# *Nutritional Assessment of Professional Rugby Players in Mpumalanga: Are Requirements being met according to Current Sports Nutrition Standards?*


## *Reon van Aardt*


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UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
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YUNIVESITHI YA
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*Supervisor: Prof CM Walsh*



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**DATE**

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# ABBREVIATIONS

| | |
|---|---|
| ACSM | American College of Sports Medicine |
| ATP | Adenosine Triphosphate |
| BMI | Body Mass Index |
| CI | Confidence Interval |
| cm | centimetre |
| DRI | Dietary Reference Intake |
| g | gram |
| IDF | International Diabetes Federation |
| IOC | International Olympic Committee |
| ISAK | International Society for the Advancement of Kinanthropometry |
| ISSN | International Society of Sports Nutrition |
| kg | kilogram |
| $kg/m^2$ | kilogram per square metre |
| kJ | kilojoules |
| L | litre |
| mcg | microgram |
| mg | milligram |
| ml | millilitre |
| mm | millimetre |
| RDI | Reference Daily Intake |
| SAMRC | South African Medical Research Council |
| SEMDSA | Society for Endocrinology, Metabolism and Diabetes of South Africa |
| STEPS | Stepwise Approach to Surveillance |
| UK | United Kingdom |
| UL | Upper Tolerable Limit |
| WHO | World Health Organisation |

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# SUMMARY


Optimal sports nutrition is directly linked to success in sporting activities, yet research indicates that adequate knowledge of nutrition is often lacking in athletes. The results of several studies have shown that the dietary intakes and eating habits of rugby players often leave much to be desired.

Evidence-based nutrition principals and recommendations for athletes are continuously summarised by a number of organisations including the American College of Sports Medicine (ACSM) and the International Society of Sports Nutrition (ISSN). The current study aimed to assess the nutritional status of professional rugby players in Mpumalanga and compared the results to current sports nutrition guidelines.

A cross-sectional study design was applied in a total population (n=41) of professional rugby players, the Steval Pumas. Participants were over 18 years old and permanent team members. The study was approved by the Health Sciences Research Ethics Committee of the University of the Free State and the team management. All participants signed written informed consent.

A self-developed questionnaire and three 24-hour recalls were used to obtain information related to dietary intake and lifestyle behaviours (smoking and alcohol intake), as well as information related to socio-demographics (age, home language, level of education and current playing position in the team). This was completed by the researcher in a structured interview with each participant. Food Finder, a dietary analysis software program, was then used to estimate energy, macronutrient and micronutrient intake. Anthropometric measurements were taken by a level one accredited International Society for the Advancement of Kinanthropometry (ISAK) biokineticist, according to standardised techniques, to calculate Body Mass Index (BMI), body fat percentage and waist circumference.

The median age of participants was 26.1 years and the majority spoke Afrikaans (83%), while half had completed a tertiary qualification (51%). Player postions were fairly equally distributed with 54% of participants being forwards (prop, hooker, lock, flanker, or number 8 position), while the remaining 46% were backs (wing, centre, or full back).

The mean body weight of participants was 101kg and 12% were classified as “overweight” according to Boksmart standards (>118 kilogram [kg] for forwards;

>100kg for backs). The mean body fat percentage of participants was 12.5%, well within the international recommendations for professional rugby players (8 – 17%), although median body fat percentages for the forwards (13.9%) and backs (10.1%) were slightly lower than national Boksmart standards.

Based on the recommendations of the ISSN, energy requirements for rugby players are 200 to 350 kilojoules (kJ) per kg body weight per day. In terms of carbohydrate requirements, 5 to 7 grams (g) per kg body weight are needed on an off day, and 6 to 10g per kg body weight are required on training and game days. The ISSN and ACSM further recommend a protein intake of 1.2 to 2.0g per kg body weight per day, while 30% of total daily energy intake should be from fat.

Only 37% of participants perceived their eating habits as “good.” This was confirmed by the fact that the majority of participants did not meet energy (95%), carbohydrate (100%), or fibre requirements (about 75%) on training and off days. In contrast to carbohydrate intake, all participants exceeded protein requirements. In terms of micronutrient intake, about 50% of participants had an intake of Thiamine and Vitamin E below the recommendations on training and off days, while 75% of participants consumed insufficient Vitamin C, as well as Calcium (85%) on these days.

In terms of associations, no significant difference was found between level of education and energy, carbohydrate, protein, fat, as well as micronutrient intake. There was also no significant difference in median energy and macronutrient intake of forwards and backline players. Although not statistically significant, there did seem to be a trend for backline players to consume slightly more energy on training days (12816kJ versus 11334kJ), with forwards consuming slightly more protein on training days (249g versus 228g). Interestingly, the micronutrient intake of participants that were using a supplement was not significantly different to that of participants that were not using a supplement, except for Thiamine on a training and off day, Vitamin B6 on a training day, Vitamin B12 on a training day, Iron on an off day and Zinc on a training day.

As expected, participants with a body fat percentage in the low category had a significantly lower BMI compared to those with a fat percentage in the normal category (95% CI = [0.3kg/m$^2$ ; 4.6kg/m$^2$]). Participants with a body fat percentage in the low category also had a significantly lower waist circumference compared to those with a fat percentage in the normal category (95% CI = [2.0cm ; 7.0cm]). Similarly,

participants with a body fat percentage in the low category had a lower median fat percentage compared to those in the normal category (95% CI = [2.4% ; 6.0%]). The median body fat percentage of backline players was significantly lower than that of the forward players, with a 95% CI for the median difference of [-5.3% ; -2.3%]. Finally, the median running distance covered by the backline players on an average field-work day was significantly higher than that of the forwards ($p=0.0005$).

In conclusion, although most participants maintained the desired body composition, dietary guidelines were not optimally adhered to and the importance of optimal nutrition did not enjoy the same level of attention as their physical training. The findings of the present study can provide valuable and useful information to the players and their coaches on adherence to dietary requirements for provincial rugby players.

It is recommended that nutrition-related issues be addressed, since inadequate dietary intakes and unhealthy eating behaviours can negatively impact on nutritional status, overall health, quality of training, performance and recovery. Further research related to the barriers that prevent rugby players from following the guidelines is warranted, in order to motivate practical, cost-effective and relevant interventions.

***Key words****: assessment, exercise, guidelines, nutritional status, rugby.*

# CHAPTER 1

# MOTIVATION FOR THE STUDY

## 1.1 Introduction and Problem Statement

Proper nutrition forms an essential component of optimal sports performance (Beck *et al*., 2015:259 & Smith *et al.,* 2015:1), yet research indicates that adequate knowledge of nutrition is often lacking in athletes (Nascimento *et al.,* 2016:1; Heaney *et al.,* 2011:248). According to the International Olympic Committee (IOC), there is limited research about the nutritional practices of professional rugby players (Holway & Spriet, 2011:115).

The results of a number of studies have shown that the dietary intakes and eating habits of athletes, especially rugby players, often leave much to be desired (Jenner *et al.,* 2018:2; Alaunyte *et al.,* 2015:2; Tooley *et al.,* 2015:559; Potgieter *et al.,* 2014:42). A study by Shriver *et al.* (2013:15) showed that athletes failed to meet their minimum energy and carbohydrate needs when compared to established sports nutrition guidelines. Based on these findings, the authors recommend that nutrition-related issues should be given attention, since inadequate dietary intakes and unhealthy eating behaviours can negatively impact on nutritional status, overall health, quality of training and recovery. Student athletes are not the only group that are affected. In a study by Tooley *et al.* (2015:557), the dietary habits of professional league rugby players in the United Kingdom (UK) were found to be inadequate to meet nutritional recommendations.

Although the assistance of a nutritional professional would be more beneficial, most athletes decide on a self-chosen nutrition strategy. This often results in poorer performance when compared to athletes following a planned scientific nutrition strategy (Beck *et al*., 2015:259). With this in mind, interventions to assess and address the importance of adequate nutrition in athletes are justified.

The current study aimed to assess energy and macronutrient intakes of professional rugby players in Mpumalanga, followed by a comparison of the results with recommendations of the American College of Sports Medicine (ACSM) and the International Society of Sports Nutrition (ISSN). Micronutrient intakes were also assessed and compared to the Dietary Reference Intakes (DRI’s) established by the

Food and Nutrition Board, Institute of Medicine, National Academies. In addition, this study explored the dietary intake and patterns, lifestyle factors (alcohol and smoking) as well as anthropometric status (Body Mass Index [BMI] and body fat percentage) of the target population. Anthropometry was compared to the South African Boksmart guidelines. These findings can translate to recommendations to address dietary and lifestyle habits that do not meet the evidence-based sports nutrition guidelines, ultimately improving the nutritional status and performance of these athletes. In view of the major consequences on nutritional inadequacy on performance, the current study was justified.

## 1.3 Aim and Objectives

The main aim of this study was to assess the nutritional status of professional rugby players in Mpumalanga, and to compare the results to current sports nutrition guidelines. In order to achieve the main aim, the study had the following specific objectives:

- To determine socio-demography
- To assess anthropometry
- To assess dietary intake
- To investigate lifestyle behaviours
- To determine associations between sociodemographic, anthropometric, dietary and lifestyle factors
- To evaluate and compare the results of the participants in the current study with the recommendations and guidelines established by the ACSM and the ISSN.

## 1.4 Outline of the Dissertation

This dissertation is divided into six chapters. Figure 1.1 provides an overview of the outline of the dissertation, highlighting chapter 1, the introduction to the study:

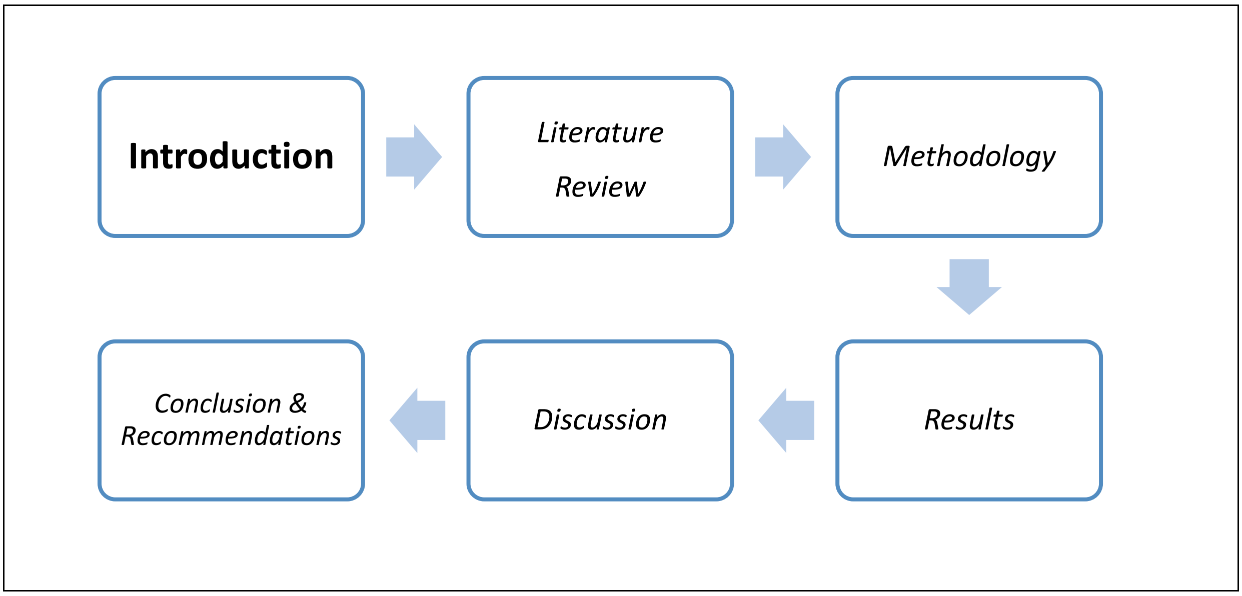


**Figure 1.1: Outline of the dissertation: Introduction**

In Chapter 1 the motivation for the study as well as the aim and objectives have been outlined. Chapter 2 comprises the literature review. In Chapter 3 the methodology is explained, including study design, population and sample selection, measurements, the data collection process and ethical considerations. Chapter 4 includes the results of the study, and in Chapter 5 these results are discussed in relation to other relevant literature. Chapter 6 comprises conclusions and recommendations related to practice as well as to future research.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Rugby is a physically challenging, multi-activity contact sport involving 15 players (eight forwards and seven backs), playing two halves of 40 minutes (Burke & Cox, 2010:418). Rugby can be characterised by short burst of high intensity interval sessions (running, heavy tackling and tactical kicking) and longer periods of lower intensity activities (walking and jogging) (Duthie *et al.,* 2006:202).

Rugby demands substantial requirements on the body's fuel stores due to the regular changes in exercise intensity. Adequate nutrition is not only a key component for optimal health and nutritional status, but also an important factor in energy production needed for exercise and recovery, as well as optimal performance of these athletes (Alaunyte *et al.,* 2015:1; Smith *et al.,* 2015:1; Shriver *et al.,* 2013:10; Duthie *et al.,* 2006:202).

It is well accepted that optimum nutrition improves an individual's exercise ability, muscle recovery, as well as metabolic adaptations relevant to endurance training (Nascimento *et al.,* 2016:1 & Potgieter, 2013:7). Multiple factors may play a role in dietary habits, including taste and food preference, as well as cultural, religious, and family beliefs (Heaney *et al.,* 2011:248). With this in mind, nutritional support should be individualised to meet the athlete's needs in order to contribute to better training and competition (Williams & Rollo, 2015:S14). When compared to endurance athletes such as long distance athletes or cyclists, rugby players usually focus much less on their diet (Alaunyte *et al.,* 2015:1). Consequently Shriver *et al.* (2013:11) suggest that good knowledge of nutrition should be considered a priority amongst athletes to contribute to improving their diet and resultant nutritional status, as well as ensuring proper post-exercise recovery. According to Mielgo-Ayuso *et al.* (2015:228), an unstable balance between dietary intake, energy expenditure with normal daily activities, as well as the additional requirements associated with physical exercise, tends to be quite common amongst athletes who exercise regularly. Poor overall nutritional status of athletes is directly linked to poor performance (Smith *et al.,* 2015:1; Shriver *et al.,* 2013:10; Kreider *et al.,* 2010:7).

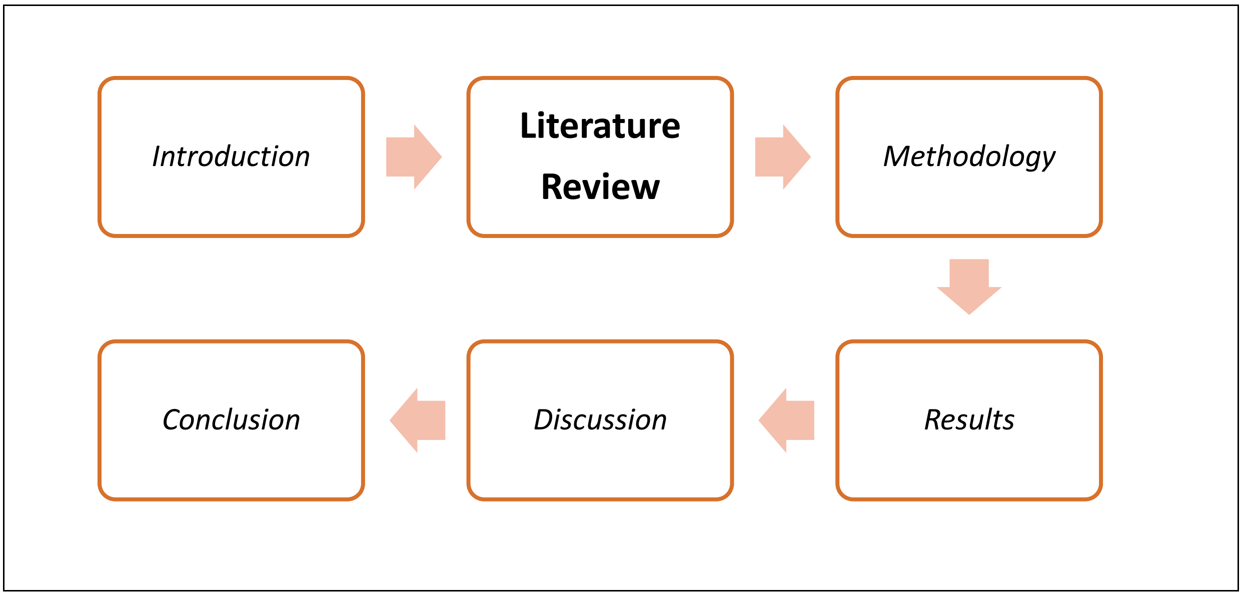


**Figure 2.1: Progression of the study: Literature Review**

In this literature review, an overview of guidelines and dietary recommendations for athletes, including energy, macro- and micronutrient requirements, as well as fluid intake is given. In addition, assessment of body composition and lifestyle behaviours that are recommended for athletes, will be discussed. Few similar studies have been undertaken amongst professional rugby players, including:

- A descriptive study on the nutritional knowledge and eating habits of 21 professional Super League rugby players in the United Kingdom (Alaunyte *et al.,* 2015:2). This study aimed to investigate the relationship between dietary habits and nutritional knowledge obtained using questionnaires. The findings revealed that many starchy and fibrous foods were consumed only occasionally by poor nutritional knowledge group, while the good nutritional knowledge group consumed significantly more fruit and vegetables and starcy foods.
- A cross-sectional study on dietary intake and body composition of 46 professional Australian football athletes during a pre-season training week (Jenner *et al.,* 2018:2). Dietary intake was assessed and compared with international guidelines. In this study, overall, no athlete met dietary their recommended energy intake or carbohydrate recommendations while only 54% met protein recommendations. Higher levels of education were also associated with higher intakes of energy and vegetables.
- A cross-sectional study that included 35 South African rugby players (the FNB Maties Varsity Cup team), in which body composition and habitual and match-day dietary intake were assessed and compared with international standards

(Potgieter *et al.,* 2014:37). Compared with current recommendations, group habitual dietary intake was inadequate for total energy and carbohydrate, while higher than recommended intakes for protein, fibre and fat were observed.

