THE ANTHROPOMETRIC STATUS AND DIETARY INTAKE OF ADULTS ENGAGING IN BODYBUILDING PROGRAMME AROUND POLOKWANE MUNICIPALITY IN LIMPOPO PROVINCE

by

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DECLARATION

I declare that the **"Anthropometric status and dietary intake of adults engaging in bodybuilding programme around Polokwane municipality in Limpopo province"** dissertation hereby submitted to the University of Limpopo, for the degree of Master of Science in Dietetics has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

______________________ ______________________

Masoga S (Mr) Date

DEDICATION

This research is firstly dedicated to the Almighty God, Who has always been with me from the conceptualisation stage, implementation and completion of this project. I would not have done it without His Grace and strength. I secondly dedicate this research to my beautiful, supportive and loving wife, Emily Masoga and my beautiful daughter, Phetollo. Lastly, to my parents, Melford and Sarina Masoga; siblings, Kekishi and Lekoba Masoga and my grandparents, Kgabo Benjamin and Lekoba Rosina Masoga, for their continuous support throughout my studies.

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ABSTRACT

Introduction: Bodybuilders around Polokwane municipality are adhering to different dietary practices some of which are not evidence based. These practices may predispose these athletes to negative health outcomes sooner or later in life. The aim of this study was to investigate the anthropometric status and dietary intake of bodybuilders around Polokwane Municipality.

Methodology: This was a descriptive analytical study where purposive sampling method was used to obtain 51 out of 65 registered bodybuilders within the training gyms around Polokwane. Weight and Height were measured to determine BMI. Four skinfold sites (triceps, biceps, subscapular and suprailliac) were measured using caliper and non-stretchable tape to estimate total body fat percentage. Dietary information was collected using the 24 hour-recall collected for three different days which was validated by the Food Frequency Questionnaire.

Results: of the 51 body builders, 94.1% were men and 5.8% women. Few athletes (15.7%) were using ergogenic agents such as powders (13.7%) and tablets (2%). Also, 64.7% of the athletes had normal body weight while 33.3% and 2.0% were overweight and obese respectively. Majority of the athletes (78.4%) had an acceptable body fat percentage. Dietary results showed that majority of the athletes consumed energy (98%) and carbohydrates (100%) below the ISSN bodybuilding recommendations.

Conclusion: The dietary intake of the bodybuilding athletes around Polokwane municipality is below the ISSN (2010) bodybuilding recommendations; however, their anthropometric status and body composition is normal.

Key Words : Bodybuilders, Anthropometry, Body fat, Energy, Carbohydrates, Fat, Protein, Micronutrients and Supplements

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ABBREVIATIONS

ADA	: American Dietetic Association
ACSM	: American Critical Society of Medicine
ATP	: Adenosine Triphosphate
BMI	: Body Mass Index
CHO	: Carbohydrates
DC	: Dietitians of Canada
EAR	: Estimated Average Requirement
FFQ	: Food Frequency Questionnaire
GI	: Glycaemic Index
Hb	: Haemoglobin
ISSN	: International Society of Sports Nutrition
IFBB	**:** International Federation of Bodybuilding
Kcal	: Kilocalorie
Kg	: Kilogram
Kj	: Kilojoules
MREC	: MEDUNSA Research Council
NCHS	: National Centre for Health Statistics
RDA	: Recommended Daily Allowance
TE	: Total Energy
UL	: Tolerable Upper intake level
WHO	: World Health Organisation

DEFINITION OF TERMS

Anthropometry: Measurement of body size, weight and proportions (Lee and Nieman, 2010). In the context of this research anthropometry refered to measurement of weight, height, and skinfolds thickness (Triceps, biceps, Suprailliac and subscapular).

Bodybuilding : is a sport in which competitors or athletes are judged on muscular appearance (Rossow *et al.,* 2013). In the context of this research bodybuilding refered to a weight training sport in an attempt to hypertrophy muscles for physical appearance.

Coach: is a qualified person who analyses a sportsman's characteristics; establishes the training programme; leads the sportsman's training; records the training development and evaluates the progress (NOSCA, 2010). In the context of this research a coach was an individual aiming at improving the athletes' performance by emphasizing and facilitating hard and strenuous training; instructing athletes in the skills, techniques and tactics of sport.

Diet: A regular or systematic scheme of diet followed by the athletes.

EAR: An intake that meets the estimated needs of nutrient of 50% of individuals in a specified gender group at a given life-stage (NICUS, 2003). In the context of this research EAR refered to the intake that meets the estimated needs of nutrient of 50% of bodybuilders.

Ergogenic aid: Any training technique, mechanical device, nutritional practice, pharmacological method or psychological technique that can improve exercise performance capacity and/or enhance training adaptations (Kreider *et al.,* 2010). In the context of this research an ergogenic aid refered to any nutritional practice or pharmacological method that can improve exercise/training performance.

Regular trainer: Individual attending training sessions at least ≥3 times per week.

Micronutrients: Nutrients that are required in smaller amounts in the body. In the context of this study, micronutrients refered to Vitamin A, B, C, E, B_1, B_2 and $B_{3.}$

UL: The maximum nutrient intake by an individual, which is unlikely to pose risks of adverse health effects in almost all individuals in a specified group (NICUS, 2003). In the context of this research, UL refered to as maximum nutrient intake by an individual, which is unlikely to pose risks of adverse health effects in almost all individuals within the bodybuilding team.

