	50	60

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace; or doubles tennis? Do not include walking.

1	1 day per week
2	2 days per week
3	3 days per week
4	4 days per week
5	5 days per week
6	6 days per week
7	7 days per week
8	**No moderate physical activities skip to question 5**

4. How much time did you usually spend doing moderate physical activities on one of those days

1	How many hours per day?	1	2	3	4	5	6	7	8	9	10
	or										
2	How many minutes per day?	10	15	20	25	30	35	40	45	50	60

Think about the time you spent walking in the last 7 days. This includes at work and at home; walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

1	1 day per week
2	2 days per week
3	3 days per week
4	4 days per week
5	5 days per week
6	6 days per week
7	7 days per week
8.	**No walking skip to question 7**

6. How much time did you usually spend walking on one of those days?

1	How many hours per day?	1	2	3	4	5	6	7	8	9	10
	or										
2	How many minutes per day?	10	15	20	25	30	35	40	45	50	60

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a weekday?

1	How many hours per day?	1	2	3	4	5	6	7	8	9	10
	or										
2	How many minutes per day?	10	15	20	25	30	35	40	45	50	60

This is the end of the questionnaire, thank you for participating

FOR OFFICE USE ONLY

Anthropometric measurements

Weight:				.
Height:				.
Waist circumference:				

Weight:				.
Height:				.
Waist circumference:				

Weight:				.
Height:				.
Waist circumference:				

Appendix E

South African Journal of Clinical Nutrition Author Guidelines

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Author instruction

All manuscripts and correspondence to be submitted electronically to www.sajcn.co.za.

Copyright

Material submitted for publication in the South /African Journal of Clinical Nutrition (SAJCN) is accepted provided it has not been published elsewhere. Copyright forms will be sent with acknowledgement of receipt and the SAJCN reserves copyright of the material published. The SAJCN does not hold itself responsible for statements made by authors.

Authorship

All named authors must give consent to publication. Authorship should be based only on substantial contributions to

- Conception, design, analysis and interpretation of data.
- Drafting the article or revising it critically for important intellectual content.
- Final approval of the version to be published. All three of these conditions must be met. (Uniform requirements for manuscripts submitted to biomedical journals; www.icmie.org/index.html.

Manuscripts

Short items are more likely to appeal to our readers and therefore to be accepted for publication. The manuscript should not exceed 4000 words in total all contents inclusive.

- Original articles of 4000 words or less, with up to 6 tables and illustrations, should normally report observations or research of relevance to the field of nutrition. References should preferably be limited to no more than 25.

- Short reports or scientific letters, which include case reports, side effect or nutrient supplements/drugs and brief or negative research findings should be 1000 words or less, with 1 table or illustration and no more than 6 references.
- Editorials, Opinions, Issues in the field of nutrition, should be about 1000 words and are welcome, but unless invited, will be subjected to the SAJCN peer review process.
- Review articles are rarely accepted unless invited.
- Letters to the editor, if intended for the correspondence column, should be marked 'for publication', signed by all authors and presented in triple spacing. Letters should be no longer than 400 words with only one illustration or table.
- Obituaries should not exceed 400 words and may be accompanied by a photograph.

Manuscript preparation

- Please submit your manuscript electronically at www.sajcn.co.za. (Register as an author, log in and follow the 5 steps to upload your manuscript.)
- Please submit the manuscript as an MS Windows Word Document.
- Please have your manuscript edited by a language expert or colleague proficient in English prior to submission. Articles must be in UK English.
- All manuscripts must include an abstract (50 – 250 words).
- Research articles should have a structured abstract not exceeding 250 words (50 for short reports comprising: Objectives, Design, Setting, Subjects, Outcome measures, Results and Conclusions.
- Refer to articles in recent issues for guidance on the presentation of headings and subheadings.
- Abbreviations should be spelt out when first used in the text and thereafter used consistently.
- Scientific measurements should be expressed in SI units except blood pressure should be given in mmHg and haemoglobin values in g/dl.
- If in doubt, refer to www,icmje.org/index.html.

Illustrations

- All illustrations must be submitted electronically. High resolution (300dpl).jpg or.tiff files are preferred.
- Figures consist of all material that cannot be set in type, such as photographs and line drawings.
- Tables and legends for illustrations should appear on separate sheets and should be clearly identified.
- Line drawings should be arranged to conserve vertical space. Note that reductions to 80mm for a single column of 170mm for double columns should not render lettering illegible. Explanations should be included in the legend and not on the figure itself.
- Figure numbers should be clearly marked on the back of prints and the top of illustrations should be indicated.
- If any tables or illustrations submitted have been published elsewhere, written consent to republication should be obtained by the author from the copyright holder and the author(s).
- A limited number of illustrations are free at the discretion of the editor. Colour illustrations are encouraged but are charged to the author.