## 2.2 Guidelines related to dietary requirements of athletes

A healthy and balanced diet is key to adequate nutrition which in turn has a significant impact on performance. It is thus recommended that athletes should follow evidence-based dietary guidelines (Alaunyte *et al.,* 2015:2).

Sport nutrition guidelines are an advantageous tool to aid in any athlete's exercise programme. The ISSN publish consensus documents that regularly review research and recommendations for exercise and sport nutrition (Potgieter, 2013:7). The most recent document was published in 2018 (Kerksick *et al.,* 2018).

Guidelines inform both dietary patterns as well as nutrient consumption. According to Shriver *et al.* (2013:10), breakfast consumption significantly improves athletes' performance due to liver and muscle glycogen levels being restored after an overnight fast. Therefore, it is recommended that athletes regularly consume breakfast. Furthermore, recommendations include the consumption of no less than five meals or snacks per day to ensure sufficient energy levels throughout the day (Shriver *et al.,* 2013:10). In addition, Thomas *et al.* (2016:508) and Burke *et al.* (2003:522) recommend that physically active individuals may benefit from the consumption of small, frequent meals, as this could help meet their energy and nutrient needs. Although well-stocked body stores may meet the energy requirements of an athlete participating in a rugby match, additional energy intake during exercise may increase performance and reduce fatigue (Burke & Cox 2010:423).

Performance enhancing agents, in the form of sport supplements, are used by the majority of elite athletes. However, because the content of most supplements are often not tightly regulated, athletes should not assume that the use of these supplements can replace scientifically proven dietary strategies (Bean, 2017:106). Nascimento *et al.* (2016:1) state that thermoregulation, energy stores, muscle protein synthesis, as well as vitamin and mineral supply may be enhanced if nutritious foods are ingested.

Although the importance of adequate nutrition and a balanced diet have been well established, many athletes still present with nutritional deficiencies, often as a result of inadequate nutritional knowledge (Nascimento *et al.,* 2016:1). According to Heaney *et al.* (2011:259), assessment of nutrition knowledge is important to inform the development of relevant nutrition education interventions for athletes. Alaunyte *et al.* (2015:1) have confirmed that healthy eating and healthy food choices are closely associated with good nutritional knowledge in athletes.

Furthermore, dietary recommendations should be individualised according to the type of sport and specific requirements of an athlete. To ensure optimal performance, advice in this regard should be provided by a skilled professional (Beck *et al*., 2015:265).

### 2.3 Energy Requirements

Adequate energy intake from a wide variety of nutritious foods, accurately distributed during the day, together with sufficient intakes of fluids, macronutrients (carbohydrates, proteins and fat), as well as micronutrients, contribute to optimal performance of athletes (Beck *et al.,* 2015:259; Potgieter, 2013:7).

The DRI for macronutrients are defined by Nelms & Habash (2016:65) as "standards of intake that are age and gender specific, designed to meet the nutrient requirements of about 98% of the healthy population."

Inadequate intake of energy and macronutrients may affect an athlete's performance negatively (Kerksick *et al.,* 2018:10; Thomas *et al.,* 2016:507; Kreider *et al.,* 2010:7). It is essential that athletes meet their energy requirements, as insufficient intakes can cause reduced performance, muscle loss, delayed recovery, and a higher risk for fatigue, injury and illness (Bean, 2017:5). In a study undertaken amongst Nigerian athletes, Folasire *et al.* (2015:223) confirmed that an athlete's performance can be improved by promoting adequate energy intake, lean muscle mass and appropriate weight gain. Despite the importance of meeting energy requirements, studies have shown that athletes often do not meet these requirements. A study by Jenner *et al.* (2018:3) showed that none of the professional Australian football players in their study met current energy recommendations.

The ISSN recommends that energy requirements are calculated according to level of physical activity and body weight, as summarised in table 2.1 (Kerksick *et al.,* 2018:10; Potgieter, 2013:7; Kreider *et al.,* 2010:8).

**Table 2.1: Energy Requirements for Physical Activity (Kerksick *et al.*, 2018:10)**

| Level of Physical Activity | Energy Intake |
|---|---|
| General physical activity 30-40 minutes/day, 3 times a week | 100 – 150kJ/kg/day |
| Moderate levels of intense training 2-3 hours/day, 5-6 times a week | 200 – 350kJ/kg/day |
| High-volume intense training 3-6 hours/day, 1-2 sessions/day, 5-6 times a week | 200 – 350kJ/kg/day |
| Elite athletes | 600 – 850kJ/kg/day |

### 2.3.1 Carbohydrate Requirements for Exercise

Carbohydrates serve as fuel for the whole body, including the brain and central nervous system. Both anaerobic and oxidative pathways use carbohydrates and it can provide a higher support of ATP per volume of oxygen than fat, thus increasing overall performance (Spriet, 2014:94). Muscle glycogen and blood glucose are the primary sources of energy for contracting muscles (Heaton *et al.,* 2017:2203). According to Jenner *et al.* (2018:6), Kerksick *et al.* (2018:11) and Thomas *et al.* (2016:508), an insufficient carbohydrate intake is associated with fatigue, impaired concentration and decreased physical output. In studies by Shriver *et al.* (2013:14) and Jenner *et al.* (2018:3), that included college athletes and professional football players respectively, participants failed to meet their carbohydrate requirements. During moderate- to high-intensity exercise, glycogen stores in the body will be depleted after approximately 90 minutes to three hours, and for this reason it is essential to ensure optimal dietary carbohydrate intake to optimise glycogen stores (Bean, 2017:34; Potgieter, 2013:8). Carbohydrates, when consumed as carbohydrate-electrolyte solutions during exercise, have been shown to enhance performance (Williams & Rollo, 2015:S13). Kerksick *et al.* (2018:11), Heaton *et al.,* (2017:2203) and Williams & Rollo (2015:S19) further state that the consumption of carbohydrates directly after exercise will result in better recovery of depleted liver and muscle glycogen stores. Practical recovery-focused carbohydrate recommendations for team sport athletes include the consumption of 1.0 - 1.2 g/kg body weight within the first hour post-exercise (Heaton *et al.,* 2017:2203). A summary of the guidelines for daily carbohydrate intake by athletes is shown in table 2.2, while strategies for promoting high carbohydrate availability for optimal performance during exercise are shown in table 2.3, and guidelines for carbohydrate intakes during exercise are summarised in table 2.4. Although these guidelines are evidence-based recommendations by the ACSM (Thomas *et al.,* 2016:508; Burke *et al.,* 2011:S20), targets should still be individualised to the athlete and event (Holway & Spriet, 2011:122).

**Table 2.2: Daily Carbohydrate Needs of Athletes (Thomas *et al.,* 2016:508; Burke *et al.,* 2011:S20)**

| Exercise Situation | Exercise Description | Carbohydrate Targets |
|---|---|---|
| Light | Low intensity or skilled-based activities | 3 - 5g/kg of athlete's body weight/day |
| Moderate | Moderate exercise program (e.g., ~1h/d) | 5 - 7 g/kg/day |
| High | Endurance program (e.g., 1 - 3 h/d moderate to high-intensity exercise) | 6 - 10g/kg/day |
| Very high | Extreme commitment (e.g., >4 - 5 h/d moderate to high-intensity exercise) | 8 - 12g/kg/day |

**Table 2.3: Fueling Strategies to Promote High Carbohydrate Availability (Thomas *et al.,* 2016:508; Burke *et al.,* 2011:S20)**

| Exercise Situation | Exercise Description | Carbohydrate Targets |
|---|---|---|
| General fueling up | Preparation for events <90 min | 7 - 12g/kg/24h |
| Carbohydrate loading | Preparation for events >90 min of sustained/intermittent exercise | 10 - 12g/kg/24h for 2 days |
| Speedy refueling | <8h recovery between 2 fuel-demanding sessions | 1 - 1.2g/kg/h for first 4h, then resume daily fuel needs |
| Pre-event fueling | Before exercise >60 min | 1 - 4g/kg consumed 1 - 4h before exercise |

**Table 2.4: Guidelines for Carbohydrate Intake by Athletes during Exercise (Thomas *et al.,* 2016:508; Burke *et al.,* 2011:S20)**

| Exercise Situation | Exercise Description | Carbohydrate Targets |
|---|---|---|
| During brief exercise | <45 min | Not needed |
| During sustained high intensity exercise | 45 - 75 min | Small amounts |
| During endurance exercise, as well as “stop and start” sports | 1 - 2½h | 30 - 60g/hour |
| During ultra-endurance exercise | >2½ - 3h | Up to 90g/hour |

### 2.3.2 Fibre Recommendations

According to the American Heart Association and the Food and Nutrition Board, a high fibre diet can assist in lowering the risk for development of metabolic risk factors. Dietary fibre can also support the growth of good gut flora due to its prebiotic properties (Sekgala *et al.,* 2018:2). As with energy and carbohydrate intake, many athletes do not meet their fibre requirements. This has been confirmed in a study by Tooley *et al.* (2015:557), amongst professional league rugby players in the UK (30 grams [g] per day is recommended by the British Nutrition Foundation) as well as in a study amongst Australian football players (Jenner *et al.,* 2018:3).

### 2.3.3 Protein Requirements for Exercise

According to the ACSM, athletes require adequate energy during periods of high intensity and/or long duration training to maintain body weight, to maximise training effects and to ensure that protein is used to build muscle mass instead of serving as an energy source (Potgieter, 2013:7).

Rugby players are involved in endurance training, as well as power, muscular strength and speed activities. As protein requirements increase for both endurance and strength training, it is crucial for these athletes to consume adequate protein to promote muscle damage repair and restoration of glycogen after exercise (Kimiyiwe and Simiyu, 2009:1307; Duthie *et al.,* 2006:202). Current literature also states that high-quality dietary protein intake is essential for metabolic adaptation, maintenance, repair and synthesis of skeletal muscle proteins (Thomas *et al.,* 2016:510-511). Additionally, the rate of digestion and/or absorption and metabolic activity of the protein also are important considerations (Kerksick *et al.,* 2018:12).

General recommendations by the ISSN and ACSM range between 1.2 to 2.0g per kilogram (kg) per day for athletes involved in moderate amounts of intense training and 1.7 to 2.2g per kg for athletes involved in high volume, intense training, while 0.3g per kg body weight protein should be consumed 0 to 2 hours after exercise (Kerksick *et al.,* 2018:12; Potgieter, 2013:12; Beelen *et al.,* 2010:12; Kreider *et al.,* 2010:9). The immediate intake of protein after exercise will enhance performance by promoting muscle repair (Bean, 2017:81). Williams & Rollo, (2015:S20) advise adding protein to carbohydrates during recovery, as this will improve muscle and glycogen re-synthesis.

An insufficient intake of protein may lead to muscle wasting and training intolerance, as protein catabolism will be increased due to a negative nitrogen balance (Kerksick *et al.,* 2018:11; Kreider *et al.,* 2010:9). On the other hand, Bean (2017:88) confirmed that there is no evidence that a protein intake higher than the recommend intakes will further increase muscle mass.

### 2.3.4 Fat Requirements for Exercise

Fat is an essential component of a healthy diet. In addition to providing energy, fat is also necessary for the absorption of fat-soluble vitamins and is an important element of cell membranes (Thomas *et al.,* 2016:511).

There are currently no weight-based guidelines for athletes in terms of dietary fat, but a moderate amount of fat is recommended, similar to or slightly greater than the recommendations for non-athletes (Kerksick *et al.,* 2018:13; Potgieter, 2013:13; Shriver *et al.,* 2013:11). According to the ISSN, 30% of total daily energy should consist of fat, while the ACSM suggests a range of 20–35 % of total daily energy intake should consist of fat (Potgieter, 2013:13; Kreider *et al.,* 2010:10). Although the popularity of high fat diets has increased, limited and mixed evidence remains regarding the overall efficacy of a ketogenic diet for athletes (Kerksick *et al.,* 2018:13).

## 2.4 Micronutrient Requirements

The ACSM recommends that athletes do not need additional vitamin and mineral supplementation if adequate energy and micronutrient intake is obtained through a wide variety of foods (Kerksick *et al.,* 2018:15). The ISSN agree that a healthy balanced diet should provide sufficient amounts of micronutrients in most cases (Potgieter, 2013:14; Kreider *et al.,* 20110:11). In a study by Burkhart and Pelly (2016:4) amongst 44 athletes who participated in the 2010 Common Wealth Games in India, 80% of athletes did not meet the DRI for Thiamine, Riboflavin, Niacin, Vitamin C and Iron. Rodriquez *et al.* (2009:515) have stated that the most common vitamins and minerals found to be of concern in the diets of athletes are calcium and vitamin D, the B vitamins, iron, zinc magnesium, as well as antioxidants such as Vitamin C and E. It was also highlighted that the use of vitamin and mineral supplements does not improve performance in individuals consuming healthy balanced diets (Rodriquez *et al.*, 2009:515). Bean (2017:93) also notes that vitamins and minerals do not in themselves provide energy and although they are crucial for health and exercise, they can be harmful when consumed in excessive amounts (above the Upper Tolerable Limit [UL]).

Table 2.5 shows the function, deficiency signs and symptoms of vitamins and minerals associated with exercise, as well as the DRI of the mentioned micronutrients for male individuals, as established by the Food and Nutrition Board, Institute of Medicine, National Academies (Dorfman, 2017:441 & Otten *et al.,* 2006:532-535).

**Table 2.5: Micronutrient Function, Deficiency Sign or Symptom, and DRIs: Recommended Intakes for Male Individuals, 19-33 years (Dorfman, 2017:441 & Otten *et al.,* 2006:532-535)**

| **Micronutrient** | **Function** | **Deficiency Sign / Symptom** | **DRI per day** |
|---|---|---|---|
| ***Vitamins*** | | | |
| Thiamin (B1) | Carbohydrate and protein metabolism | Decreased endurance, muscle wasting, reduced performance and fatigue | 1.2mg |
| Riboflavin (B2) | Oxidative metabolism and electron transport system | Limited nervous system function | 1.3mg |
| Niacin (B3) | Oxidative metabolism and electron transport system | Diarrhoea and irritability | 16mg |
| Vitamin B6 | Gluconeogenesis | Dermatitis and convulsions | 1.3mg |
| Vitamin B12 | Haemoglobin formation | Anaemia and neurological symptoms | 2.4mcg |
| Vitamin C | Antioxidant | Fatigue and loss of appetite | 90mg |
| Vitamin E | Antioxidant | Nerve and muscle damage | 15mg |
| Vitamin D | Bone health and muscle development | Inadequate calcium absorption | 5mcg |
| ***Minerals*** | | | |
| Iron | Haemoglobin synthesis | Anaemia, cognitive impairment and immune abnormalities | 8mg |
| Calcium | Bone health and muscle contraction | Decreased bone mass | 1000mg |
| Zinc | Glycolysis | Appetite loss and growth retardation | 11mg |
| Magnesium | Protein and fat metabolism | Increased heart rate and muscle spasms | 400mg |

### 2.4.1 Vitamins

Since B vitamins play an important role in energy cycles, there is often an elevated need for B vitamins due to the increased energy metabolism of athletes (Dorfman, 2017:441). Adequate intake of B vitamins is important for optimum energy production, as well as the building and repair of muscle tissue (Rodriquez *et al.*, 2009:515). Thiamin, Riboflavin and Niacin are needed for energy release from food, while vitamin B6 and B12 are needed for the production of red blood cells and protein metabolism (Bean, 2017:99). There is, however, no evidence that the performance of well-nourished athletes will increase as a result of B vitamin supplementation (Dorfman, 2017:411).

Exercise can increase oxygen consumption, increasing oxidative stress in the muscles and other cells (Rodriquez *et al.*, 2009:516). According to Dorfman (2017:442) and Kreider *et al.,* (2010:11), Vitamin C and Vitamin E may have a protective effect against exercise-induced oxidative damage, helping athletes tolerate training better, but supplementing with these vitamins does not necessarily improve physical performance.

Vitamin D is needed for adequate calcium absorption, regulation of serum calcium levels, as well as promotion of bone health and the regulation of skeletal muscle development (Rodriquez *et al.*, 2009:516). According to Bean (2017:98), sufficient intakes may protect against muscle weakness, stress fractures, impaired muscle function and decreased performance.

### 2.4.2 Minerals

Clénin *et al.,* (2016:6) stated that iron deficiency is common among athletes. Iron deficiency should be treated, since it is very likely to affect physical performance by impairing muscle function. Being involved in energy production, iron is also needed for the formation of the oxygen-carrying proteins, haemoglobin and myoglobin (Clénin *et al.,* 2016:6 & Rodriquez *et al.*, 2009:516).