CHAPTER ONE
INTRODUCTION

1.1. Introduction and Background

Resistance training has become one of the most popular forms of exercise for developing musculoskeletal fitness and overall health (Hass, Garzarella, De Hoyo and Pollock, 2000). Bodybuilders are primarily interested in enhancing power relative to body weight and thus almost all undertake some form of resistance training. While other athletes are primarily concerned with enhancing power and strength, bodybuilding training primarily aims to induce skeletal muscle hypertrophy (Slatter and Phillips, 2011). Gaines (2001) defined bodybuilding as the practice of performing regular exercises designed to increase muscle strength and size.

Bodybuilders participating in competitions are judged on muscle size, shape, definition, proportionality and visual presentation (Lambert, Frank and Evans, 2004 and Rossow, Fukuda, Fahs *et al.*, 2013). This body composition involving high muscle mass and low body fat enables bodybuilding athletes to reflect what is referred to as “incredible” appearance. This composition of high muscles and low body fat, is likely to be obtained from the evidence based diets, training support and the use of anabolic agents (Spendlove, Mitchell and Gifford *et al.*, 2015). Competitive bodybuilders are therefore dedicated to achieving an extremely muscular, symmetrical and well-proportioned physique through a rigorous diet and training regime (Spendlove, Mitchell, Gifford *et al.*, 2015). These, according to Vînturis (2009), the bodybuilders achieve by employing two strategies: bulking and cutting. Bulking entails gaining of muscles and this occurs mostly throughout the year, during which time weight gain becomes common (Brill and Keane, 1994). The second strategy is cutting where body fat loss is encouraged while minimising loss of muscle mostly done 12-14 weeks before the competition. Cutting generally involves reducing energy intake and increasing aerobic exercise while monitoring body fat percentage. Relative absence of fat improves the appearance of muscles by revealing the muscle size, shape, and striation (Spendlove *et al.*, 2015). Nutrition plays a significant role in three aspects of training athletes: fuelling of sport-specific and strength training, recovery from the training, and the promotion of training adaptations, including skeletal muscle hypertrophy (Slatter and Phillips, 2011). Therefore, intake of dietary protein, carbohydrates and/or dietary supplements becomes increasingly high at this stage of cutting. The aim and training regimen for bodybuilders is to increase the muscular mass (Masedu, Ziruolo, Valent, and Di Giulio, 2012). Jazayeri and Amani (2004) explain that nutrition is an important complement of any fitness programme and has an effect in improving performance and promotes healthy dietary practices in the long term. However, athletes engaging in strength and power sports, habitually consume a high-protein diet that can reach values in excess of 2.5 g/kg/day in the belief that this is necessary for muscle growth and repair. These very high dietary proteins are used as a substrate for oxidative metabolism, either directly or as a precursor of glucose, and the excess nitrogen will be lost in the urine (Maughan and Shirreffs, 2011). There are health concerns over excessive intake of dietary protein (>2g/kg/day) which may induce urea genesis, gout (Van Heerden, Hall and Schonfeldt, 2014) dehydration and calcium losses which may later lead to osteoporosis and kidney failure (Spendlove *et al.,* 2015; Kim, Lee and Choue, 2011; Cotugna *et al.*, 2005 and Wright *et al.,* 2004). The high intake of protein is usually coupled with a low or high intake of carbohydrate and low intake of fruit and vegetables. It is important for bodybuilding athletes to consume a varied diet that supports performance while promoting good health. Information relating to dietary intake of bodybuilders around some parts of South Africa (especially Gauteng Province) has been well documented (Barnard, 2012); however, that of bodybuilders in Limpopo remains unreported. Therefore, this research aims at investigating the dietary intake of the bodybuilders training at gyms around Polokwane municipality in Limpopo.

1.2. Problem statement

Bodybuilding athletes around Polokwane Municipality follow a variety of dietary practices. There is a concern over whether these nutritional practices are safe or not (Manore, Thompson, and Ruso, 1993 and Gaines, 2001) as some are deviating from the recommendations by the International Society of Sports Nutrition (ISSN) (Kreider, Wilborn, Taylor, Campbell, Almada *et al*., 2010). According to Vînturis (2009), bodybuilders change their dietary intake a few weeks before competition. This change leads to drastic reduction of dietary fats, vegetables and fruits with an increase in protein and carbohydrates intake (Steen, 1991), predisposing athletes to fat soluble vitamins and mineral deficiencies. These nutrients are required for antioxidant properties, oxygen carrying capacity and other related metabolism during training and/or performance. Preparation for bodybuilding competition involves drastic reductions in body fat (Rossow *et al.,* 2013), while maintaining muscle mass which is achieved by decreasing caloric intake, intensifying strength training, and increasing cardiovascular exercise (Helms, Aragon and Fitschen, 2014). It is not known whether bodybuilding athletes around Polokwane Municipality do take adequate amount of protein, fats and/or starchy foods which are needed for muscle formation and whether they maintain adequate energy supply required during training and/or performance. On the other hand, coaches in bodybuilding sport play a major role in influencing dietary habits of these athletes. At times, these coaches do not have formal training in sports nutrition and often provide nutritional advice that may be contrary to ISSN recommendations. Cotugna, Vickery and McBee (2005) and Mohamad, Mosavi and Amani (2004) reported that coaches have an influence on nutrients intake among athletes and it may be detrimental to the health of athletes if the coach does not have adequate knowledge on what food the athlete should take for a specific sporting code, such as bodybuilding. There is a possibility that bodybuilding athletes around Polokwane municipality are following the dietary recommendations that are given by their coaches; however, it is not known whether these coaches have undergone any training on sports nutrition or not. Emerging athletes in Polokwane Municipality may therefore, follow unproven dietary recommendations, predisposing them to sports related health problems such as renal failure and osteoporosis during active years of participation and later in life. It is therefore important to establish the dietary intake of bodybuilding athletes around Polokwane Municipality in order to encourage adherence to nutrition recommendations so that these athletes can enjoy their lifelong bodybuilding career. Furthermore, to develop diets per weight categories in order to encourage healthy eating patterns in order to prevent nutritional deficiencies while enjoying involvement in bodybuilding.