References

References should be inserted in the text as superior numbers and should be listed at the end of the article in numerical and not in alphabetical order. Authors are responsible for the verification of references from the original sources. References should be set out in the Vancouver style and approved abbreviations of journal titles used; consult the List of Journals in Index Medicus for these details. Names and initials of all authors should be given unless there are more than six, in which case the first three names should be given followed by *et al*. First and last page numbers should be given.

Journal references should appear thus:

1. Price NC, Importance of asking about glaucoma. BMJ 1983; 286: 349 – 350.

Book references should be set out as follows:

1. Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975: 96 – 101.

2. Weinstein L, Swartz MN. Pathogenic properties of invading microorganisms. In: Sodeman WA jun, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease, Philadelphia: WB Sauders, 1974: 457 – 472.

Manuscripts accepted but not yet published can be included as references followed by (in press).

Unpublished observations and personal communications may be cited in the text, but not in the reference list.

Manuscript revisions

In the event of a manuscript needing revision following the peer review process, all revision changes to the original manuscript should be made using the "track changes" function in Microsoft Word, or in any other such similar format so as to facilitate the speedy completion of the review process. In the event of an "author-reviewer" difference of opinion, the author(s) should state their opinion in writing in the text, which should be bracketed. Revised manuscripts which do not conform to the revision format will be returned to the authors for editing.

Revised manuscript should be resubmitted electronically within 3 weeks of receipt thereof.

Galley proofs

Galley proofs will be forwarded to the author before publication and if not returned, it will be regarded as approved. Please, note that alterations or typeset an order form for reprints, with a price list, will be sent to the author as soon as an article has been placed.

CPD points

Authors can earn up to 15 CPD points for published articles. Certificates will be provided on request after the article has been published.

Privacy Statement

The names and email addresses entered in this journal site will be used exclusively for the stated purposes of this journal and will not be made available for any other purpose or to any other party.

Submission Preparation Checklist

As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.

1. The submission has not been previously published, nor is it before another journal for consideration (or an explanation has been provided in Comments to the Editor).
2. The submission file is in Microsoft Word or RTF file format
3. When available, the URLs to access references online are provided, including those for open access versions of the reference. The URLs are ready to click (e.g., http://pkp.sfu.ca).
4. The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
5. The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines, which is found in About the Journal.
6. If submitting to a peer-reviewed section of the journal, the instructions in Ensuring a Blind Review have been followed.
7. The manuscript has an abstract.
8. The second abstract should be written in simple and clear spoken language highlighting the reason(s) that the research work was undertaken, the key findings and the key recommendations WITHOUT, overtly or covertly implying or containing any claims of whatsoever nature, but rather explaining how the work will help scientists (and/or lay persons) better understand and address the topic of investigation. The abstract should not exceed an absolute maximum of 75 words. In addition, please also include a < 140 character, “strong” message that can be used for social media.

S Afr J Clin Nutr: ISSN (Print): 1607-0658, ISSN (Web): 2221-1268

Appendix F

African Journal of Primary Health Care and Family Medicine Author Guidelines

Aims, scope and review policy

The *African Journal of Primary Health Care and Family Medicine* aims to publish original research and review articles of relevance and interest to the in primary health care practitioners, family medicine specialists and academics from both the developing and developed worlds, public sector and private practice. Papers are peer-reviewed to ensure that the contents are understandable, valid, important, interesting and enjoyed. All manuscripts must be submitted online. All articles in PHCFM will be peer-reviewed.

Article sections and length

The author guideline is available in HTML format for convenience, as it contains large information. If you experience any difficulties please do not hesitate to contact us.

The following contributions are accepted (word counts exclude abstracts, tables and references):
* Original research (3500 and 5000 words)
* Scientific Letters (1000 words]
* Review Articles (4000 words]
* Correspondence (500 words]
* Book reviews [500 and 1000 words]
* Case studies [500 and 1000 words]
* Conference reports, proceedings and abstracts [1000 words]
* Educational material [3500 words]
Please see the journal's section policies section policies for further details.