In a study by Coutinho *et al.* (2016:6) undertaken in 56 young modern pentathlon athletes in Brazil, both male and female athletes were found to have low calcium intakes. Calcium is important for growth, maintenance, and repair of bone tissue, as well as the regulation of muscle contraction. It is also needed in many metabolic processes, and a deficiency in athletes may therefore contribute to muscle numbness and musculoskeletal pain (Coutinho *et al.,* 2016:6 & Rodriquez *et al.*, 2009:515).

According to Rodriquez *et al.*, (2009:517), zinc plays an important role in growth, building and repair of muscle tissue, as well as energy production, while magnesium plays a role in cellular function, thus a deficiency may impair endurance performance. It is also a regulator of hormonal and immune functions (Dorfman, 2017:444).

## 2.5 Fluid intake

### 2.5.1 Fluid before exercise

To promote optimal pre-exercise hydration, a fluid intake 500 millilitre (ml) of water or sports drink is recommended the night before competition and another 500ml upon waking up (Kerksick *et al.,* 2018:19), as well as 400 to 600ml of water or sports drink 20 to 30 minutes before the start of exercise (Dorfman, 2017:439). In addition to these guidelines, the ACSM recommends about 5 to 7 ml per kg body weight of fluid, at least 4 hours before exercise (Rodriquez *et al.*, 2009:517). Because rugby matches and training sessions usually take place in hot weather, it is important that these players should consume sufficient fluids before exercise, ensuring good hydration status for optimal performance and thus decreasing the risk of dehydration and heat stress (Burke and Cox, 2010:422).

### 2.5.2 Fluid during exercise

Inadequate fluid intake during exercise is a common phenomenon, even amongst elite athletes. This was confirmed in a study by Shriver *et al.* (2013:14) that reported that many athletes consumed limited amounts of fluids during practice. Kerksick *et al.* (2018:19) and Kreider *et al.* (2010:13) stated that when 2% or more of an athlete’s body weight is lost through perspiration, physical performance can be significantly impaired. Therefore, it is strongly recommended that frequent, adequate amounts of fluid should be consumed during exercise (150 to 200ml every 5 to 20 minutes), as this is essential to maintain hydration status (Potgieter, 2013:13; Kreider *et al.,* 2010:13).

### 2.5.3 Fluid after exercise

According to Thomas *et al.* (2016:515), most athletes will experience a fluid deficiency post-exercise and should therefore consume a volume of 1.25 to 1.5 litre (L) fluid for every 1kg of body weight that has been lost during exercise. Some studies report that post-exercise intake of carbohydrate and protein beverages, e.g. chocolate milk, can enhance recovery from heavy aerobic exercise, such as that experienced by the backline players in a rugby team, as well as improve muscle glycogen synthesis. Milk has also been proved to be a good hydration drink (Bean, 2017:86).

## 2.4 Assessment of Nutritional Status

### 2.4.1 Dietary Assessment

Since food-related habits and dietary patterns influence energy, nutrient and fluid intake, in-depth dietary assessments are an essential component of ensuring athletic performance and optimal recovery (Mielgo-Ayuso *et al.,* 2015:228 & Shriver *et al.,* 2013:11). It is often a challenge to choose an appropriate diet-assessment tool for athletes because of wide variation in energy intake, poor skills in portion estimation, and consumption of specific sport foods. Thorough collection and analysis of dietary data can also be time-consuming (Shriver *et al.,* 2013:10 & Heaney *et al.,* 2011:258). Despite these challenges, Shriver *et al.,* (2013:10) have suggested that tools needed for collection of these food-related assessments can include 24-hour dietary recalls, food frequency questionnaires and food records. In a study by Noda *et al.,* (2009:348) on Japanese soccer players, it was found that 7-day dietary records provided reliable dietary information. However, this method of obtaining dietary data is very demanding for professional athletes with a busy training and academic schedule and for this reason the researchers used a food frequency questionnaire for the assessment of dietary intake of participants in the Japanese study.

In studies that have assessed dietary intake in rugby players, 7-day food diaries, 3-day food records and 24-hour recalls were used (Jenner *et al*. 2018:3; Potgieter *et al*. 2014:39; Shriver *et al.,* 2013:13).

### 2.4.2 Anthropometric and Body Composition Assessment

In terms of anthropometric assessment, King *et al.* (2005:74) and Thomas *et al.* (2016:506) suggest that BMI is an inappropriate tool for the classification of overweight and obesity in the athletic population, especially those participating in rugby or body building. This is especially true when performance related specific physical characteristics such as a high body mass, physical stature and large musculature are predictors of success (King *et al.,* 2005:74).

Body composition assessment is considered to be a more appropriate anthropometric assessment amongst sportsmen and can be done using various techniques. These include duel energy x-ray absorptiometry, hydrodensitometry, air displacement plethysmography, skin fold measurements, as well as single and multifrequency bioelectrical impedance analysis (Thomas *et al.,* 2016:506).

Although assessment of body composition is widely accepted as an important indicator of nutritional status, athletic performance and health, there are still no clear appropriate reference values for athletes (Santos *et al.,* 2014:4). However, as a rule, athletes have a lower percentage fat mass than non-athletes (Santos *et al.,* 2014:5). Thomas *et al.* (2016:506) stated that athletes' body fat content will vary over their career and the season. Carrying excess body fat may also have a negative effect on performance (Santos *et al.,* 2014:5). According to national normative data, presented by Boksmart, the mean percentage body fat of South African rugby players ranges from 12-14% for backline players, and 15-20% for forward players. In terms of body weight, 88 – 100kg is the recommended range for backline players, and 102 – 118kg for forward players (Boksmart:online; Potgieter *et al.,* 2014:38). Because forwards need to tackle and run the ball offensively, they are often heavier with a higher body fat percentage than backline runners, who are usually 10 – 20kg lighter, having lower body fat percentages (Burke & Cox, 2010:421).

## 2.5 Lifestyle Behaviours

### 2.5.1 Alcohol and Exercise

Although moderate alcohol consumption may be considered to be beneficial to health, excessive intake is a concerning practice that is often identified in athletes that participate in team sports (Barnes, 2014:909). Thomas *et al.* (2016:512) urges against consumption of excessive amounts of alcohol before and during training, due to the negative effect on skills, concentration, thermoregulation and exercise metabolism. According to Barnes, (2014:914) alcohol consumption impacts normal hormonal balance detrimentally, which can affect sleep quality and patterns, mood, metabolism, as well as cardiovascular function. Potgieter *et al.* (2014:42) also note that drinking alcohol after exercise increases urinary fluid losses. This may lead to dehydration and increased muscle weakness. In rugby players, consumption of acutely large doses of alcohol has a negative effect on testosterone production, leading to certain feminising effects. Additionally, a decrease in testosterone may also impact skeletal muscle function, bone density and red blood cell numbers (Barnes, 2014:914). For these reasons, team discussions concerning alcohol intake are important. It is recommended that athletes abstain from using alcohol to avoid it affecting recovery and sporting performance (Barnes, 2014:909; Burke & Cox, 2010:421).

### 2.5.2 Smoking and Exercise

Smoking is not recommended for the general population, and also not for athletes. Various studies have shown that tobacco consumption by athletes leads to a decline in physical performance. The inhalation of cigarette smoke can decrease an athlete's exercise tolerance, as well as air capacity of lungs, leading to poorer performance during exercise. Early fatigue during physical activity is also more common in smokers in comparison to non-smokers (Hesami *et al.,* 2012:297). Pacifici *et al.* (2015:133) have confirmed that there is an association between cigarette smoking and a decline in physical performance over time.

# CHAPTER 3

## METHODOLOGY

### 3.1 Introduction

In this chapter the study design, population and sampling, methodology and procedures that were applied in the study are described. A description of validity and reliability of the tools, statistical analysis and ethical considerations is also included.

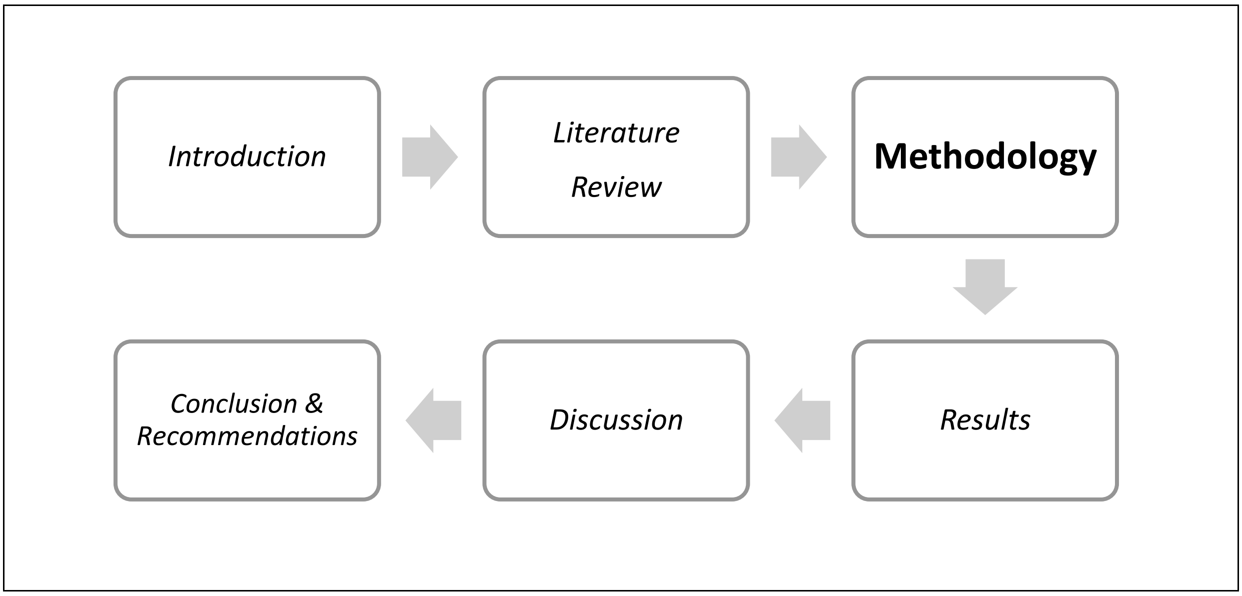


**Figure 3.1: Progression of the study: Methodology**

### 3.2 Study Design

A cross-sectional study design was applied whereby the researcher collected data at a single point in time.

### 3.3 Population and Sample

Professional rugby players in Mpumalanga constituted the research population for this study, as it was of interest to the researcher. At the time that the study was undertaken, the main provincial rugby team in Mpumalanga, the Steval Pumas, consisted of 41 players.

All team members of the Steval Pumas were eligible to participate and agreed to participate, thus, no sampling took place.

Inclusion criteria included:

- Those that provided written informed consent
- Contracted rugby players from the Steval Pumas team

Although no participants were excluded, exclusion criteria included:

- Non-permanent team members
- Injured team members

## 3.4 Measurements

### 3.4.1 Operational Definition

The following operational definitions are defined:

- Socio-demography
- Anthropometry
- Dietary assessment
- Lifestyle behaviours

#### 3.4.1.1 Socio-demography

For the purpose of this study, socio-demographic information included age, home language, highest level of education and current playing position.

#### 3.4.1.2 Anthropometry

For the purpose of this study, anthropometry included weight and height to calculate BMI, body fat percentage, and waist circumference.

Weight and height were measured to determine BMI (weight divided by height squared) and interpreted according to the WHO classification. Cut-off points that were used are indicated in Table 3.1.

**Table 3.1: WHO Classification of Weight by BMI in Adults (WHO, 2006: online)**

| Weight Status Classification | International BMI category ($kg/m^2$) |
|---|---|
| Underweight | < 18.5 |
| Normal Weight | 18.5 – 24.9 |
| Overweight | 25.0 – 29.9 |
| Obese | ≥ 30.0 |
| *Class I* | >30.0 – 34.9 |
| *Class II* | > 35.0 – 39.9 |
| *Class III* | ≥40.0 |

In terms of body composition, the ideal body fat percentage of elite rugby players ranges from 8 to 17% (Potgieter *et al.,* 2014:38 & Gallagher *et al.,* 2000:699). South African Boksmart recommendations for both forward and backline players are illustrated in Table 3.2. These cut-off points were used to interpret fat percentage of players included in this study.

**Table 3.2: Recommendations for Body Weight and Fat Percentage of South African Rugby Players, presented by Boksmart (Boksmart:online; Potgieter *et al.,* 2014:38)**

| | Forward Rugby Players | Backline Rugby Players |
|---|---|---|
| Body Weight | 102 – 118 Kg | 88 – 100 Kg |
| Body Fat Percentage | 15 – 20 % | 12 – 14 % |

Finally, the healthy waist circumference cut off point for men is established as <94 centimetre (cm) (IDF, 2006:11).

### 3.4.1.3 Dietary Assessment

For the purpose of this study, a dietary assessment to estimate energy and nutrient intakes included three 24-hour recalls: one after a training day, one after an off day, and one after a game day. In addition, information related to whether the participant had received dietary advice from a dietitian before, how the participant perceived his eating habits, how many meals were eaten daily, total fluid intake, how often take away foods were eaten, the use of sport supplements, as well as the use of multi-vitamins was collected via a self-developed questionnaire in a structured interview.

The following categories (recommended intakes) were used to interpret the daily energy, carbohydrate, fibre, as well as protein and fat intake of participants in this study:

- According to the ISSN, the energy requirements for physical activity for moderate levels of intense training of 2 to 3 hours per day, 5 to 6 times a week, as well as for high-volume intense training of 3 to 6 hours per day, 5 to 6 times per day are 200 to 350 kilojoules (kJ) per kg body weight per day (Potgieter, 2013:7).
- The ACSM suggests that the daily carbohydrate needs for a moderate exercise programme of 1 hour per day are 5 to 7g per kg body weight, while moderate to high-intensity endurance exercise of 1 to 3 hours per day requires 6 to 10g of carbohydrates per kg body weight per day (Thomas *et al.,* 2016:508).
- The Food and Nutrition Board recommends an intake of 30g of fibre per day (Otten *et al.,* 2006:110).
- Protein requirements, as recommended by the ACSM and the ISSN, are 1.2 to 2.0g per kg body weight per day (Kerksick *et al.,* 2018:12; Potgieter, 2013:12; Beelen *et al.,* 2010:12; Kreider *et al.,* 2010:9).
- Potgieter (2013:13) and Kreider *et al.* (2010:10) recommend approximately 30% of total daily energy intake from fat (as per ISSN recommendations).

For the purpose of this study, the micronutrient intakes that were included in the dietary assessment included B Vitamins (Thiamine, Riboflavin, Niacin, Vitamin B6 and Vitamin B12), Vitamin C, Vitamin E, Vitamin D, Iron, Calcium, Zinc and Magnesium.

According to the Food and Nutrition Board, Institute of Medicine, the recommended daily intake of thiamine for a 19-33 year old male is 1.2 milligrams (mg) per day, 1.3 mg is recommended for Riboflavin and Vitamin B6, 16 mg for Niacin, and 2.4 micrograms (mcg) for Vitamin B12.

For Vitamin C, 90 mg per day is recommended for 19-33 year old males, while 15 mg is recommended for Vitamin E, 5 mcg per day for Vitamin D, 8 mg per day for Iron and 1000 mg per day for Calcium. Eleven mg of Zinc is recommended per day, while the RDI of Magnesium is 400mg.

#### 3.4.1.4 Lifestyle Behaviours

For the purpose of this study, lifestyle behaviours included information about exercise schedules, smoking, as well as alcohol consumption.

Participants were asked about alcohol consumption before or after practice. If they answered "yes", alcohol consumption was categorised as per the Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA, 2017) guidelines:

- low (less than 2 units per day),
- moderate (2 units per day) or
- high (more than 2 units per day).

One unit of alcohol is measured as 10g pure alcohol (SEMDSA, 2017):

- 330 ml beer,
- 100ml wine or
- 30ml spirits.

Although these guidelines are recommended for South African patients with diabetes, they were applied in this study, as there are no specific guidelines for the use of alcohol in athletes.

Based on the SEMDSA (2017) guidelines, smoking habits were categorised into the following three groups:

- never smoked,
- current smoker, and
- quit smoking.

### 3.4.2 Techniques

An average of 10 participants were interviewed per day over a three-week period during the pre-competition season until the 41 team members were included and each rugby player had been assessed on three occasions. Socio-demographic, dietary and lifestyle information were collected by the researcher in a structured interview with each participant, while anthropometric measurements were obtained from the professional biokineticist of the rugby team.

#### 3.4.2.1 Socio-demography

The socio-demographic questionnaire was a self-developed questionnaire, completed by the researcher in a structured interview with each participant (appendix A). The questionnaire included socio-demographic variables that have been assessed in the relevant literature.

#### 3.4.2.2 Anthropometry

Height and body weight were measured using a wall-mounted stadiometer and an electronic scale. Body fat percentage was measured in accordance with the techniques recommended by the International Standards for Anthropometric Assessment (ISAK). Waist circumference was measured using a non-stretchable measuring tape. All measurements were taken by a level one accredited ISAK biokineticist.

To measure height, the participant stood barefoot and wore minimal clothing, standing with heels together, arms to the side, legs straight, shoulders relaxed, and the head in the Frankfort horizontal plane. Heels, buttocks, scapulae, and back of the head were against the vertical surface of the stadiometer. Just before the measurement was taken, the participant was asked to inhale deeply, hold the breath and maintain an erect posture while the head board was lowered onto the highest point of the head with enough pressure to compress the hair. The measurement was taken after exhaling (ISAK, 2016). The height of each participant was measured twice to the nearest 0.1 cm, with an average of the 2 measurements used for the final analysis. This was noted on a data form.