1.3. Aim of study

The aim of this study was to determine the anthropometric status and dietary intake of bodybuilders around Polokwane Municipality in Limpopo Province. The other aim of this study was to develop meal plans suitable for the bodybuilding athletes.

1.4. Objectives

1.4.1 To determine the socio-demographic profile of bodybuilders around Polokwane Municipality.

1.4.2 To determine the anthropometric profile of bodybuilders around Polokwane Municipality.

1.4.3 To assess the dietary intakes of bodybuilders around Polokwane Municipality

1.4.4 To determine the association between the socio-demographic profile to both dietary intake and the anthropometric data of the bodybuilders around Polokwane Municipality

1.4.5 To develop and recommend dietary plans for the bodybuilders around the Polokwane municipality.

1.5. Research Question

1.5.1. What is the body composition and dietary intake of bodybuilding athletes around Polokwane Municipality in the Limpopo Province?

1.6. Significance of the study

This study will inform bodybuilders around Polokwane Municipality of their dietary and anthropometric status. The results of this study will also be used to advise bodybuilders on the most suitable nutritional guidelines to follow in relation to the bodybuilding sporting code. Adherence to the nutritional guidelines may improve the bodybuilder's performance. The results of the study may further highlight training needs and/or programmes for the bodybuilding athletes and their coaches.

1.7. Structure of the dissertation

The dissertation is composed of six chapters in total. In chapter one, the researcher gives an introduction and the background to bodybuilding, training practices and dietary practices of bodybuilders. The chapter further covers the problem statement, aim and objectives and the research question. In chapter two, the researcher reviews the literature on both macronutrients and micronutrients recommendations for bodybuilding sports as well as the anthropometric and dietary assessment methods to be used in this particular sport. The chapter further reviews the use of ergogenic aids. Chapter three is the methodology used in this research which includes the research design, study area, population, sampling, data collection and analysis and the ethical considerations of the study. Chapter four presents the results of this study while discussion of the results is done in Chapter five. Chapter six of this study covers the conclusion of the study and recommendations.

CHAPTER TWO
LITERATURE REVIEW

In this chapter, the researcher reviews the literature on dietary intakes, dietary recommendations, anthropometry and body composition of athletes engaging in bodybuilding sport. The dietary components explore both the macro- and micro-nutrient intakes, their recommendations including supplementation as well as dietary intake assessment methods.

2.1. Macronutrients recommendation

Bodybuilding athletes aim at developing lean body mass, symmetry, definition, and good posing presentation (Gaines, 2001). Muscle mass is an important determinant of performance in bodybuilding sports (Garthe, Raastad, and Refsnes *et al.*, 2013). These athletes utilize the continuum of energy systems to supply adenosine triphosphate (ATP) to meet the athlete's energy demands, and are completely reliant upon endogenously stored fuel (Stellingwerff, Maughan and Burke, 2011). Muscles are stimulated to grow through exercise, but the growth is achieved through a proper diet. High levels of muscle growth and repair achieved by bodybuilders justify a higher absolute dietary protein and total energy intake (Trabelsi, Stannard, Maughan, Jammoussi, Zeghal, Hakim *et al.*, 2012). Therefore, to reach the level of optimal performance, proper nutrition is amongst the list of things required (Vînturis, 2009).

2.1.1. Energy recommendations

In terms of improving the overall muscular appearance and physique, nutrient intake is critical for bodybuilders. Total energy intake and the proportion of the energy derived from carbohydrates, protein, and fats are often precisely planned and implemented to maximize skeletal muscle hypertrophy and reduce body fat (Lankford and Campbell, 2012). The first component in optimizing training and performance through nutrition is to ensure that athletes are consuming enough energy to offset energy expenditure (Kreider *et al.*, 2010). Energy intakes of strength-power athletes are generally unremarkable relative to those reported for athletes in other sports (Slatter and Phillips, 2011). According to ADA/DC/ACSM (2009), a usual energy intake for endurance male athletes ranges from 3000 to 5000 kcal/day.

Slater and Phillips (2013), also supported by ADA/DC/ACSM (2000) recommend intakes of 44-50 kcal/kg/day among strength athletes. However; Kreider, Wilborn and Taylor *et al*. (2010) and Potgieter (2013) in their review articles (ISSN, 2010 and Potgieter, 2013 respectively) recommend higher intakes of about 50-80 kcal/kg/day of energy as this group of athletes (bodybuilders) may expend 600-1200 kcals or even more per hour during their prolonged exercise. Consumption of a diet that is low in energy can negatively affect performance primarily due to impaired acid-based balance, reduced enzyme levels in the anaerobic pathway and abnormal muscle contractile function (Coleman, 2011). It is suggested by the ADA/DC/ACSM (2009) that, in order to estimate energy expenditure, Harris-Benedict equation can be used with an activity factor of between 1.8 and 2.3 used for moderate to very heavy physical activity.