FULL AUTHOR GUIDELINES

Title page: All articles must have a title page with the following information and in this particular order: title of the article; surname, initials, qualifications and affiliation of each author; the name, postal address, e-mail address and telephonic contact details of the corresponding author; at least 5 keywords.

Abstract: All original and review articles should include an abstract of around 250 words. The structured abstract for an Original Research article should consist of five paragraphs labelled Setting, Objective, Methods, Results and Conclusion. Abstracts for other types of articles need not follow the structured abstract format.

Structure of the article: Original research articles should be organised according to the following sections: Introduction, Method, Results, Discussion and References.
Keywords: All articles should include keywords. Up to five words or short phrases should be used. Use terms from the Medical Subject Headings (MeSH) of Index Medicus when available and appropriate. Keywords are used to index the article and may be published with the abstract.

Acknowledgements: In a separate section, acknowledge any financial support received. This section may also be used to acknowledge substantial contributions to the research or preparation of the manuscript made by persons other than the authors.

References: Cite references in numerical order in the text, in **superscript** format. Do not use brackets. In the References section, references must be numbered consecutively in the order in which they are cited, not alphabetically.

The style for references should follow the format set forth in the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" prepared by the International Committee of Medical Journal Editors.

Abbreviations for journal titles should follow Index Medicus format. Authors are responsible for the accuracy of all references. Personal communications and unpublished data should not be referenced. If essential, such material should be incorporated into the appropriate place in the text. List all authors when there are six or fewer; when there are seven or more, list the first three, then "*et al*.".

Tables: Tables should be self-explanatory, clearly organised and supplemental to the text of the manuscript. Each table should include a clear descriptive title on top and be numbered in Arabic numerals (1, 2, etc) in order of its appearance as called out in the text. Tables must be inserted in the correct position in the text or uploaded separately as supplementary files. Authors should place the explanatory matter in footnotes, not in the heading. Explain all nonstandard abbreviations in table footnotes. For footnotes use the following symbols, in sequence: *,†,‡,§,||,**,††,‡‡.

Figures: All figures must be inserted in the appropriate position of the electronic document, or uploaded separately as supplementary files. Symbols, lettering and numbering (in Arabic numerals e.g. 1, 2, etc. in order of appearance in the text) should be placed below the figure, clear and large enough to remain legible after the figure has been reduced. Figures must have clear descriptive titles.

Photographs and images: If photographs of patients are used, the human subject should not be identifiable and use of the picture should be authorised by enclosed written permission from the subject. The position of photographs and images should be clearly indicated in the text. Electronic images should be saved as either .jpeg or .gif files. All photographs should be scanned at a high resolution (300dpi, print optimised). Provision is made to upload individual images on the website as supplementary files. Please number the images appropriately.

Permission: Permission should be obtained from the author and publisher for the use of quotes, illustrations, tables, and other materials taken from previously published works which are not in the public domain. The author is responsible for the payment of any copyright fee(s) if these have not been waived. Letters of permission should accompany the manuscript. The original source(s) should be mentioned in the figure legend or as a footnote to a table.

Review and action: Manuscripts are initially examined by editorial staff and are sent by the Editor to independent reviewers who are not informed of the identity of the author(s). When the publication in the article's original form is not recommended, the reviewers' comments (without the identity of the reviewer being disclosed) may be passed to the first author and may include suggested revisions. Manuscripts not approved for publication will not be returned, in any format.

Ethical considerations: Papers based on original research must adhere to the Declaration of Helsinki on "Ethical Principles for Medical Research Involving Human Subjects" and must specify from which recognised ethics committee approval for the research was obtained.

Case studies must have the consent of the patient(s) or waiver of consent approved by an ethics committee.

Conflict of interest: Authors must declare all financial contributions to their work or other forms of conflict of interest which may potentially prevent them from executing and publishing unbiased research. [Conflict of interest exists when an author (or the author's institution), has financial or personal relationships with other persons or organisations that inappropriately influence (bias) his or her opinions or actions.]*
**Modified from: Davidoff F, et al. Sponsorship, Authorship, and Accountability. (Editorial) JAMA 2001: 286(10)*

The following declaration may be used if appropriate: "I declare that I have no financial or personal relationship(s) which may have inappropriately influenced me in writing this paper."

Submissions and correspondence

All submissions must be made online at www.phcfm.org and correspondence regarding manuscripts should be addressed to:

The Editor, PHCFM, E-mail: editor@phcfm.org

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