To measure weight, an electronic scale was used. The scale was placed on a flat, hard surface. The participant was weighed after voiding and dressed in an examination gown with light underclothing with the scale placed where adequate privacy was provided. The participant stood still in the middle of the scale's platform without touching anything and with the body weight equally distributed on both feet (ISAK, 2016). The body weight of each participant was measured twice to the nearest 0.1 kg, with an average of the 2 measurements used for the final analysis. This was noted on a data form.

Weight and height were used to determine BMI as follows:

$$BMI = \frac{mass\ (kg)}{length^2 (m^2)}$$

To assess body composition, the following skinfold measurements were taken by a level one ISAK accredited biokineticist: triceps, sub-scapular, biceps, iliac crest, abdominal, front thigh and medial calf. All these measurements were taken according to the guidelines set out by the ISAK (ISAK, 2016) and then converted to body fat percentage according to standarised formulas.

All measurements were taken on the right side of the participant’s body. The site to be measured was marked with a koki pen. Skinfolds were grasped firmly with the left hand’s thumb and index finger, 1 cm from the skinfold site, while the caliper was held in the right hand. Measurement were read approximately 4 seconds after pressure had been released from the caliper. Measurements were noted to the nearest 1 millimetre (mm), and a minimum of two measurements were taken at each skinfold site (ISAK, 2016).

The WHO Stepwise Approach to Surveillance (STEPS) protocol was used to measure waist circumference. Waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch-resistant tape that provided a constant 100g tension (WHO, 2008:5). The participant stood with arms at the sides, feet positioned close together, and weight evenly distributed across the feet.

#### 3.4.2.3 Dietary Assessment

The researcher collected information related to dietary intake during a structured interview with each participant on three different days in a private consultation room at the Health and Sport Performance Centre. Data was obtained using three 24-hour recalls: one after a training day, one after an off day, and one after a game day (appendix A). By making use of household measures, every effort was made to obtain accurate portion sizes of foods eaten. Energy and nutrient intakes were determined by the researcher using Food Finder, a dietary analysis software program developed by the South African Medical Research Council (SAMRC). These results were then compared to the energy- and macronutrient recommendations and guidelines established by the ACSM (Thomas *et al.,* 2016:508) and the ISSN (Kerksick *et al.,* 2018:10; Kreider *et al.,* 2010:8). Micronutrient intakes (B Vitamins, Vitamin C, Vitamin E, Vitamin D, Iron, Calcium, Zinc and Magnesium) were compared to the Dietary Reference Intakes (DRIs) established by the Food and Nutrition Board, Institute of Medicine (Dorfman, 2017:441 & Otten *et al.,* 2006:532-535).

#### 3.4.2.4 Lifestyle Behaviours

A questionnaire including questions related to lifestyle behaviours was completed by the researcher in a structured interview with each participant (appendix A). The questionnaire included variables that have been assessed in the relevant literature.

### 3.4.3 Validity and Reliability

Most variables in this study, namely dietary intake, alcohol consumption, smoking and physical activity, were compared with guidelines from the ACSM and ISSN, as well as SEMDSA which have been regularly reviewed and updated.

Validity refers to the extent to which a tool actually measures a trait. According to Monsen and Van Horn (2008:85) and Golafshani (2003:599), validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are.

Monsen and Van Horn (2008:85), defines reliability as “the characteristics in which repeated measurements done in a steady-state period yield similar results.” A research instrument can thus be considered to be reliable if the results of a study can be reproduced using similar methodology (Golafshani 2003:598).

#### 3.4.3.1 Questionnaire to determine socio-demography, lifestyle habits and dietary patterns

To ensure validity, information included in the questionnaire was directly related to the aims and objectives of the study. To ensure reliability, only one trained researcher conducted structured interviews. The participants were interviewed individually and not in groups to encourage true responses and to prevent researcher bias. All communication took place in either English or Afrikaans, whichever the participant preferred.

#### 3.4.3.2 Anthropometry

Validity of anthropometric measurements was ensured by including anthropometric measures that are commonly used in similar studies reported in the scientific literature. Furthermore, all participants were weighed and measured according to the guidelines puplished by ISAK (ISAK, 2016). To ensue reliability, all equipment, namely: scale, stadiometer and measuring tape was in an excellent working condition. The scale and stadiometer were calibrated in advance and the measuring tape was of good quality and non-stretchable. Reliability of the scale was further assured by measuring an object of which the weight is known to confirm a correct weight.

The participants were measured by a level one ISAK accredited biokineticist, qualified to accurately take these measurements. Each measurement was taken twice and the average noted.

### 3.4.4 Pilot Study

A pilot experiment, also called a pilot study, is a small-scale preliminary study conducted in order to evaluate feasibility, time and cost in an attempt to predict an appropriate sample size and improve upon the study design prior to performance of a full-scale research project. The pilot study is important in order to indicate potential problems and to correct them before the actual study takes place (Monsen and Van Horn 2008:5; Lancaster *et al.,* 2004:307).

The questionnaire was piloted on five participants from a local rugby team in Nelspruit, Mpumalanga. This was to ensure that the participants understood the questions and that the researcher could established the time period needed to collect information from the participant. All questions were understood easily by participants; thus, wording of questions was not amended.  These five participants were not included in the final data analysis, as they did not meet the inclusion criteria.

### 3.4.5 Data Collection Process

After approval was obtained from the Health Sciences Research Ethics Committee of the University of the Free-State (appendix B), a formal letter of permission was sent out to the management of the applicable rugby team, (appendix C). Three appointments were made with each participant by the researcher. Participants were assessed by the researcher at a time that was convenient to them in a private consultation room at a Health and Sport Performance Centre in Nelspruit.

The pilot study and the actual study were conducted in the same manner. The participants were asked to sign the consent form (appendix E) after explanation of the study using the information document (appendix D), after which data collection commenced. The researcher interviewed and assessed each participant individually. All interviews, information documents and consent forms were available in English or Afrikaans, whichever the participant was more comfortable with. Questionnaires and 24-hour recalls were completed by the researcher, while anthropometric measurements were taken by the biokineticist.

After all the participants had completed the interview and anthropometric measurements were obtained, data was coded by the researcher and entered into Excel spreadsheets. Food intakes were summarised to g per day and entered into the Food Finder programme by the researcher. This information was exported into Excel and after input errors had been checked, the data was sent to the biostatistician at the Department of Biostatistics, University of the Free State, to be verified and for data analysis.

## 3.5 Statistical Analysis

Statistical analysis was performed by the Department of Biostatistics at the University of the Free State. Descriptive statistics, namely frequencies and percentages for categorical data and medians and percentiles for continuous data, were calculated. Associations were also calculated and described by means of 95% confidence intervals (CI) for relative risk and differences between percentages, medians or/and means ($p<0.05$ was considered significant).

### 3.6 Ethical Aspects

Approval for the research was obtained from the Health Sciences Research Ethics Committee of the University of the Free-State (ethical clearance number: UFS-HSD2017/1532) (appendix B), as well as from the management team involved with the Steval Pumas rugby team (appendix C).

An information document (appendix D) was given to each participant to keep, explaining the purpose of the study and the procedures that would be followed. The document explained that participation in the study was voluntary, that participants would not be penalised nor lose benefits if they refused to participate or decided to terminate participation. Written informed consent (appendix E) in the language of choice (English and Afrikaans) was obtained from each participant.

All information was collected in a private consultation room at the Health and Sport Performance Centre. All information was used only for the purpose of the study and kept strictly confidential. The document also explained that participation may assist the researcher to plan and implement interventions to improve nutritional status, overall health and possibly performance.

The study and the collection of information were not harmful to the health of the participant. If any issues/problems were identified that needed to be treated, the participant would have been referred to the suitable health care professional – this was not necessary. The anonymity of participants was ensured in any publication of the data, and the obtained data and results will be stored in a storage room for ten years.

# CHAPTER 4

# RESULTS

## 4.1 Introduction

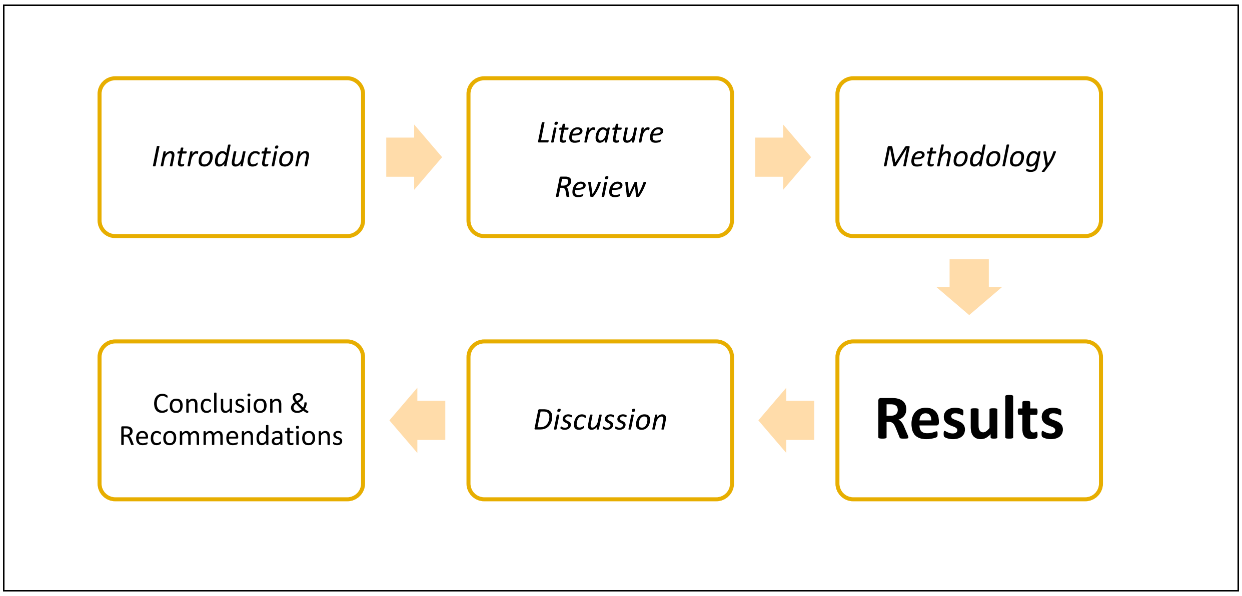


**Figure 4.1: Progression of the study: Results**

## 4.2. Participant Profile

The median age of the 41 male participants, was 26.1 years, ranging from 19.8 years to 32.9 years.

The majority of the participants listed Afrikaans as their home language (83%). Almost half (49%) of the participants have matric as their highest level of education, while the remaining 51% have completed a tertiary qualification. Twenty percent of participants played prop or hooker, while 34% were in the lock, flanker, or number 8 position. Thirty four percent of participants played in the backline (wing, centre, full back) with the remaining 12% in the scrum half or fly half position (table 4.1).

**Table 4.1: Participant profile**

| Variable | Frequency (n) | Percent (%) |
|---|---|---|
| ***Home Language*** | | |
| Afrikaans | 34 | 82.9 |
| English | 4 | 9.8 |
| Other | 3 | 7.3 |
| Xhosa | 2 | |
| Zulu | 1 | |
| ***Highest Level of Education*** | | |
| Matric | 20 | 48.8 |
| Undergraduate | 14 | 34.2 |
| Post-Graduate | 7 | 17.1 |
| Other | 0 | 0.0 |
| ***Current Position in Team*** | | |
| Prop or Hooker | 8 | 19.5 |
| Lock or Flanker or Number 8 | 14 | 34.2 |
| Scrum Half or Fly Half | 5 | 12.2 |
| Wing or Centre or Full Back | 14 | 34.2 |

## 4.3 Anthropometric Status of Participants

For the purpose of this study, anthropometric variables included BMI, waist circumference, body fat percentage and body weight. The median, as well as minimum and maximum values for BMI, body fat percentage and waist circumference are presented in table 4.2.

**Table 4.2: Median Anthropometric values**

| Variable | Median | Range |
|---|---|---|
| Body mass index (kg/m$^2$) | 29.0 | 25.3 – 35.9 |
| Waist circumference (cm) | 90.0 | 82.0 – 99.0 |
| Body fat percentage (%) | 12.0 | 7.7 – 21.2 |

According to the Boksmart recommendations, body weight of South African rugby players should range from 102-118 kg for forward players, and 88-100 kg for backline players. According to these cut-off points, almost three quarters of participants (68%)

were classified as having a normal body weight (table 4.3). The mean body weight of participants was 101kg, while the mean height was 1.84m.

**Table 4.3: Body Weight**

| Variable | Frequency (n) | Percent (%) |
|---|---|---|
| Underweight | 8 | 19.5 |
| Normal body weight | 28 | 68.3 |
| Overweight | 5 | 12.2 |

In terms of BMI, most participants (59%) were classified in the 25.0 – 29.9 $kg/m^2$ category (table 4.4). As expected, the median BMI of backline players (28.0 $kg/m^2$) was significantly lower than that of the forward players (31.4 $kg/m^2$) with a 95% Confidence Interval (CI) for the median difference of [-4.8 $kg/m^2$ ; -2.3 $kg/m^2$].

**Table 4.4: Body Mass Index**

| Variable | Frequency (n) | Percent (%) |
|---|---|---|
| < 18.5 | 0 | 0.0 |
| 18.5 – 24.9 | 0 | 0.0 |
| 25.0 – 29.9 | 24 | 58.5 |
| >30.0 – 34.9 | 14 | 34.2 |
| > 35.0 – 39.9 | 3 | 7.3 |
| ≥40.0 | 0 | 0.0 |

The SEMDSA (2017) cut-off point for a healthy waist circumference for men is established as below 94cm. Most of the participants (85%) had a normal waist circumference (table 4.5). Of the 19 backline players, all had a waist circumference in the normal range. Of the 22 forward players, 16 had a waist circumference in the normal category, while 6 had a waist circumference in the at-risk category (above 94cm). A significantly higher percentage of forward players (27.3%) had a waist circumference in the high-risk category compared to backline players (0.0%) (p=0.02). The median waist circumference of backline players (87cm) was significantly lower than that of the forward players (91cm) with a 95% CI for the median difference of [-7cm ; -3cm].

**Table 4.5: Waist Circumference**

| Variable | *Forward Players* | | *Backline Players* | |
|---|---|---|---|---|
| | **Frequency (n)** | **Percent (%)** | **Frequency (n)** | **Percent (%)** |
| Normal | 16 | 72.7 | 19 | 100.0 |
| Over | 6 | 27.3 | 0 | 0.0 |

Categories of body fat percentage are presented in table 4.6 below. Boksmart recommends that body fat percentages for South African rugby players should be between 15-20% for forward players, while 12-14% is recommended for backline players. Of the 19 backline players, 63.2% had a body fat percentage in the low category, 36.8% had a body fat percentage in the normal category, while none had a high body fat percentage. Of the 22 forward players, 59.1% had a body fat percentage in the low category, 36.4% had a body fat in the normal category, while only one participant had a body fat percentage that was higher than recommended. None of the differences in categories of body fat percentage of forwards and backline players were, however significant (p=1.0). However, the median body fat percentage of backline players (10.1%) was significantly lower than that of the forward players (13.9%) with a 95% CI for the median difference of [-5.3% ; -2.3%]. Mean percentage body fat for all participants was 12.5%.

**Table 4.6: Body Fat Percentage**

| Variable | *Forward Players* | | *Backline Players* | | *Total* | |
|---|---|---|---|---|---|---|
| | **Frequency (n)** | **Percent (%)** | **Frequency (n)** | **Percent (%)** | **Frequency (n)** | **Percent (%)** |
| Low body fat % | 13 | 59.1 | 12 | 63.2 | 25 | 61.0 |
| Normal body fat % | 8 | 36.4 | 7 | 36.8 | 15 | 36.6 |
| High body fat % | 1 | 4.5 | 0 | 0.0 | 1 | 2.4 |

Participants with a body fat percentage in the low category had a significantly lower BMI (28.7 kg/m$^2$) compared to those with a fat percentage in the normal category (31.8kg/m$^2$) with a 95% CI of [0.3kg/m$^2$ ; 4.6kg/m$^2$].

Participants with a body fat percentage in the low category also had a significantly lower waist circumference (87.0cm) compared to those with a fat percentage in the normal category (92.5cm) with a 95% CI of [2.0cm ; 7.0cm].

Finally, participants with a body fat percentage in the low category had a median fat percentage of 10.6%, compared to those with a fat percentage in the normal category (15.3%). As expected, this difference was statistically significant with a 95% CI for the median difference [2.4% ; 6.0%].

### 4.4 Dietary Assesment

As seen in table 4.7, two thirds of the participants (63%) had previously received dietary advice from a dietitian. Despite this, only 37% of participants described their eating habits as “good”. Three quarters of participants (73%) reported eating breakfast every day, while almost everyone ate lunch (88%) and dinner (100%). Two thirds of participants (66%) drank more than two litre (L) fluid per day, and the same percentage drank 150-200ml frequently during practice. When asked about the intake of take-away foods, 85% reported an intake of one to three times per week. The majority of participants used sport supplements (88%), while only half (49%) used micronutrient supplements on a daily basis. Of the 36 participants that reported using sport supplements, a whey protein shake was consumed by all. Four participants used creatine, while only two participants used a pre-workout drink and branched-chain amino acids. In terms of the intake of micronutrient supplements, multi-vitamins, vitamin C, calcium, omega-3 fatty acids, and probiotics were reported.