2.1.2. Carbohydrate recommendations

Carbohydrate (CHO) is the preferred fuel for exercise intensities above 65% of VO_2 max levels, which is a level at which most bodybuilding athletes train and/or compete; therefore, adequate carbohydrate intake and stores are essential to fuel this high-intensity resistance training. The timing, amount and type of carbohydrate have a bearing on muscle glycogen synthesis (Lambert *et al.,* 2004). Both glycogen in the muscles and glucose in the blood serve as the main sources of energy for contracting muscles (Potgieter, 2013), and when this is depleted, glycogenolysis and then gluconeogenesis maintains the glucose supply (Mahan and Escott-Stump, 1996). Athletes exercising with low carbohydrate reserves are much predisposed to increased levels of stress hormones, ultimately impairing the functional capacity of the immune system (Maughan and Shirreffs, 2011). Optimal CHO intake for bodybuilding athletes has not been clearly defined due to lack of adequate information for the formulation of guidelines (Lambert *et al.*, 2004). Dietary survey literature relating to strength athletes by Slater and Stuart (2013) and Helms *et al.* (2014) suggests that bodybuilders (independent of gender) should maintain daily CHO intakes equivalent to 4 to 7g/kg/day. During periods of intensive training, CHO amount of up to 10g/kg/day are recommended (Maughan and Shirreffs, 2011 and ADA/DC/ACSM, 2009). Depending on the form of activity, gender and environmental conditions researchers recommend high CHO amounts of up to 12g/kg/day in order to enhance recovery, optimise glycogen stores for the next training and maintain the immune function (Smith, Holmes and McAllister, 2015; Stellingwerff *et al.,* 2011 and Coleman, 2011). However, the position statement on CHO dosing ISSN (2010) is that in order to maintain glycogen stores during a high volume intense training, a higher recommendation of between 8 to 10g/kg/day is advisable (Kreider *et al.,* 2010).

2.1.2.1. CHO recommendations before performance

The timing, amount and type of CHO have a significant role on muscle glycogen synthesis (Lambert *et al.,* 2004) and should be personalised according to individual's preferences (Potgieter, 2013). An easy-to-digest high glycaemic index (HGI) carbohydrate meal is recommended 3hours before exercise. Pre-exercise meals that are low in GI are slowly absorbed, reduces fatty acid mobilisation and release glucose slower in to the circulation, ultimately negatively affecting performance (Williams and Rollo, 2015). Meals that are low in fat and fiber, consumed at least 3–4 hours before competition are associated with minimized gastrointestinal problems (such as nausea, vomiting and cramps) (Cotugna, Vickery and McBee, 2005). Wright (2005) indicates that, the intake of CHO an hour before training/performance may result in raised blood glucose followed by hyperinsulinaemia which might be a potential disadvantage. It is therefore recommended that athletes consume about 2.5 g/kg of body mass or 200-300g of high glycaemic index CHO 3hours before performance to positively impact on performance (Williams and Rollo, 2015 and ADA/DC/ACSM, 2006). However, a meal containing CHO amount of 1.0-2.0 g/kg of body weight, consumed 1-2hours before exercise is suggested in athletes who may have limited time before performance (Potgieter, 2013). Kerksick, Harvey and Stout *et al.* (2008) conversely indicate that because of number of factors that pre-exercise meal is depended upon, the optimal amount of CHO and protein recommended would be 1–2g and 0.15–0.25g/kg taken 3-4hours before exercise/performance respectively.

2.1.2.2. CHO recommendations during performance.

Providing exogenous carbohydrates of 6-8% (typically from sports drinks) in events lasting ≥1hour consumed every 15-20 minutes (Kerksick *et al.,* 2008) and 0.7g/kg/hour for longer/strenuous events has been associated with maintained blood glucose levels and improved performance (ADA/DC/ACSM, 2009). Simple sugars such as glucose and sucrose should be opted in order to impact the post-performance glycogen synthesis and prevent delayed hypoglycaemia (ADA/DC/ACSM, 2009). Fructose should be avoided as it has a likelihood of inducing gastrointestinal problems which may negatively affect performance (Kerksick *et al.,* 2008). Combination of CHO and protein is recommended as it stimulate the release of insulin which in turn stimulate muscles to take up amino acids thus building muscles (Van Heerden *et al.,* 2014)

2.1.2.3. CHO recommendations after performance

Athletes are advised to ingest 1.0-1.5g/kg of CHO 30 minutes immediately (and continued up to 6 hours) after performance (Potgieter, 2013 and Smith *et al.,* 2015). The CHO should however be of a high glycaemic index (Lambert *et al.,* 2004). Addition of protein at 0.2-0.5g/kg to CHO has been shown to stimulate re-synthesis of glycogen to a greater extent (Kerksick *et al.,* 2008).

2.1.3. Protein recommendations

Debate around protein requirements in sports has been on-going (Kreider *et al.,* 2010). However, literature recommends adequate protein intake to optimize the rate of muscle protein synthesis sufficient to attain a positive net muscle protein balance. Recommendations for protein reported by various authors and associations are summarised in table 2.1 and range from 1.0 g/kg to 2.0 g/kg/day. Protein recommendations depend on the intensity and duration of exercise, as well as the training status of the individual (ADA/DC/ACSA, 2009; Kim *et al.,* 2011; Stellingwerff *et al.,* 2011; Philips and Van Loon, 2011 and Guardia *et al.,* 2015). For the moderate intense involved athletes, the lower values of the protein range are suggested (Van Heerden *et al.,* 2014). These recommendations by different researchers can generally be met through diet alone, without the use of protein or amino acid supplements, if energy intake is adequate to maintain body weight (ADA and ACSM, 2000). The upper recommended limit of protein intake recommended by American Medical Journal (AMJ) (2011); Campbell *et al.* (2007) and Bilsborough and Mann (2006) are levels up to 2.0g/kg/day. This level is considered safe and renal considerations are not an issue at this level in individuals with normal renal function. Lambert *et al.* (2004) suggested protein intakes of 25-30% of total energy levels allowing adequate CHO and fat intake by bodybuilding athletes.

A study conducted by Kim *et al.* (2011) involving eight bodybuilding athletes indicated that participants' average dietary protein intake was 4.3 g/kg/day, which was about 30% of total energy intake. In a review article, Helms *et al*. (2014) indicated that protein recommendations by different researchers varied, and concluded that intakes up to 2.3-3.1 g/kg/day can be consumed by athletes with higher protein requirements.

A summary of protein recommendations is given in table 2.1 below:

Table 2.1: Protein recommendation for athletes

Author/Association	Year	Recommendations g/kg/day	Percentage of TE	Category of athletes
Phillips *et al.*	2007	1.0 - 1.6	20-25%	Sedentary to moderate intense athletes
Campbell	2009			
ADA/DC/ACSA	2009	1.2-1.7	25-30%	Moderate to heavy intense athletes
Kim *et al.*	2011			
Guardia *et al.*	2015			
AMJ	2011	≤ 2.0	≤ 30%	heavy intense athletes e.g. bodybuilders
Campbell *et al.*	2007			
Bilsborough and Mann	2006			

2.1.4. Dietary fat recommendations

Fat serves many important roles and is a vital fuel source during endurance training. Throughout all phases of training, dietary fat is needed to aid absorption of fat soluble vitamins, protecting organs, providing insulation to the body and facilitating provision of substrates for hormone synthesis, as well as for cellular membrane and myelin sheath integrity (Stellingwerff *et al.,* 2011). Fat intake should be adequate to provide the essential fatty acids and fat-soluble vitamins and help provide adequate energy for weight maintenance (ADA/DC/ACSM, 2009). Therefore, diets should provide moderate amounts of energy from fat (20% to 25% of TE). Dietary fat recommendations (and other macronutrients) reported by various authors and associations are summarised in table 2.2. Recommendations are similar or slightly higher than those recommended for non-athletes, 20 to 30% of TE in order to promote good health (Kreider *et al.,* 2010; Pramukova, Szabadosova and Šoltesova, 2011 and Helms *et al.,* 2011). There appears to be no health or performance benefit to consuming a diet containing less than 15% of TE from fat (ADA/ACSM, 2000). Furthermore, a diet high in fat, above 30% of TE appears to impair high intensity exercise or performance relative to a diet high in carbohydrates (Potgieter, 2013 and Lambert *et al.*, 2004). Diet high in fat, taken 2-3 hours before performance triggers gastrointestinal symptoms (bloating, nausea and vomiting), negatively impacting on the outcome. Furthermore, high fat intake of above 30% has been associated with weight gain (Smith *et al.*, 2015), obesity and cardiovascular diseases later in life (Van Heerden *et al.*, 2014 and Lambert *et al.*, 2004).

Table 2.2: Macronutrients recommendation for bodybuilding

Macronutrient	**Recommendations/day**		
	(Kreider *et al.*, 2010)	**ADA/DC/ACSM, 2000**	**Potgieter, 2013**
Energy	50-80 kcal/kg	44 - 50 kcal/kg	50 - 80 Kcal/kg
Protein	1.4-2 g/kg	1.2 – 1.7 g/kg	1.5-1.7 g/kg
Carbohydrates	8-10 g/kg	6 – 10 g/kg	50-65 % TE
Fat	<30% TE	20 – 25% TE	< 30 % TE

2.2. Micronutrients recommendations

2.2.1. Vitamins

Vitamins and minerals are a group of organic compounds required in tiny amounts in the diet of humans for proper biological functioning and maintenance of health (Maughan, 1999). Vitamins and minerals are essential nutrients in terms of providing health benefits. Generally, there is no need for vitamin supplementation in sports when there is adequate intake from a varied diet. Although the ergogenic effect of most micronutrients is still unclear and warrants further research (Potgieter, 2013); few micronutrients have been reported to directly provide ergogenic value for athletes. Vitamin E (15mg/day) and C (75-90mg/day) may help in reducing oxidative damage or maintain healthy immune system during heavy training (Kreider, 2010 and Potgieter, 2013). Lukaski (2004) demonstrated that vitamins, especially vitamin C, can influence physical performance positively because of its potent antioxidant properties. Vitamin C has been further associated with the production of L-carnitine, which transports long-chain fatty acids into mitochondria.

The B-vitamins are also of special interest to athletes as they govern the energy producing reactions during metabolism and the need for these vitamins increases proportionally with energy expenditure (Nande, Mudafale and Vali, 2009). Niacin is required for energy production and treatment of dyslipidaemia through the production of nicotinic acid (Guardia *et al.*, 2015).