**Table 4.7: Dietary Assessment**

| Variable | Frequency (n) | Percent (%) |
|---|---|---|
| ***Have you received dietary advice from a dietitian before?*** | | |
| Yes | 26 | 63.4 |
| No | 15 | 36.6 |
| ***How would you describe your eating habits?*** | | |
| Good | 15 | 36.6 |
| Fair | 24 | 58.5 |
| Poor | 2 | 4.9 |
| ***How often do you eat breakfast?*** | | |
| Everyday | 30 | 73.2 |
| 4-6 times per week | 7 | 17.1 |
| 1-3 times per week | 3 | 7.3 |
| Never | 1 | 2.4 |

**Table 4.7: Dietary Assessment (continued)**

| Variable | Frequency (n) | Percent (%) |
|---|---|---|
| ***How often do you eat lunch?*** | | |
| Everyday | 36 | 87.8 |
| 4-6 times per week | 5 | 12.2 |
| 1-3 times per week | 0 | 0.0 |
| Never | 0 | 0.0 |
| ***How often do you eat dinner?*** | | |
| Everyday | 41 | 100.0 |
| 4-6 times per week | 0 | 0.0 |
| 1-3 times per week | 0 | 0.0 |
| Never | 0 | 0.00 |
| ***What is your usual daily fluid intake?*** | | |
| ±500ml per day | 1 | 2.4 |
| 1.2L per day | 13 | 31.7 |
| More than 2L per day | 27 | 65.9 |
| ***What is your fluid intake during practice?*** | | |
| None | 0 | 0.0 |
| Sips only when thirsty | 14 | 34.1 |
| 150-200ml every 5-20min | 27 | 65.9 |
| ***How often do you eat take-away foods?*** | | |
| Everyday | 0 | 0.0 |
| 4-6 times per week | 1 | 2.4 |
| 1-3 times per week | 35 | 85.4 |
| Never | 5 | 12.2 |
| ***Do you use any sport supplements on a daily basis?*** | | |
| Yes | 36 | 87.8 |
| No | 5 | 12.2 |
| ***Do you use any vitamin or mineral supplements on a daily basis?*** | | |
| Yes | 20 | 48.8 |
| No | 21 | 51.2 |

Participants' energy intake, as well as protein, carbohydrate, fibre, and fat intakes were the highest on a game day. The difference between days was calculated and only the CI of that comparison is noted in the last column. No significant differences in median energy and macronutrient intake of forwards and backline players were observed on game days, training days and off days. Although not statistically significant, there did seem to be a trend for backline players to consume more energy on training days and off days, with forwards consuming more protein on training days and off days (table 4.8). On game days, a set meal plan is provided to the participants for that specific day. Therefore, a range is not relevant.

**Table 4.8: Median intake of energy, macronutrients and micronutrients on game, training, and off days**

| | Game Day | | Training Day | | Off Day | | 95% CI for the median difference for paired data |
|---|---|---|---|---|---|---|---|
| Variable | Median | Range | Median | Range | Median | Range | |
| Energy (kJ) | 19785.0 | N/A | 11896.0 | 7198.0 – 24668.0 | 11502.0 | 6182.0 – 24160.0 | Off – Game [-9392KJ; -5599KJ]*<br>Off – Train [-1016KJ; -508KJ]*<br>Train – Game [-8884KJ; -6133KJ]* |
| Protein (g) | 251.0<br>***2.5g/kg*** | N/A | 242.0<br>***2.4g/kg*** | 143.0 – 429.0 | 205.0<br>***2.0g/kg*** | 93.0 – 404.0 | Off – Game [-66g; -15g]*<br>Off – Train [-50g; -25g]*<br>Train – Game [-24g; 24g] |
| Carbohydrates (g) | 456.0<br>***4.5g/kg*** | N/A | 167.0<br>***1.7g/kg*** | 39.0 – 404.0 | 166.0<br>***1.6g/kg*** | 39.0 – 395.0 | Off – Game [-319g; -240g]*<br>Off – Train [-5g; -3g]*<br>Train – Game [-319g; -259g]* |
| Fibre (g) | 42.0 | N/A | 25.0 | 6.0 – 46.0 | 25.0 | 6.0 – 46.0 | Off – Game [-23g; -14g]*<br>Off – Train [0g; -0g]<br>Train – Game [-22g; -13g]* |
| Fat (g) | 189.0<br>***36% TE*** | N/A | 116.0<br>***37% TE*** | 34.0 – 344.0 | 125.0<br>***41% TE*** | 31.0 – 343.0 | Off – Game [-97g; -20g]*<br>Off – Train [-2g; -1g]*<br>Train – Game [-95g; -35g]* |
| Thiamine (mg) | 2.0 | N/A | 2.0 | 0.0 – 9.0 | 1.0 | 0.0 – 9.0 | Off – Game [-1mg; 0mg]<br>Off – Train [0mg; 0mg]<br>Train – Game [-1mg; 0mg] |
| Riboflavin (mg) | 3.0 | N/A | 2.0 | 1.0 – 6.0 | 2.0 | 0.0 – 6.0 | Off – Game [-2mg; -1mg]*<br>Off – Train [-1mg; 0mg]<br>Train – Game [-1mg; 0mg] |
| Niacin (mg) | 39.0 | N/A | 51.0 | 18.0 – 107.0 | 48.0 | 18.0 – 107.0 | Off – Game [0mg; 18mg]<br>Off – Train [0mg; 0mg]<br>Train – Game [2mg; 21mg]* |

**Table 4.8: Median intake of energy, macronutrients and micronutrients on game, training, and off days (continued)**

| | Game Day | | Training Day | | Off Day | | 95% CI for the median difference for paired data |
|---|---|---|---|---|---|---|---|
| Variable | Median | Range | Median | Range | Median | Range | |
| Vitamin B6 (mg) | 3.0 | N/A | 3.0 | 1.0 – 5.0 | 3.0 | 1.0 – 7.0 | Off – Game [-1mg; 0mg]<br>Off – Train [0mg; 0mg]<br>Train – Game [-1mg; 0mg] |
| Vitamin B12 (mcg) | 12.0 | N/A | 14.0 | 5.0 – 26.0 | 9.0 | 1.0 – 20.0 | Off – Game [-6mcg; -3mcg]*<br>Off – Train [-4mcg; 0mcg]<br>Train – Game [0mcg; 5mcg] |
| Vitamin C (mg) | 387.0 | N/A | 71.0 | 9.0 – 233.0 | 69.0 | 9.0 – 233.0 | Off – Game [-334mg; -305mg]*<br>Off – Train [0mg; 0mg]<br>Train – Game [-334mg; -303mg]* |
| Vitamin E (mg) | 39.0 | N/A | 13.0 | 2.0 – 47.0 | 14.0 | 2.0 – 47.0 | Off – Game [-29mg; -22mg]*<br>Off – Train [0mg; 0mg]<br>Train – Game [-29mg; -21mg]* |
| Vitamin D (mcg) | 28.0 | N/A | 12.0 | 0.0 – 34.0 | 12.0 | 0.0 – 34.0 | Off – Game [-25mcg; -11mcg]*<br>Off – Train [0mcg; 0mcg]<br>Train – Game [-25mcg; -11mcg]* |
| Iron (mg) | 26.0 | N/A | 20.0 | 10.0 – 42.0 | 20.0 | 10.0 – 42.0 | Off – Game [-9mg; -3mg]*<br>Off – Train [0mg; 0mg]<br>Train – Game [-9mg; -3mg]* |
| Calcium (mg) | 1321.0 | N/A | 805.0 | 477.0 – 2918.0 | 612.0 | 149.0 – 2747.0 | Off – Game [-845mg; -632mg]*<br>Off – Train [342mg; 171mg]*<br>Train – Game [-638mg; -187mg]* |
| Zinc (mg) | 30.0 | N/A | 26.0 | 12.0 – 61.0 | 25.0 | 10.0 – 59.0 | Off – Game [-9mg; -3mg]*<br>Off – Train [-4mg; -2mg]*<br>Train – Game [-9mg; 0mg] |
| Magnesium (mg) | 720.0 | N/A | 452.0 | 208.0 – 878.0 | 448.0 | 208.0 – 878.0 | Off – Game [-348mg; -220mg]*<br>Off – Train [0mg; 0mg]<br>Train – Game [-348mg; -216mg]* |

Table 4.9 illustrates the intake of energy, protein, carbohydrate, fibre and fat, according to recommendations of the ACSM and ISSN.

In terms of the participants' level of education, the energy- and macronutrient intake of those who graduated (n = 21) was not significantly different to that of participants that only have matric (n = 20).

**Table 4.9: Energy and Macronutrient intake compared to ACSM and ISSN Guidelines**

| **Variable** | | **Frequency (n)** | **Percent (%)** |
|---|---|---|---|
| ***Energy*** | | | |
| Game day | *low* | 24 | 58.5 |
| | *normal* | 17 | 41.5 |
| | *above* | 0 | 0.0 |
| Training day | *low* | 39 | 95.1 |
| | *normal* | 2 | 4.9 |
| | *above* | 0 | 0.0 |
| Off day | *low* | 39 | 95.1 |
| | *normal* | 2 | 4.9 |
| | *above* | 0 | 0.0 |
| ***Protein*** | | | |
| Game day | *low* | 0 | 0.0 |
| | *normal* | 1 | 2.4 |
| | *above* | 40 | 97.6 |
| Training day | *low* | 0 | 0.0 |
| | *normal* | 8 | 19.5 |
| | *above* | 33 | 80.5 |
| Off day | *low* | 2 | 4.9 |
| | *normal* | 17 | 41.5 |
| | *above* | 22 | 53.7 |

**Table 4.9: Energy and Macronutrient intake compared to ACSM and ISSN Guidelines (continued)**

| Variable | | Frequency (n) | Percent (%) |
|---|---|---|---|
| ***Carbohydrate*** | | | |
| Game day | *low* | 41 | 100.0 |
| | *normal* | 0 | 0.0 |
| | *above* | 0 | 0.0 |
| Training day | *low* | 41 | 100 |
| | *normal* | 0 | 0.0 |
| | *above* | 0 | 0.0 |
| Off day | *low* | 41 | 100.0 |
| | *normal* | 0 | 0.0 |
| | *above* | 0 | 0.0 |
| ***Fibre*** | | | |
| Game day | *low* | 0 | 0.0 |
| | *normal* | 0 | 0.0 |
| | *above* | 41 | 100.0 |
| Training day | *low* | 30 | 73.2 |
| | *normal* | 0 | 0.0 |
| | *above* | 11 | 26.8 |
| Off day | *low* | 31 | 75.6 |
| | *normal* | 0 | 0.0 |
| | *above* | 10 | 24.4 |
| ***Fat*** | | | |
| Game day | *low* | 0 | 0.0 |
| | *sufficient* | 41 | 100.0 |
| Training day | *low* | 10 | 24.4 |
| | *sufficient* | 31 | 75.6 |
| Off day | *low* | 7 | 17.1 |
| | *sufficient* | 34 | 82.9 |

The ISSN recommend 30% of total energy intake from fat. As seen in table 4.10, a dietary fat percentage higher than recommended was consumed by participants on the average of all three days.

**Table 4.10: Median Dietary Fat Intake as percentage of Total Energy**

| Variable | Median | Range |
|---|---|---|
| Game day Fat (%) | 36.3 | 36.3 – 36.3 |
| Training day (%) | 37.0 | 16.1 – 58.5 |
| Off day (%) | 40.3 | 18.2 – 62.1 |

The participants' micronutrient intakes are presented in table 4.11 and compared to the relevant DRIs.

**Table 4.11: Micronutrient intake compared to guidelines**

| Variable | | Frequency (n) | Percent (%) |
|---|---|---|---|
| ***Thiamine*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 20 | 48.8 |
| | *meet recommendation* | 21 | 51.2 |
| Off day | *below recommendation* | 21 | 51.2 |
| | *meet recommendation* | 20 | 48.8 |
| ***Riboflavin*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 5 | 12.2 |
| | *meet recommendation* | 36 | 87.8 |
| Off day | *below recommendation* | 16 | 39.0 |
| | *meet recommendation* | 25 | 61.0 |

**Table 4.11: Micronutrient intake compared to guidelines (continued)**

| Variable | | Frequency (n) | Percent (%) |
|---|---|---|---|
| ***Niacin*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Off day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| ***Vitamin B6*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 5 | 12.2 |
| | *meet recommendation* | 36 | 87.8 |
| Off day | *below recommendation* | 4 | 9.8 |
| | *meet recommendation* | 37 | 90.2 |
| ***Vitamin B12*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Off day | *below recommendation* | 2 | 4.9 |
| | *meet recommendation* | 39 | 95.1 |
| ***Vitamin D*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 15 | 36.6 |
| | *meet recommendation* | 26 | 63.4 |
| Off day | *below recommendation* | 15 | 36.6 |
| | *meet recommendation* | 26 | 63.4 |

**Table 4.11: Micronutrient intake compared to guidelines (continued)**

| Variable | | Frequency (n) | Percent (%) |
|---|---|---|---|
| ***Vitamin C*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 31 | 75.6 |
| | *meet recommendation* | 10 | 24.4 |
| Off day | *below recommendation* | 32 | 78.0 |
| | *meet recommendation* | 9 | 22.0 |
| ***Vitamin E*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 23 | 56.1 |
| | *meet recommendation* | 18 | 43.9 |
| Off day | *below recommendation* | 22 | 53.7 |
| | *meet recommendation* | 19 | 46.3 |
| ***Iron*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Off day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| ***Calcium*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 26 | 63.4 |
| | *meet recommendation* | 15 | 36.6 |
| Off day | *below recommendation* | 35 | 85.4 |
| | *meet recommendation* | 6 | 14.6 |

**Table 4.11: Micronutrient intake compared to guidelines (continued)**

| Variable | | Frequency (n) | Percent (%) |
|---|---|---|---|
| ***Zinc*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Off day | *below recommendation* | 1 | 2.4 |
| | *meet recommendation* | 40 | 97.6 |
| ***Magnesium*** | | | |
| Game day | *below recommendation* | 0 | 0.0 |
| | *meet recommendation* | 41 | 100.0 |
| Training day | *below recommendation* | 17 | 41.5 |
| | *meet recommendation* | 24 | 58.5 |
| Off day | *below recommendation* | 18 | 43.9 |
| | *meet recommendation* | 23 | 56.1 |

The micronutrient intake of participants that were using a supplement (n = 36) was not significantly different to that of participants that were not using a supplement (n = 5), except for Thiamine on an off day (1.5mg per day compared to 1.0mg per day, p=0.49); Thiamine on a training day (2.0mg per day compared to 1.0mg per day, p=0.48); Vitamin B6 on a training day (3.0mg per day compared to 2.0mg per day, p=0.03); Vitamin B12 on a training day (14.0mcg per day compared to 7.0mcg per day, p=0.09); Iron on an off day (20.5mg per day compared to 17.0mg per day, p=0.34); and Zinc on a training day (27.0mg per day compared to 18.0mg per day, p=0.03).

In terms of the participants' level of education, the micronutrient intake of those who graduated (n = 21) was not significantly different to that of participants that have matric (n = 20), except for Calcium on an off day (680mg per day compared to 559mg per day, p=0.19).

## 4.5 Lifestyle Behaviours

When asked how frequently moderate to vigorous-intensity sports as well as fitness or recreational (leisure) activities were done, 88% reported 5 days per week (range from 4 to 6 days). In terms of time spent on these exercises, 85% of participants reported 4 hours per day (range from 3 to 5 hours).

Routine information about running distance per player was also available. On an average field-work day, the median distance covered by the backline players (3111m) was significantly different to that of the median distance of forwards (2106m per day) ($p=0.0005$). This data was obtained from reports by the team analysts.

Most of the participants (71%) had never smoked, although 22% reported smoking on social occasions. Three quarters of participants (75%) used alcohol on social occasions, but nobody reported alcohol consumption before practice. After practice, alcohol was consumed “sometimes” by a third (32%) of participants (table 4.12).