Walberg-Rankin, Edmonds and Gwazdauskas (1993) reported an inadequate intake of vitamin A, C, B_{12} and folate among female bodybuilder's pre-competition diet.

2.2.2. Minerals

Iron is an important mineral needed for metabolic functions including transportation of oxygen in blood to tissues and muscles. There is an increased iron need in athletes, most importantly in female athletes (Williams, 2005) as they tend to lose more iron during menstruation (Smith *et al.,* 2015). Other accounted losses are through gastrointestinal bleeding, heavy sweat and urinary excretion. According Latunde-Dada (2012), athletes require high iron intake (up to 18 mg/day) for the enlarged red blood cell volume, gastrointestinal bleeding and haemolysis that occurs due to stress and repeated injuries. Intense and rigorous exercise transiently results in haemodilution due to increased plasma volume which culminates in transitory lowering of haemoglobin (Hb) levels. Iron transports oxygen because it forms part of haemoglobin molecule. Van Heerden *et al.* (2014) concluded that individuals engaging in exercise should ensure adequate intake of this mineral.

Calcium is another mineral of importance in sports. Walberg-Rankin *et al.* (1993) found that calcium intake was below 67% of the RDA's in female bodybuilders and this was related to the low calorie intake in this group. Evidence suggests that dietary calcium may help manage body composition and supplementation (1000 mg/day) in athletes susceptible to osteoporosis may help maintain bone mass (Kreider, 2010). However, Mahan and Escott Stump (1999) suggest a higher intake of up to 1500mg/day in order to offset any loss in bone mass. Selenium, currently recommended at safety range of 400 μg/day, plays an important role in redox reactions and hormone production. There is lack of research on the role of selenium in sports.

2.3. Dietary Assessment Methods

I. Food frequency questionnaire

The food frequency questionnaire (FFQ) is considered to be the most practical dietary assessment method used mostly in epidemiological studies (Schroder *et al.,* 2001). The questionnaire (FFQ) is convenient, cost effective (Bountziouka, Bathrellou, Giotopoulou, Katsagoni, Bonou *et al.,* 2010) and an easy method that can be used in investigating habitual food intake of an individual (Dehghan, Jaramillo, Due~nas, Anaya, Garcia *et al.,* 2012) over an extended period of time, such as months or years (Hernández-Avila, Romieu, Parra, Hernández-Avila, Madrigal *et al*., 1998). The FFQ enables the reporting of the quantity of food usually eaten by adding the number of portions for each in an open column (Shai, Rosner, Shahar *et al.*, 2005). FFQ is a closed-ended form with limited food lists. These food lists may sometimes need to be validated for each new questionnaire and for each new population group assessed (Va´zquez, Alonso, Garriga *et al.*, 2010). Therefore, to provide a reasonable estimation of intake that will reflect the food consumption patterns and choices of the population under study, the food items that are included in the FFQ need to be selected prudently (Hernández-Avila *et al*., 1998).

II. The 24-Hour-recall

The 24-hour-recall interviews are mostly used in assessment methods for the intervention studies and/or for the validation of assessment of the FFQ (Yunsheng, Olendzki, Pagoto *et al.,* 2009). The 24-hour-recall questionnaire requires the subject to recall his/her exact food intake in the last 24 hours. The questionnaire may be administered by a less trained person in a short period of time. However, Yunsheng *et al.* (2009) indicated that a single 24-hour-recall record does not give a true representation of the individual's energy intake and therefore need to be collected up to three times in order to improve its accuracy. The 24-hour-recall method can be validated by observing the actual intake, preferably measured (Block, 1982). However, imbalance of energy intakes were reported by Yunsheng *et al.* (2009) on weekdays (under-reported) and weekends (over-reported) among the 81 women attending university at Massa-Chusset medical school.

2.4. ANTHROPOMETRIC MEASUREMENTS

Bodybuilding athletes are judged on physical appearance and posing ability/technique (Van der Ploeg, Brooks, Withers *et al.,* 2001); therefore, body weight and composition are important performance factors in this sport. Body composition, which is the main component of health related fitness, refers to the relative amounts of fat and tissues devoid of fat or fat free mass (Marefat and Meysam, 2010). Resistant training may assist in weight control because it increases muscle mass and when conducted over months or years can have significant positive effects on the composition and amount of muscle, adipose tissue, and bone in men and women of all ages (Williams, William, Philip *et al.*, 2007).

2.4.1. Body Mass Index (BMI)

Body mass index (BMI) is a statistical measure of weight of an individual scaled according to height. It is defined as the individual's body weight (kg) divided by the square of their height (m^2) (Marefat and Meysam, 2010). BMI is a recommended tool by World Health Organization (WHO) as a simple marker to reflect total body composition storage. Wang, Xu-hong, Ming-liang, Bao *et al.* (2010) referred to BMI as an index of weight excess, rather than body fatness composition. According to WHO (2011), normal BMI ranges between 18.5 and 24.9kg/m^2 in the post-pubertal male population; however, Marefat and Meysam (2010) indicated that BMI in sports tends to overestimate the body composition values of athletes. Gallagher, Heymsfield, Heo *et al.* (2000) also indicated that the main assumption of BMI guidelines is that, it is closely associated with body fatness and consequent morbidity and mortality. However, some individuals (e.g. bodybuilders) who are interpreted as overweight by BMI are not overfat. An individual who is very muscular (with low body fat) could be classified as overweight by BMI, particularly athletes, leading to undertreating (Witt and Bush, 2005). This is due to the fact that BMI does not separate body compartments into fat free mass (FFM) and body fat (BF) (Kyle, Schultz, Dupertuis *et al.*, 2003). Therefore, BMI alone should not be used to conclude on the anthropometric status of bodybuilding athletes.