**Table 4.12: Lifestyle Behaviours**

| Variable | Frequency (n) | Percent (%) |
|---|---|---|
| ***How often do you smoke cigarettes?*** | | |
| Everyday | 0 | 0.0 |
| Over weekends | 0 | 0.0 |
| On social occasions | 9 | 22.0 |
| Quite smoking | 3 | 7.3 |
| Never smoked | 29 | 70.7 |
| ***How often do you consume alcohol?*** | | |
| Everyday | 0 | 0.0 |
| Over weekends | 7 | 17.1 |
| On social occasions | 31 | 75.6 |
| Never | 3 | 7.3 |
| ***Do you consume alcohol before practice?*** | | |
| Yes | 0 | 0.0 |
| No | 41 | 100.0 |
| Sometimes | 0 | 0.0 |
| ***Do you consume alcohol after practice?*** | | |
| Yes | 0 | 0.0 |
| No | 28 | 68.3 |
| Sometimes | 13 | 31.7 |

# CHAPTER 5

# DISCUSSION

## 5.1 Introduction

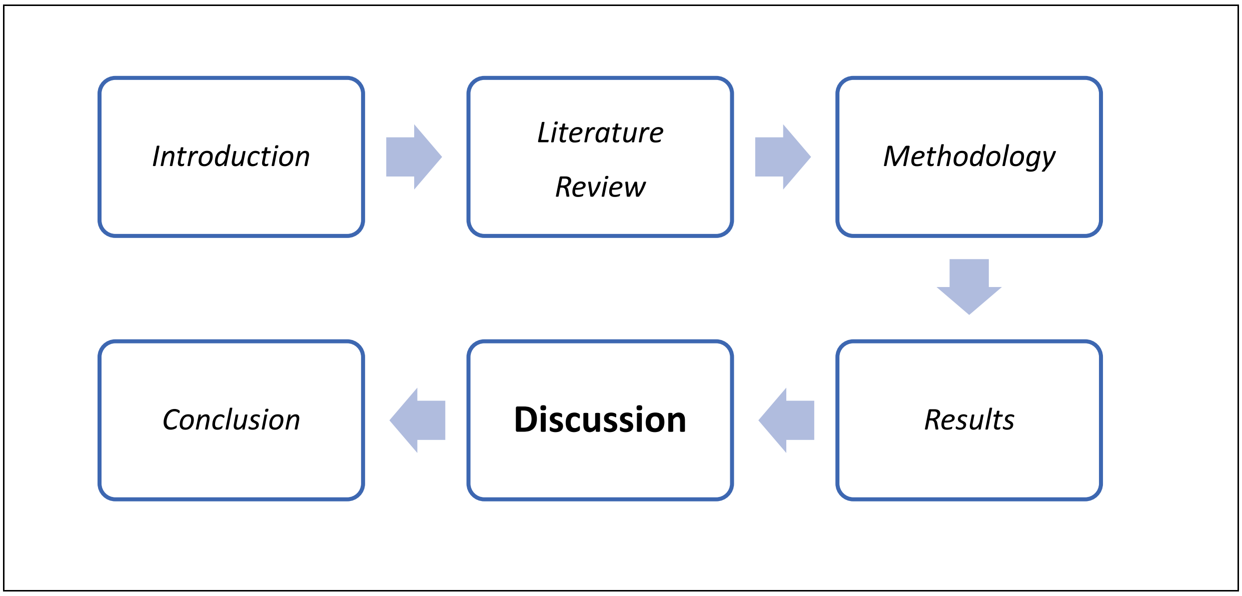


**Figure 5.1: Progression of the study: Discussion**

As previously mentioned, the aim of the current study was to assess the nutritional status of professional rugby players in Mpumalanga, and to compare the results to current sports nutrition guidelines. Few similar studies have been undertaken amongst professional rugby players. A search of the literature yielded three studies that have been used for comparison with the findings of the current study. These included the following:

- A descriptive study on the nutritional knowledge and eating habits of 21 professional Super League rugby players in the United Kingdom (Alaunyte *et al.,* 2015:2). This study aimed to investigate the relationship between dietary habits and nutritional knowledge obtained using questionnaires.
- A cross-sectional study on dietary intake and body composition of 46 professional Australian football athletes during a pre-season training week (Jenner *et al.,* 2018:2). Dietary intake was assessed and compared with international guidelines.

- A cross-sectional study that included 35 South African rugby players (the FNB Maties Varsity Cup team), in which body composition and habitual and match-day dietary intake were assessed and compared with international standards (Potgieter *et al.,* 2014:37).

## 5.2 Limitations of the Study

While this study aimed to assess the nutritional status of professional rugby players, we acknowledge the following limitations:

- The study sample included only one provincial team (n=41). Therefore, findings may reflect the individual characteristics and demographics of the observed population and may not be representative of other teams.
- Although it would have added value if longitudinal data could have been collected, time and financial considerations meant that only cross-sectional data could be collected.
- The dietary assessment in the present study was limited to three days of reported food intake. Although a 7-day food record or weighed food diaries may have provided a more comprehensive assessment of dietary intakes (Jenner *et al.,* 2018:7; Shriver *et al.,* 2013:15), three 24-hour recalls are considered a valid assessment of dietary intake (we included a game day, rest day and training day).
- Dietary intake of participants was self-reported. This may have resulted in over-reporting and/or under-reporting, which is considered to be a limitation (Jenner *et al.,* 2018:7; Potgieter *et al.,* 2014:37). By making use of household measures, every effort was made to obtain accurate portion sizes of foods eaten.
- Micronutrient intake was determined by assessing intake only from food, although 50% of the participants reported the intake of multi-vitamin supplements, which would have added to the intake of micronutrients in those participants. There were, however, very few differences in micronutrient intake of players that used a supplement compared to those that didn't.

## 5.3 Participant Profile

As previously mentioned, 41 rugby players participated in the present study, with 54% of participants playing prop, hooker, lock, flanker, or number 8 position (forwards), while the remaining 46% played wing, centre, or full back (backs) (table 4.1).

In the present study, the median age of the participants was 26.1 years. This is similar to the median age of 25 years of the professional Super League rugby players in the United Kingdom (Alaunyte *et al.,* 2015:2) and the Australian athletes (24.2 years) (Jenner *et al*., 2018:2). In the Stellenbosch (South African) study, median age of the participants was younger at 21.9 years (Potgieter *et al*., 2014:37), because they included participants that were at university. The majority of the participants (83%) in the present study listed Afrikaans as their home language (table 4.1). The Stellenbosch study didn't assess home language, and although not stated, it is assumed that the majority of participants in the UK and Australian studies spoke English.

Almost half (49%) of the participants that took part in the present study reported matric as their highest level of education, while the remaining 51% had completed a tertiary qualification (table 4.1). In the UK study, only 29% of participants had obtained a tertiary degree, while the remaining 71% had qualifications more or less equivalent to matric in South Africa. In the Australian and Stellenbosch study, educational qualification was not assessed.

In the present study, 54% of the participants were forwards, and 45% played in the backline (table 4.1). In the Stellenbosch study, 37% were forwards, 46% backs, while 17% of the participants did not indicate their position. The UK and Australian studies did not state the positions of participants.

## 5.4 Anthropometric Status of Participant

According to national standards that have been set by Boksmart (Boksmart:online; Potgieter *et al.,* 2014:38), body weight of South African rugby players should range from 102-118 kg for forwards, and 88-100 kg for backs (table 4.3).

The mean body weight of participants in the present study was 101kg, while the mean height was 1.84m. Based on the recommendations for weight, only 12% of participants were classified as "overweight." Participants in the UK study had a lower mean weight of 93kg, and mean height of 1.80m. Participants from the Australian study's mean weight and height were 86.3kg and 1.88m, respectively. In the Stellenbosch study, a mean weight of 95.5kg and mean height of 1.80m was reported.

In the present study, the mean body fat percentage of participants was 12.5%, well within the international recommendations of 8 – 17% (Potgieter *et al.,* 2014:38 and Gallagher *et al.,* 2000:699), while the median percentage body fat of the forwards (13.9%) was slightly lower than national standards (15 – 20%). The backs had a median body fat percentage of 10.1%, also slightly lower than the national standards of 12 – 14% (Potgieter *et al.,* 2014:38). However, exercise performance will only be impaired when body fat is reduced to extremely low percentages.

The Australian study found a mean body fat percentage of 10.8%, also well within the international recommendations. In the Stellenbosch study, participants had a much higher mean body fat percentage of 18.2%. Both their forwards (21.9%) and backline players (15.8%) had a mean body fat percentage higher than the national recommendations. A lower body fat percentage can be beneficial, as it will optimize speed and agility, as well as improve stamina and heat tolerance (Meltzer & Fuller, 2008:140).

As previously mentioned, the literature has shown that BMI is not an ideal anthropometric parameter to use when assessing weight status in the rugby population, due to the fact that these athletes often have a high muscle mass and low fat mass. BMI may then incorrectly classify a muscular individual as being overweight (Thomas *et al.,* 2016:506; Potgieter *et al.,* 2014:38, and King *et al.,* 2005:74). This statement was confirmed in the present study, as the median BMI of the forwards (31.4 $kg/m^2$) and backline players (28.0 $kg/m^2$) falls in the obese class 1 category for the forwards, and overweight for the backs (mean BMI for all players was 30 $kg/m^2$). However, body fat percentages of the participants in the current study were, in fact, lower than the mean percentage body fat of South African rugby players, according to national normative data, presented by Boksmart (table 4.6) (Boksmart:online; Potgieter *et al.,* 2014:38).

## 5.5 Dietary Assessment

Studies from America (Shriver *et al.,* 2013:13), Australia (Jenner *et al*. 2018:3), the UK (Alaunyte *et al.,* 2015:3), and South Africa (Potgieter *et al*. 2014:39) have assessed dietary intake of athletes. These studies have determined dietary intake using food frequency questionnaires (UK), 7-day food diaries (Stellenbosch, Australia), 3-day food records (America) and 24-hour recalls (America, Stellenbosch) and compared their findings with current international dietary guidelines for athletes from the ACSM and ISSN.

In the present study, only 37% of participants described their eating habits as “good”. This is similar to the American study where 44% of the participants considered their diet to be “good,” with 56% stating that their diet was “fair” or “poor.”

It is recommended that athletes regularly consume breakfast, as breakfast consumption significantly improves athletes’ performance due to liver and muscle glycogen levels being restored after an overnight fast (Shriver *et al.,* 2013:10). Seventy-three percent of participants from the present study reported eating breakfast every day, which is much higher than that of participants in the American study, where only 27% of participants reported regular intake of breakfast.

The majority of participants from the present study used sport supplements (88%), which is similar to that reported by participants in the Stellenbosch study, where 91% reported supplement use, mainly for recovery, to increase muscle mass, for weight gain, or to enhance performance (Potgieter *et al.,* 2014:37). In the present study, all participants who reported use of sport supplements indicated the use of whey protein, while four participants used creatine as well. Meltzer & Fuller (2008:141) advised against overuse of these supplements, as it can be counterproductive and result in gaining excessive bulk and fat mass. The ACSM advises that protein requirements can be met through dietary intake alone, without the additional use of supplements (Rodriguez *et al.,* 2009).

In the present study, half of the participants reported the intake of micronutrient supplements. These included multi-vitamins, vitamin C, calcium, omega-3 fatty acids and probiotics (table 4.7). According to Dorfman (2017:442) and Kreider *et al.,* (2010:11), supplementing with Vitamin C does not necessarily improve physical performance, even though it may have a protective effect against exercise-induced oxidative damage. According to Potgieter *et al.,* (2014:37), there are currently no clear guidelines supporting the intake of additional micronutrient supplements in athletes.

### 5.5.1 Energy and Macronutrients

Based on the recommendations of the ISSN, energy requirements for rugby players are 200 to 350kJ per kilogram body weight per day (Kreider *et al.,* 2010:7) (table 2.1). In terms of carbohydrate requirements, 5 to 7g per kg body weight are needed on an off day, and 6 to 10g per kg body weight are required on training- and game days (Thomas *et al.,* 2016:508) (table 2.2). The ISSN and ACSM further recommend a protein intake of 1.2 to 2.0 grams per kg body weight per day (Beelen *et al.,* 2010:12).

In the present study, the median energy and macronutrient intake of forwards and backline players were compared. No significant differences were observed. It was not possible to compare these findings with those of other studies since the Stellenbosch study didn't compare intakes of forwards and backs, due to limited data received from the backline players in their study.

In the present study, 95% of participants didn't meet energy requirements on a training day and an off day. Carbohydrate intake of all the participants was insufficient, while protein intake was above the current recommendations on all three days for most of the participants (table 4.9). Similarly, participants in the Stellenbosch study also had an inadequate intake of energy and carbohydrates, with protein intake also being higher than recommended. In the Australian study, none of the participants met current recommendations for energy and carbohydrate intake, while only 54% met protein recommendations. Although not calculated in the UK study, the authors indicated that carbohydrate intake is often inadequate in rugby players. In the American study, 91% of participants reported energy and carbohydrate intakes that were significantly lower than requirements.

According to Bean (2017:5), insufficient energy intakes can cause reduced performance, muscle loss, delayed recovery, and increase the risk of fatigue, injury and illness. An insufficient carbohydrate intake is also associated with fatigue, impaired concentration and decreased physical output (Jenner *et al.,* 2018:6; Thomas *et al.,* 2016:508). Although the benefits of adequate intakes of protein are well recognised, there is currently no evidence that a protein intake higher than the recommended intake will further increase muscle mass (Bean, 2017:88).

On training days and off days, three quarters (73% and 76%) of participants from the present study did not meet daily fibre recommendations. This is similar to the findings of the Australian study, where only 37% of participants met the fibre requirement of 30g per day. Most of the participants from the Stellenbosch study, however, met the recommended intake, with a median intake of 37.7g, which is similar to median intake on a game day in the present study (42g). Dietary fibre is known for its prebiotic properties to support the gut microbiome and can further reduce the development of metabolic risk factors (Sekgala *et al.,* 2018:2).

The ISSN recommends that 30% of total daily energy intake should be from fat (Potgieter, 2013:13; Kreider *et al.,* 2010:10). In the present study median total fat intake was higher than recommended. This was also found in the Stellenbosch study where total fat intake exceeded recommendations. This can possibly be due to a high intake of fatty take-away foods, since 85% of participants in the present study reported intakes of 1-3 days per week (table 4.7).

Although not statistically significant, there was a trend for backline players to consume more energy than the forwards in the present study, even though the forwards still had a significantly higher BMI and median waist circumference than the backs. A reasonable explanation for this could be the fact that the backs have a significantly higher running distance than the forwards (3111m versus 2106m per day), leading to higher energy expenditure.

As in the present study, the Australian study also found no significant difference between level of education and macro- and micro-nutrient intake (Jenner *et al.,* 2018:2), although in their study, higher levels of education were associated with higher energy intakes.

### 5.5.2 Micronutrient Intake

In a study by Burkhart and Pelly (2016:4) amongst 44 athletes who participated in the 2010 Common Wealth Games in India, 80% of athletes did not meet the DRI for Thiamine, Riboflavin, Niacin, Vitamin C and Iron.

In the present study, about 50% of participants had an intake of Thiamine and Vitamin E below the recommendations on a training day and an off day, while 75% of participants consumed insufficient Vitamin C on training and off days, which may limit the protective effect that Vitamin C and E may have against exercise-induced oxidative damage (Dorfman 2017:442; Kreider *et al.,* 2010:11). Insufficient Thiamine intakes may cause fatigue and reduced performance (Dorfman, 2017:441; Otten *et al.,* 2006:532-535). Calcium intake was also insufficient, with 85% of participants in the present study not meeting the DRI's (table 4.11). In the Australian study, the participants also failed to meet calcium requirements of 1000mg per day, while participants from the Stellenbosch study's intake was within the DRI's. As Calcium is needed for the regulation of muscle contraction, a deficiency may result in muscle numbness (Coutinho *et al.,* 2016:6*;* Rodriquez *et al.*, 2009:515). Almost 50% of the participants in the present study reported the intake of a daily multi-vitamin, with some participants even taking additional Vitamin C and Calcium. As the reported micronutrient values only included intake from food, the use of supplements would have added to the intake of micronutrients. However, as already stated, there are currently no clear guidelines supporting the intake of additional micronutrient supplements in athletes (Potgieter *et al.,* 2014:37).

### 5.5.3 Fluid Intake

It is essential to maintain hydration status. Potgieter (2013:13) and Kreider *et al.* (2010:13) recommended that frequent, adequate amounts of fluid should be consumed during exercise (150 to 200ml every 5 to 20 minutes) to avoid the implications of impaired physical performance related to poor fluid intake.

In the present study, 66% of players drank more than 2L of fluid per day, as well as consuming above recommended amounts during practice. In the American study, only 16% of the participants reported monitoring hydration status. During practice, 58% of the participants reported consuming less than 500ml of fluids, with 3 athletes consuming no fluids. The participants from the Stellenbosch study seemed to be better hydrated during practice, with a mean fluid intake of 954.6ml.

## 5.6 Lifestyle Behaviours

In the present study, 88% of the participants reported moderate to vigorous-intensity exercise on 4 to 6 days per week, ranging from 3 to 5 hours per day (table 4.12). Classifications used to calculate nutritional requirements for participants in this study where thus based on these levels of physical activity.

### 5.6.1 Smoking and Alcohol Intake

In the present study, 22% of participants reported smoking on social occasions (table 4.12). In addition to the well-known health risks associated with smoking, Pacifici *et al.* (2015:133) further caution that tobacco consumption by athletes leads to a decline in physical performance and should thus be avoided.

In the present study, 75% of the participants reported using alcohol on social occasions, but none reported alcohol consumption before practice. After practice, 68% of participants reported not drinking alcohol (table 4.12). In the Stellenbosch study, a high alcohol intake after games was reported, with a mean of five alcoholic drinks. Barnes (2014:909) recommends that athletes should abstain from using alcohol before and after exercise, as this may have a negative impact on recovery and sporting performance.

# CHAPTER 6

# CONCLUSION AND RECOMMENDATIONS

## 6.1 Introduction

The main aim of this study was to assess the nutritional status of professional rugby players in Mpumalanga, and to compare the results to current sports nutrition guidelines. In the final chapter, conclusions are drawn from the findings of the present study. Recommendations related to addressing the identified challenges associated with proper nutrition for athletes are made and recommendations for future research are suggested.

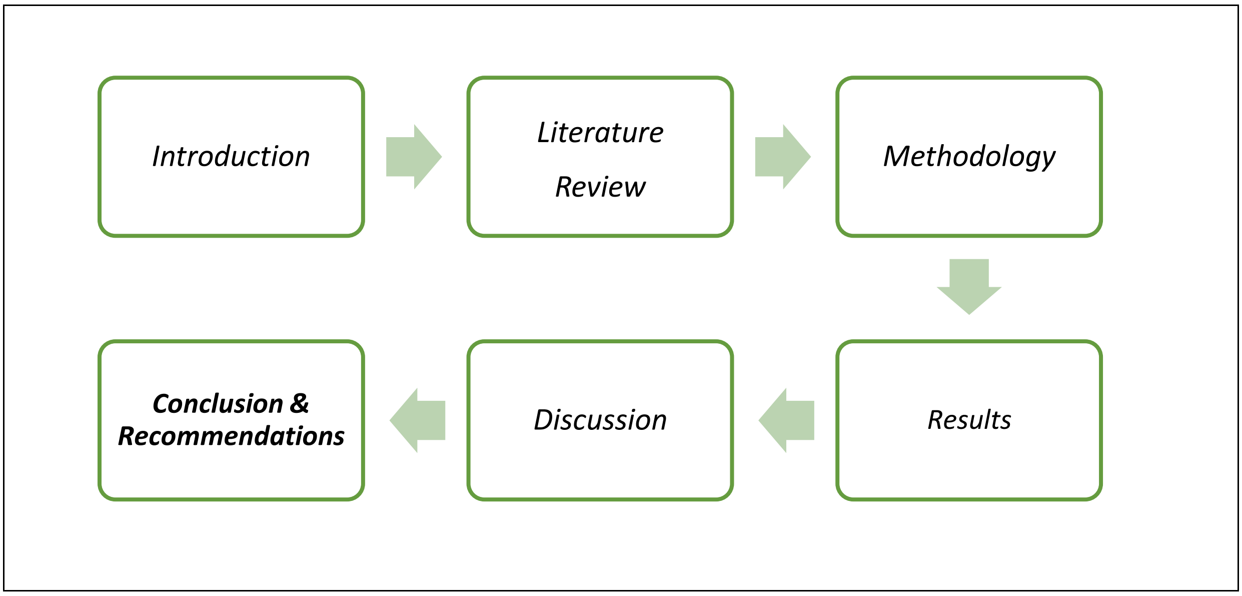


**Figure 6.1: Progression of the study: Conclusion and Recommendations**

## 6.2 Conclusions

The data from the present study can provide valuable and useful information to the players and their coaches on the dietary intake and requirements for provincial rugby players during practices and rugby matches. Although most participants maintained a desired body composition, dietary guidelines were not optimally adhered to and the importance of optimal nutrition did not enjoy the same level of attention as their physical training.

It is recommended that nutrition-related issues be addressed, since inadequate dietary intakes and unhealthy eating behaviours can negatively impact on nutritional status, overall health, quality of training, performance and recovery. Further research related to the barriers that prevent rugby players from following the guidelines is warranted, in order to motivate practical, cost-effective and relevant interventions.

### 6.2.1 Anthropometry

Body weight and body fat percentage of the majority of participants were well within international standards.

### 6.2.2 Diet

- Insufficient energy, carbohydrate and fibre intakes in most participants were observed on training- and off days
- Most participants consumed additional protein supplements, while protein intake of all participants was, in fact, already higher than recommended
- Fat intake exceeded recommendations, with a high intake of take-away foods
- Although most reported micronutrient intakes were satisfactory, intakes of Thiamine, Vitamin E, Vitamin C and Calcium were insufficient
- For most nutrients, nutrient intake was not significantly different between participants that used a supplement compared to those that did not use a supplement
- Fluid intake was lower than recommended
- Level of education did not affect dietary intake

### 6.2.3 Lifestyle

- Although not drinking before practice, the majority of the participants consumed alcohol on social occasions
- Despite the negative impact of tabacco on physical performance, some individuals smoked

## 6.3 Recommendations

As observed in the current study, the results of several other studies have shown that the dietary intakes and eating habits of athletes often leave much to be desired (Tooley *et al.,* 2015:559; Potgieter *et al.,* 2014:42; Shriver *et al.,* 2013:15). It is thus recommended that nutrition-related issues be addressed, since inadequate dietary intakes and unhealthy eating behaviours can negatively impact on nutritional status, overall health, quality of training and recovery.

Findings from the present study also indicated that rugby players require nutritional education and support to make better dietary choices for optimal physical performance; thus, the following recommendations are made from the results obtained in the study:

In terms of recommendations for further research:

- Further research needs to be conducted on professional athletes for the development and improvement of sport specific nutritional guidelines
- More rugby teams in South Africa may be researched to establish an accurate overall indication of players' nutritional status (larger sample size)
- Further research related to the barriers that prevent rugby players from following the guidelines is warranted, in order to motivate practical, cost-effective and relevant interventions

In terms of recommendations for practice:

- The permanent involvement of a registered dietitian, can add value by frequently assessing and monitoring nutritional status of players and making relevant and practical individualised recommendations

- Emphasis should be placed on the importance of adequate energy and especially carbohydrate intakes of athletes, as a low carbohydrate intake can contribute to fatigue, impaired concentration and decreased physical output (Jenner *et al.,* 2018:6; Thomas *et al.,* 2016:508)
- Foods containing high amounts of the micronutrients that were lower than the DRI's, should be encouraged
- Players should refrain from smoking tobacco and using alcohol, particularly during training and game seasons, as various studies have shown a decline in physical performance (Thomas *et al.,* 2016:512; Pacifici *et al.,* 2015:133; Potgieter *et al.,* 2014:42; Hesami *et al.,* 2012:297)
- Relevant guidelines, training and information sessions with athletes and their coaches could be implemented to strengthen nutritional knowledge

# REFERENCES

Alaunyte I, Perry JL & Aubrey T. 2015. Nutritional Knowledge and Eating Habits of Professional Rugby League Players: Does Knowledge Translate Into Practice? *Journal of the International Society of Sports Nutrition,* 12(18):1-7.

Barnes MJ. 2014. Alcohol: Impact on Sports Performance and Recovery in Male Athletes. *Journal of Sports Medicine*, 44(7):909-919.

Bean A. 2017. In The Complete Guide to Sports Nutrition. 8th edition. Bloomsbury: 5-140.

Beck KL, Thomson JS, Swift RJ & von Hurst PR. 2015. Role of nutrition in performance enhancement and postexercise recovery. *Open Access Journal of Sports Medicine*, *6*:259-267.

Beelen M, Burke LM, Gibala MJ & Van Loon LJC. 2010. Nutritional Strategies to Promote Postexercise Recovery. *Journal of Physical Activity and Health*, 2010:1-17.

BokSmart. Normative Data (Average + SD) form, Senior. Available from: http://www.sarugby.co.za/ boksmart/pdf/BokSmart%20-%20normative%20data%20(display%20only%20 Average%20SD)%20SENIOR.pdf [Date of access: 12 May 2017].

Burkhart SJ & Pelly FE. 2016. Dietary Intake of Athletes Seeking Nutrition Advice at a Major International Competition. *Nutrients Journal,* 8(638): 1-14.

Burke LM, Hawley JA, Wong SH, Jeukendrup AE. 2011. Carbohydrates for Training and Competition. *Journal of Sport Sciences,* 29(1):S17-27.

Burke LM & Cox G. 2010. Rugby League and Union. In The Complete Guide to Food for Sports Performance. 1st edition. Allen & Unwin: 418-425.

Burke LM, Slater G, Broad EM, Haukka J, Modulon S & Hopkins WG. 2003. Eating patterns and meal frequency of elite Australian athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* (13):521-538.

Clénin GE, Cordes M, Huber A, Schumacher YO, Noack P, Scales J & Kriemler S. 2016. Iron Deficiency in Sports – Definition, Influence on Performance and Therapy. *Journal of Swiss Sports & Exercise Medicine*, 64(1):6-18.

Coutinho LAA, Porto CPM, Pierucci APTR. 2016. Critical evaluation of food intake and energy balance in young modern pentathlon athletes: a cross-sectional study. *Journal of the International Society of Sports Nutrition,* 13(15):1-8.

Dorfman L. 2017. Nutrition for Exercise and Sport Performance. In Krause's Food & Nutrition Therapy by Mahan LK, Raymond JL. 14th edition. St Louis, Missouri: Elsevier Inc: 426-455.

Duthie GM, Pyne DB, Marsh DJ & Hooper SL. 2006. Sprint patterns in rugby union players during competition. *Journal of Strength and Conditioning Research*, 20:208-214.

Folasire OF, Akomolafe AA & Sanusi RA. 2015. Does Nutrition Knowledge and Practice of Athletes Translate to Enhanced Athletic Performance? Cross-Sectional Study Amongst Nigerian Undergraduate Athletes. *Global Journal of Health Science,* 7(5):215-225.

Gallagher D, Heymsfield SB, Heo M, Jebb SA Murgatroyd PR, & Sakamoto Y. 2000. Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index. *American Journal of Clinical Nutrition*, 72:694-701.

Golafshani N. 2003. Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report, 8*(4):597-607.

Heaney S, O'Connor H, Michael S, Gifford, J & Naughton G. 2011. Nutrition Knowledge in Athletes: A Systematic Review*. International Journal of Sport Nutrition and Exercise Metabolism*, 21(3):248-261.

Heaton LE, Davis JK, Rawson ES, Nuccio RP, Witard OC, Stein KW, Baar K, Carter JM & Baker LB. 2017. Selected In-Season Nutritional Strategies to Enhance Recovery for Team Sport Athletes: A Practical Overview*. Journal of Sport Medicine,* 47:2201-2218.

Hesami Z, Aryanpur M, Emami H & Masjedi M. 2012. Behavior and Knowledge of Iranian Professional Athletes towards Smoking. *Asian Journal of Sports Medicine*, 3(4):297-300.

Holway FE & Spriet LL. 2011. Sport-specific nutrition: Practical strategies for team sports. *Journal of Sports Sciences,* 29(1):115-125.

International Diabetes Federation (IDF). 2015. South Africa. Available from: http://www.idf.org/membership/afr/south-africa [Date of access: 26 March 2017].

ISAK (2016) International standards for anthropometric assessment. The International Society for the Advancement of Kinanthropometry, Potchefstroom.

Jenner SL, Trakman G, Coutts A, Kempton T, Ryan S, Forsyth A & Belski R. 2018. Dietary Intake of Professional Australian Football Athletes Surroundig Body Composition Assessment. *Journal of the International Society of Sports Nutrition,* 15(43):1-8.

Kerksick CM, Wilborn CD, Roberts MD, Smith-Ryan A, Kleiner SM, Jäger R, Collins R, Cooke M, Davis JN, Galvan E, Greenwood M, Lowery LM, Wildman R, Antonio J & Kreider RB. 2018. ISSN Exercise & Sports Nutrition Review Update: Research & Recommendations. *Journal of the International Society of Sports Nutrition,* 15(38):1-57.

Kimiyiwe ME & Simiyu NWW. 2009. The extent of dietary supplements use by male rugby players in Kenya. *Journal of Applied Biosciences*, 22:1306-1311.

King NA, Hills AP & Blundell JE. 2005. High Body Mass Index is not a barrier to physical activity: Analysis of international rugby players' anthropometric data. *European Journal of Sports Science*, 5(2):73-75.

Kreider RB, Wilborn CD, Taylor L, Campbell B, Almada AL, Collins R, Cooke M, Earnest CP, Greenwood M, Kalman DS, Kerksick CM, Kleiner SM, Leutholtz B, Lopez H, Lowery LM, Mendel R, Smith A, Spano M, Wildman R, Willoughby DS, Ziegenfuss TN & Antonio J. 2010. ISSN exercise & sport nutrition review: research & recommendations. *Journal of the International Society of Sports Nutrition*, 1(1):1-44.

Lancaster GA, Dodd S & Williamson PR. 2004. Design and analysis of pilot studies: recommendations for good practice. *Journal of Evaluation in Clinical Practice,* 10(2): 307-312.

Meltzer F & Fuller C. 2008. Bursts of Energy: Rapid Recovery. In The Complete Book of Sports Nutrition: A Practical Guide to Eating for Sport. 2nd edition. New Holland Publishers (UK) Ltd: 140- 143.

Mielgo-Ayuso J, Maroto-Sánchez B, Luzardo-Socorro R, Palacios G, Palacios Gil-Antuñano N & González-Gross M. 2015. Evaluation of nutritional status and energy expenditure in athletes. *Nutricion Hospitalaria*, 31(s03):227-236.

Monsen ER & Van Horn L. 2008. An Introduction to Discovery through Research in Nutrition and Dietetics. In Research Successful Approaches. 3rd edition. Academy of Nutrition and Dietetics: 5, 85.

Nascimento M, Silva D, Ribeiro S, Nunes M, Almeida M & Mendes-Netto R. 2016. Effect of a Nutritional Intervention in Athlete's Body Composition, Eating Behaviour and Nutritional Knowledge: A Comparison between Adults and Adolescent. *Nutrients Journal,* 8(535): 1-14.

Nelms M & Habash D. 2016. Nutrition for Exercise and Sport Performance. In Nutrition Therapy and Pathophysiology. 3rd edition. Cengage Learning: 36-71.

Noda Y, Lide K, Masuda R, Kishida R, Nagata A, Hirakawa F, Yoshimura Y & Imamura H. 2009. Nutrient intake and blood iron status of male collegiate soccer players. *Asia Pacific Journal of Clinical Nutrition,* 18 (3):344-350.

Otten JJ, Hellwig JP & Meyers LD. 2006. Dietary Reference Intakes. In The Essential Guide to Nutrient Requirements by Institute of Medicine of the National Academies. National Academy of Sciences: 110, 532-535.

Pacifici R, Pichini S, Palmi I, De la Torre X, Botrè F & the Anti-Doping Commission at the Ministry of Health. 2015. Smoking habits of Italian athletes undergoing anti-doping control. *Drug Testing Analysis,* 2016(8):133-135.

Potgieter S. 2013. Sport Nutrition: A review of the latest guidelines for exercise and sport nutrition from the American College of Sport Nutrition, the International Olympic Committee and the International Society for Sports. *South African Journal of Clinical Nutrition*, *26*(1):6-17.

Potgieter S, Visser J, Croukamp I, Markides M, Nascimento J & Scott K. 2014. Body composition and habitual and match-day dietary intake of the FNB Maties Varsity Cup rugby players. *South African Journal of Sports Medicine*, *26*(2):35-43.

Rodriquez NR, DiMarco NM & Langley S. 2009. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the American Dietetic Association,* 109(3): 509-527.

Santos DA, Dawson JA, Matias CN, Rocha PM, Minderico CS, Allison DB, Sardinha LB & Silva AM. 2014. Reference Values for Body Composition and Anthropometric Measurements in Athletes. *Plos One*, 9(5):1-11.

Sekgala MD, Mchiza ZJ, Parker W & Monyeki KD. 2018. Dietary Fibre Intake and Metabolic Syndrome Risk Factors among Young South African Adults. *Nutrients,* 10(504):1-15.

SEMDSA Type 2 Diabetes Guidelines Expert Committee. 2017. SEMDSA 2017 Guidelines for the Management of Type 2 Diabetes Mellitus. *Journal of Endocrinology, Metabolism and Diabetes of South Africa,* 22(1):S1-S196.

Shriver LH, Betts NM & Wollenberg G. 2013. Dietary intakes and eating habits of college athletes: are female college athletes following the current sports nutrition standards? *Journal of American College Health*, *61*(1):10-16.

Smith JW, Holmes ME & McAllister MJ. 2015. Nutritional Considerations for Performance in Young Athletes. *Journal of Sports Medicine (Hindawi Publishing Corporation)*, *2015*(734649):1-13.

Spriet L. 2014. New Insights into the Interaction of Carbohydrate and Fat Metabolism During Exercise. *Journal of Sports Medicine*, 44(1):87-96.

Thomas DT, Erdman KE, Burke LM & Mackillop M. 2016. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the Academy of Nutrition and Dietetics*, 116(3):501-528.

Tooley E, Bitcon M, Briggs MA, West DJ & Russell M. 2015. Estimates of Energy Intake and Expenditure in Professional Rugby League Players. *International Journal of Sports Science & Coaching*, 10(2,3):551-560.

Williams C & Rollo I. 2015. Carbohydrate Nutrition and Team Sport Performance. *Sports Medicine Journal*, 45(1):S13-S22.

World Health Organisation. 2006. *BMI Classification*. Available from: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html [Date of access: 26 March 2017].

World Health Organization (WHO). 2008. STEPS approach to chronic diseases and health promotion- user manual. Available from: http://www.who.int/chp/steps/manual/en/index3.html. [Date of access: 26 March 2017].