2.4.2. Body fat stores

Skinfolds measurements are amongst the several available methods used in estimating body fat, and can be measured all over the body (Silva, Minderico, Teixeira, Pietrobelli *et al.*, 2006). Skinfolds measurement is a method used to estimate the thickness of subcutaneous fat and skin. Skinfolds measurement is generally accepted as a valid method to estimate body fat percentage and density that measures in adults (Shinji, 2010). According to Silva *et al.* (2006), the most commonly measured skinfolds for the assessment of total body fat are those on the upper arm (biceps and triceps), under the scapula (subscapular) and above the iliac crest (suprailliac). Even though the technique for measurement is difficult and requires more time, they are used as a direct indicator of body fat (Witt and Bush, 2005).

Weight category sport such as bodybuilding, has a specific focus on weight control and percentage of fat (Malina and Geithner, 2011). Well-trained bodybuilders have a very low percentage of body fat (Snijder, van Dam, Visser and Seidell, 2006). Low body fat percentage has been associated with improved performance in endurance activities, while a large muscle mass is important during strength and power events (Marefat and Meysam, 2010). According to Kyle *et al.* (2003), healthy body fat percentages are suggested to be 12-20% and 20-30% for both men and women respectively. However, some authors (Lee and Nieman, 2003; Marefat and Meysam, 2010 and McArdle and Katch, 2013) have concluded that the acceptable average percentage of body fat is around 12-15% for men and 15-23% for women. This recommendation is based on Behnke's theoretical concept of minimal body mass as reported by Torstveit and Sundgot-Borgen (2011) that a body fat level below 12% is unhealthy for females. Excess body fat percentage has been shown to be associated with metabolic dysregulation regardless of body weight (Okorodudu, Jumean, Montori *et al.*, 2010). Gallagher & colleagues (2000) defined over-fatness as a percentage of body fat ≥20% in men and ≥33% in women. Currently there are no specific cut-off points for bodybuilders, therefore the available rages used in healthy individuals will be applied to the bodybuilders in this study.

2.5. Ergogenic agents

An ergogenic aid as defined by Kreider *et al.* (2010) as any form of training technique, mechanical device, nutritional practice, pharmacological method, or psychological technique that can improve exercise performance capacity and/or enhance training adaptations. Ergogenic aids are aimed primarily at enhancing athlete's performance (either by affecting energy metabolism or by an effect on the central nervous system), increasing lean body mass or muscle mass by stimulation of protein synthesis and at reducing body fat content (Maughan, 1999). Regardless of lack of scientific evidence supporting the use of supplements in improving bodybuilding performance, the use of dietary supplements and/or drugs in this sport remain a common practice among athletes (Tokish *et al.,* 2004). Most of these dietary supplements used by athletes are usually in a format of powders (Brill and Keane, 1994), capsules, soft gels, liquids and/or bars (Kreider *et al.,* 2010). Compared to other sports, the use of creatine supplementation among weightlifting athletes is suggested to be up to 10% in bodybuilding population (Eric, 2003). Currently, South Africa does not have a governing body to regulate or control the supplement industry. Therefore, products which make claims relating to improved physic and endurance should be avoided (van Heerden *et al.*, 2014) as most of these products may be containing banned substances or a chance that not all the ingredients in the supplement are accurately labelled.

2.6. Summary of the literature review

The demands of competitive bodybuilding mandate behaviours such as intense weight training to gain lean muscle and intentional fat loss through a combination of exercise and dietary manipulation (Pickett, Lewis and Cash, 2005). This dietary manipulation should be coherent with the bodybuilding recommendations as prescribed by the ISSN (2010); Energy of 50-80 kcal (210-336 kJ)/kg/day, Protein of 1.5-2 g/kg/day; CHO of 8-10 g/kg/day and Fat of <30% TE. Micronutrients (vitamins and minerals) enable the metabolism of macronutrients for all physiological processes. However, the use of these vitamins and minerals above RDA's has not been shown to improve measures of performance in individuals consuming adequate diets (Lukaski, 2004). In assessment of dietary intake, a FFQ can be used as a valid tool (Schroder *et al.*, 2001). The acceptable average body fat percentage is 12-15% and 15-23% for both men and women respectively. Currently there are no specific cut-off points for bodybuilders, therefore the available ranges will be applied to the bodybuilders in this study.

CHAPTER THREE
RESEARCH METHODOLOGY

This chapter presents the research methodology which was used in this study. The researcher reports about the research design, study area and the sampling technique used to obtain the population for the current study. The chapter further explains the procedures which the researcher followed during the anthropometric and dietary data collection.

3.1. Research design

This was a descriptive cross-sectional study with an analytical component. A Descriptive study is a study concerned with and designed only to describe the existing distribution of variables, without regard to causal or other hypotheses (Grimes and Schulz, 2002). In this research, anthropometric and dietary intake of bodybuilding athletes around Polokwane municipality were described. The design had an analytical component as the researcher aimed to determine associations between the socio-demographic profile to both dietary intake and anthropometric data of bodybuilders around Polokwane Municipality. The study had a quantitative component as the bodybuilding athlete's anthropometric and dietary data were presented in numerical format and the final result expressed in statistical terminologies (Golafshani, 2003).