# APPENDICES

## Appendix A: Questionnaire and 24-hour Recall

*Nutritional Assessment of Professional Rugby Players in Mpumalanga:*
*Are Requirements being met according to Current Sports Nutrition Standards?*

**NUTRITIONAL ASSESSMENT QUESTIONNAIRE**

1 Today's date: d d m m y y

**i. SOCIO-DEMOGRAPHY**

2 Date of Birth: d d m m y y

Age: _________years

3 Home Language:
1 Afrikaans
2 English
3 Other *If other, please specify:*_________________

4 Highest level of Education
1 Matric
2 Undergradute
3 Post-Graduate
4 Other *If other, please specify:*_____________

5 Current Position in Steval Pumas Rugby Team
1 Prop or Hooker
2 Lock or Flanker or Number 8
3 Scrum Half or Fly Half
4 Wing or Centre or Full Back

**ii. ANTHROPOMETRY - *obtained from Biokineticists***

6 Weight: ____________Kg

7 Height: ____________cm

8 Body Mass Index _____________Kg/m²

9 Waist Circumference _____________cm

10 Body Fat Percentage _____________%

**iii. DIETARY ASSESSMENT**

11 Have you recveived dietary advice from a dietitian before?
1 Yes
2 No

12 How would you describe your eating habits?
1 Good
2 Fair
3 Poor

13 How often do you eat breakfast?
1 Everyday
2 4-6 times per week
3 1-3 times per week
4 Never

14 How often do you eat lunch?
1 Everyday
2 4-6 times per week
3 1-3 times per week
4 Never

15 How often do you eat dinner?
1 Everyday
2 4-6 times per week
3 1-3 times per week
4 Never

16 What is your usual daily fluid intake?

1 ±500ml per day
2 1-2L per day
3 More than 2L per day

17 What is your fluid intake during practice?

1 None
2 Sips only when thirsty
3 150 - 200ml every 5-20min

18 How often do you eat take aways?

1 Everyday
2 4-6 times per week
3 1-3 times per week
4 Never

19 Do you use any sport supplements on a daily basis?

1 Yes
2 No

*If yes, please specify:* ____________________________________________________________

20 Do you use any vitamin or mineral supplements on a daily basis?

1 Yes
2 No

*If yes, please specify:* ____________________________________________________________

**iv. LIFESTYLE BEHAVIOURS**

21 In a typical week, on how many days do you do moderate to vigorous - intensity sports, fitness or recreational (lesuire) activities? _______________

22 How much time do you spend doing moderate to vigorous-intensity sports, fitness or recreational (lesuire) activities on a typical day? ______ : ________

hours : minutes

23 How often do you smoke cigarettes?

1 Everyday
2 Over weekends
3 On social occasions
4 Quit smoking
5 Never smoked

24 How often do you consume alcohol?

1 Everyday
2 Over weekends
3 On social occasions
4 Never

25 Do you consume alcohol before practice?

1 Yes
2 No
3 Sometimes

*If yes, please specify (less / more than 2 units):* ____________________________________________________________

26 Do you consume alcohol after practice?

1 Yes
2 No
3 Sometimes

*If yes, please specify (less / more than 2 units):* ____________________________________________________________

***Nutritional Assessment of Professional Rugby Players in Mpumalanga: Are Requirements being met according to Current Sports Nutrition Standards?***

*24-hour recall*

**Respondent number: ____________**

**Interview date: _________________**

**___ Training day**

**___ Off day**

**___ Game day**

| Time | Place eaten | Food | Description and cooking method | Amount eaten | Weight equivalent (g) | Food code |
|---|---|---|---|---|---|---|
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**Probes to obtain detailed descriptions of specified foods**

| ***Food Type*** | ***Required Detailed Information*** |
|---|---|
| Meat | Kind of meat; description of cut, raw or cooked weight, method of cooking, lean or lean plus fat, bone in or not (waste factor) |
| Fish and seafood | Kind of fish or seafood; raw or cooked weight; method of cooking; amount of bones, skin, or shell (waste factor) |
| Poultry | Kind of poultry; parts or pieces eaten (e.g., breast, thigh), raw or cooked weight, method of cooking, white or dark meat, meat plus skin or meat only, bones (waste factor) |
| Fats | Kind of fat, brand name (if possible) |
| Milk products | Kind of dairy product, brand name (if commercial product), percentage fat (as butter fat or milk fat), liquid vs. powdered milk |
| Cheese | Kind of cheese (whole milk hard cheese, fresh cheese, cream cheese, etc.), percentage fat (if known), brand name (if commercial product) |
| Bread, rolls | Type of grain (rye, whole wheat, etc.), homemade or bought, size: standard or unusual, toasted or not, topping and condiments, brand name (if commercial product) |
| Baked goods | Type of product, whether iced or not, homemade or commercial, type of filling |
| Cereal, pasta, or rice | Type of grain, whole or refined, brown or white (for rice), brand name, raw or cooked weight, cereal plus milk (if dry quantity unknown), method of cooking |
| Vegetables | Fresh, frozen, or canned; peeled or unpeeled; method of cooking; topping (butter, etc.) |
| Fruits | Fresh, stewed, frozen, or canned; peeled or unpeeled; type of liquid (heavy, light): sweetened or unsweetened; waste factor (e.g., peel, pips) |
| Beverages, soup | Fresh or frozen; canned or bottled; fruit juice: sweetened or unsweetened; added vitamins or minerals (e.g., vitamin C); coffee: brewed, instant, decaffeinated, regular; soups: homemade or canned, dilutant (milk or water), proportion of dilutant: concentrate (e.g., 1:1), recipe; brand name (if commercial product) |
| Fast foods | Food (e.g., French fries and chips), brand name (if commercial product), condiments added, method of cooking |
| Mixed dishes | Product name, homemade or commercial, recipe ingredients, cooking method |
| Herbs, spices | Name; fresh or dried |

***Assessering van Voedingstatus van Professionele Rugby Spelers in Mpumalanga: Word daar aan Vereistes voldoen Volgens Huidige Sportsvoeding Standaarde?***

*24-huur herroep*

**Nommer van respondent: ____________** **___ Oefen dag**

**Datum van onderhoud: ______________** **___ Rus dag**

**___ Wedstryd dag**

| Tyd | Plek | Voedsel | Beskrywing en gaarmaak metode | Hoeveelheid ingeneem | Gewigs-ekwivalent (g) | Voedsel-kode |
|---|---|---|---|---|---|---|
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**Terme om gedetailleerde beskrywings van gespesifiseerde voedsel te verkry**

| ***Voedseltipe*** | ***Inligting Benodig vir Beskrywing*** |
|---|---|
| Vleis | Tipe vleis; beskrywing van snit, rou of gekookte gewig, gaarmaak metode, maer of vet ingesluit, met of sonder (afvalsfaktor) |
| Vis en Seekos | Tipe vis of seekos; rou of gekookte gewig; gaarmaak metode; hoeveelheid bene, vel of skulp (afvalsfaktor) |
| Pluimvee | Tipe pluimvee; dele of stukkies geëet (bv. bors, dye), rou of gekookte gewig, gaarmaak metode, wit of donker vleis, vleis saam met die vel, of net vleis, bene (afvalfaktor) |
| Vette | Tipe vet, handelsnaam (indien moontlik) |
| Melk Produkte | Tipe suiwelproduk, handelsnaam (indien kommersiële produk), persentasie vet (soos bottervet of melkvet), vloeistof teenoor melkpoeier |
| Kaas | Tipe kaas (volroom harde kaas, vars kaas, roomkaas, ens.), Persentasie vet (indien bekend), handelsnaam (indien kommersiële produk) |
| Brood | Tipe graan (rog, volgraan, ens.), Tuisgemaak of gekoop, grootte: standaard of ongewoon, gerooster of nie, bo-laag en speserye, handelsnaam (indien kommersiële produk) |
| Gebakte Goedere | Tipe produk, gevries of nie, tuisgemaak of kommersieel, tipe vulsel |
| Ontbytgrane, Pasta of Rys | Tipe graan, volgraan of verfyn, bruin of wit (vir rys), handelsnaam, rou of gekookte gewig, ontbytgraan plus melk (indien droë hoeveelheid onbekend is), gaarmaak metode |
| Groente | Vars, bevrore of ingemaakte groente; geskil of ongeskil; gaarmaak metode; bo-laag (botter, ens.) |
| Vrugte | Vars, gestoof, bevrore of ingemaakte vrugte; geskil of ongeskil; tipe vloeistof (swaar, lig): versoet of onversoet; afvalsfaktor (bv. skil, pitte) |
| Drinkgoed en sop | Vars of bevrore; ingemaak of gebotteld; Vrugtesap: versoet of onversoet; bygevoegde vitamiene of minerale (bv. vitamien C); koffie: gebrou, kits, gedekaffineer, gewone; sop: tuisgemaakte of ingemaakte verdunningsmiddel (melk of water), verhouding van verdunningsmiddel: konsentrasie (bv. 1: 1), resep; handelsnaam (indien kommersiële produk) |
| Kitskos | Tipe kos (bv. aartappelskyfies en tjips), handelsnaam (indien kommersiële produk), bygevoegde speserye, gaarmaak metode |
| Gemengde Geregte | Produknaam, tuisgemaak of kommersieel, resep bestanddele, gaarmaak metode |
| Kruie, Speserye | Naam; Vars of gedroog |

## Appendix B: Approval Letter from Ethics Committee

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

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

**Health Sciences Research Ethics Committee**

29-Jan-2018

Dear **Van Aardt, Reon R~Walsh, Corinna CM~**

Ethics Clearance: **Nutritional Assessment of Professional Rugby Players in Mpumalanga: Are Requirements being met according to Current Sports Nutrition Standards?**

Student/Student Group leader: **Mr Reon Van Aardt**

Department: **Nutrition and Dietetics (Bloemfontein Campus)**

**APPLICATION APPROVED**

Please ensure that you read the whole document

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

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2017/1532**

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

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

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

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

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

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

Yours Sincerely

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

**Health Sciences Research Ethics Committee**
**Office of the Dean: Health Sciences**
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa

**Appendix C: Letter of Permission**

# ***LETTER OF PERMISSION***

## *Nutritional Assessment of Professional Rugby Players in Mpumalanga: Are Requirements being met According to Current Sports Nutrition Standards?*

Mr Marius van Rensburg, Mpumalanga Rugby Team: Manager

This study will be performed by a registered dietitian during the first semester of 2019, as part of his Master's degree in Dietetics at the Department of Nutrition and Dietetics from the University of the Free State. The study will aim to determine the nutritional status of provincial, professional rugby players in Mpumalanga.

As part of the study, energy intakes, as well as macro- and micronutrient intakes of rugby players from the Steval Pumas in Nelspruit will be determined, followed by a comparison of the results with the minimum sport nutrition recommendations for energy and macronutrients, and established DRI's for the applicable micronutrients. Secondly, this study will explore the dietary patterns and lifestyle behaviours (alcohol and smoking) in the target population. Thirdly, anthropometry (body mass and body fat percentage) will be assessed and compared to National standards.

**What is involved in the study** – Three (3) separate diet histories (24-hour recalls) on three (3) different days will be obtained from participants: after a training day, after an off day, and after a game day. The participants will be asked to answer simple questions about their diet, daily activity and certain eating and lifestyle habits. This should only take about 30 minutes of their time.
In addition, results from anthropometric measurements performed by the LowMed biokineticists, will be obtained after written consent from the participant.

**Risks** – There are no risks involved in participating in this study.

**Benefits** – The findings of this study will aid in identifying gaps in the knowledge and practices of provincial rugby players in Mpumalanga and assist in compiling basic sports nutrition recommendations to address the identified challenges.

**For further information, please do not hesitate to contact us.**

*Reon van Aardt*
*083 257 4563*
*dietitian@lowmed.co.za*

*Prof Corinna Walsh*
*051 401 3818*
*walshcm@ufs.ac.za*

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Approved by: M. van Rensburg

Contact details: 082 960 1732

Signature: [signature]

Date: 16/01/2018

**Appendix D: Information Document**

# ***INFORMATION DOCUMENT***

## *Nutritional Assessment of Professional Rugby Players in Mpumalanga: Are Requirements being met According to Current Sports Nutrition Standards?*

-------------------------------------------------------------------------------------------------------

Dear prospective participant,

I, Reon van Aardt, would like to include you in this study. The main aim of this study is to assess the nutritional status of professional rugby players in Mpumalanga, and compare the results to the current sports nutrition guidelines.

**What is involved in the study** – Three (3) separate diet histories (24-hour recalls) on three (3) different days will be obtained: after a training day, after an off day, and after a game day. You will be asked to answer simple questions about your diet, daily activity and certain eating and lifestyle habits. This should only take about 30 minutes of your time.
In addition, results from anthropometric measurements performed by the LowMed biokineticists, will also be obtained. These measurements will be done privately and include weight, height, waist- and hip circumference, as well as skin fold measurements needed to calculate body fat percentage.

**Benefits** – The findings of this study will aid in identifying gaps in the knowledge and practices of provincial rugby players in Mpumalanga and assist in compiling basic sports nutrition recommendations to address the identified challenges.

**Risks** – There are no risks involved in participating in this study. The body measurements are rapid, non-invasive, neither harmful nor painful.

**Confidentiality** – Efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law.
Organisations 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.

**Contact details of researcher –** for further information/reporting of study-related adverse events: *Reon van Aardt – 083 257 4563 / dietitian@lowmed.co.za*

**Contact details of Head of Ethics Administration –** for reporting of complaints/problems: *Mrs (MGE) Maré Marais – (051) 401 7795*

# ***<u>INLIGTINGSDOKUMENT</u>***

## *Assessering van Voedingstatus van Professionele Rugby Spelers in Mpumalanga: Word daar aan Vereistes voldoen Volgens Huidige Sportsvoeding Standaarde?*

---

Geagte voornemende deelnemer,

Ek, Reon van Aardt, wil u graag by bogenoemde studie insluit. Die hoofdoel van hierdie studie is om die voedingstatus van professionele rugby spelers in Mpumalanga te assesseer, asook dan vergelyk met die huidige sportvoeding riglyne.

**Wat behels die studie** – ‘n Dieetgeskiedenis (24-uur herroep) gaan op drie (3) verskillende dae geneem word: na ‘n oefen dag, na ‘n rusdag, asook na ‘n wedstryd dag. Daar gaan eenvoudige vrae gevra word oor u dieet, daaglikse aktiwiteite, asook sekere eetgewoontes. Dit sal ongeveer 30 minute per persoon neem.
Resultate van antropometriese afmetings wat deur die LowMed biokinetikus gedoen is, gaan ook gebruik word in hierdie studie. Hierdie afmetings sal privaat geskied en sluit in: gewig, lengte, middel- en heup omtrek, asook velvoue wat nodig is vir die bepaling van vetpersentasie.

**Voordele** – Die resultate van hierdie studie sal help om moontlike tekorte by provinsiale rugbyspelers in Mpumalanga te identifiseer en sodoende ‘n bydra te lewer tot die ontwikkeling van basiese sportvoeding aanbevelings.

**Risiko’s** verbonde aan deelname – Daar is geen risiko met die deelname aan hierdie studie nie. Die afmetings geskied vinnig en is nie-indringend, onskadelik en glad nie pynlik nie.

**Vertroulikheid** – Daar sal gepoog word om persoonlike inligting vertroulik te hou. Volkome vertroulikheid kan nie gewaarborg word nie. Persoonlike inligting kan bekend gemaak word as die wet dit vereis.
Organisasies wat u navorsingsrekords mag ondersoek en/of kopieer vir kwaliteitsversekering en data-analise sluit groepe soos die Etiekkomitee vir Mediese Navorsing in.

**Kontakbesonderhede van navorser –** Vir verdere inligting/rapportering van studieverwante newe-effekte:
*Reon van Aardt – 083 257 4563 / dietitian@lowmed.co.za*

**Kontakbesonderhede van Hoof van Etiek Administrasie –** vir rapportering van klagtes/probleme: *Mev (MGE) Maré Marais – (051) 401 7795*

**Appendix E: Consent Form**

# ***CONSENT TO PARTICIPATE IN RESEARCH***

## *Nutritional Assessment of Professional Rugby Players in Mpumalanga: Are Requirements being met According to Current Sports Nutrition Standards?*

You have been asked to participate in a research study by the Department of Nutrition and Dietetics, University of the Free State.

You have been informed about the study by a Master's student, Reon van Aardt.

You may contact Reon at 083 257 4563 if you have questions about the research.

You may contact Mrs Maré Marais, Head of the Health Sciences Research Ethics Committee Administration of the Faculty of Health Sciences, UFS at telephone number (051) 401 7795 if you have questions about your rights as a research participant.

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

If you agree to participate, you will be given a 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*

# ***TOESTEMMING TOT DEELNAME AAN NAVORSING***

## *Assessering van Voedingstatus van Professionele Rugby Spelers in Mpumalanga: Word daar aan Vereistes voldoen Volgens Huidige Sportsvoeding Standaarde?*

U is deur die Departement Voeding en Dieetkunde aan die Universiteit van die Vrystaat versoek om aan ‘n navorsingstudie deel te neem.

U is oor die studie ingelig deur Reon van Aardt.

Kontak gerus vir Reon by 083 257 4563 indien u vrae oor die navorsing het.

U kan vir Mev Maré Marais, die Hoof van Etiek Administrasie van die Gesondheidswetenskappe se Navorsings- Etiekkomitee aan die Fakulteit Gesondheidsweteskappe, UV by telefoonnommer (051) 401 7795 kontak indien u enige vrae het oor u regte as ‘n proefpersoon.

U deelname aan hierdie navorsing is vrywillig, en u sal nie gepenaliseer word of voordele verbeur as u weier om deel te neem of besluit om deelname te staak nie.

As u instem om deel te neem, sal ‘n ondertekende kopie van hierdie dokument sowel as die deelnemerinligtingsblad, wat ‘n geskrewe opsomming van die navorsing is, aan u gegee word .

-----------------------------------------------------------------------------------------------------------

Die navorsingstudie, insluitend die bogenoemde inligting is verbaal aan my beskryf. Ek begryp wat my betrokkenheid by die studie beteken en ek stem vrywillig in om deel te neem.

____________________________ ____________________

*Handtekening van deelnemer* *Datum*