3.2. Study area

The study was conducted in bodybuilding gyms around Polokwane Municipality in Limpopo Province, South Africa. Polokwane Municipality had three bodybuilding gyms at the time of data collection, two situated in Polokwane City and one in Mankweng Township. Polokwane

City is situated in the central area of Polokwane Municipality and Mankweng Township is situated 30 km, East of Polokwane City.

3.3. Population

The study population of this research were adult bodybuilding athletes (both male and female) who were engaging in bodybuilding sport around Polokwane Municipality in Limpopo Province practicing at various gym centers. There were 65 bodybuilding athletes training in these three gym centers. Most of these bodybuilding athletes were registered athletes within the gym and the bodybuilding society in Limpopo Province. Each of these bodybuilding gyms, had one head coach.

3.4. Sampling

Purposive sampling method was used to select the participants of this study. A list of all bodybuilders was requested from the head coaches. All 65 bodybuilding athletes from various gyms were approached for participation in the study. Of the 65 bodybuilding athletes, only 51 athletes consented to participate in the study giving a response rate of 78%. Purposive sampling is a sampling method used in selecting units such as individuals or groups based on a specific purpose associated with answering a research study's question (Teddlie and Yu, 2007).

3.5. Inclusion and exclusion criteria

3.5.1. Inclusion

The study included bodybuilding athletes, males and females, registered and training at the gyms situated in Polokwane Municipality who consented to participate in the study.

3.5.2. Exclusion

The bodybuilding athletes who were not willing to participate in the study were excluded.

3.6. Data collection

Data collection was done by the researcher himself at the gym centers around the Polokwane Municipality in the evening, just before the commencement of the training session. Athletes were first briefed on the objectives of the study in English and thereafter in Sepedi as these are the predominantly used languages in the area. During data collection a questionnaire which had three sections was used. Demographic information (section A of the questionnaire) consisted of 13 questions which included the age, gender, duration and frequency of training, type of ergogenic used and source of nutrition knowledge. Anthropometric data recorded in section B of the questionnaire included weight and height, which were used to calculate BMI and the measurement of the four skinfold sites which was used to assess the body fat percentage. Dietary information (section C of the questionnaire) questionnaire included the 24-hour-recall used to determine food items that were consumed in the previous day and the modified FFQ which was used to determine the amount, type and the frequency of consumption of each particular food item.

3.6.1. Anthropometric measurements

For anthropometric measurements, same tools were used for data collections in all the three sites (gyms) and the following tools were used: digital weighing scale (scales 2000), stadiometer (SECA), non-stretchable measuring tape, slim guide body care caliper, and questionnaires.

I. Body Mass Index (BMI)

Both height and weight of the athletes were measured using stadiometer and digital scale respectively with the athletes being in their minimal clothing and bare footed. Standing height was measured with the portable stadiometer (from SECA) which was put on a flat surface. The athletes stood upright with the arms relaxed to the side. They maintained the Frankfurt plane and measurement was taken at full inspiration (Lee and Nieman, 2013). Actual weight of the athletes was obtained from a calibrated and zeroed scale (scales 2000) which was placed on a flat surface in a gym. Athletes were requested to empty their bladder (Norton and Olds, 1996), take off their shoes and be in their lightest clothing (performance trunks). Thereafter, athletes were requested to stand upright on a measuring scale with weight spread evenly on both legs. Measurements of weight and height were recorded to the nearest 0.1 kg and 0.1 m and then used to calculate the BMI (weight (kg)/height (m^2). All the measurements were taken twice.

II. Skinfolds measurements

All four sites for the skinfold measurement (triceps, biceps, subscapular and supra-iliac) were assessed using a slim guide body fat caliper. During measurements, the athletes stood erectly with the feet together and the arms hanging at the sides. The skinfold was firmly grasped by the thumb and index finger of the left hand, about 1 cm proximal to the skinfold site and pulled away from the body. The caliper was held in the right hand, perpendicular to the long axis of the skinfold and placed 1cm distal to fingers holding the skinfold. The measurement was read from the caliper dial facing up, within 2-3 seconds after the full pressure of the caliper was applied. All the measurements were recorded to the nearest 0.1 mm (Lee and Nieman, 2013). A minimum of two measurements were taken at each skinfold site of the skinfolds and successive measurements were 15 seconds apart from each other to allow the skinfold site to return to normal. These skinfold measurements were taken in succession to avoid experimenter bias and measured before the commencement of the training to avoid shifts in body fluids to the skin that might inflate normal skinfold (Norton and Olds, 1996).

- **Triceps and Biceps skinfolds**

In measuring triceps and biceps skinfolds, the left site of the mid-upper arm was located half-way between the tip of the acromion process and olecranon process while the elbow is flexed at a 90^0 angle. Triceps skinfold was then measured at the back of the upper arm at the level of the marked midpoint halfway between shoulder and tip of the elbow. Biceps skinfold thickness was measured on the anterior aspect of the upper arm at the same level as the triceps skinfold. The arm was flexed at the elbow and the hand supinated. The crest of the fold ran parallel to the long axis of the arm (Lee and Nieman, 2013).

- **Subscapular skinfold**

Subscapular skinfold site was located 1 cm below the lowest or interior angle of the scapula. The long axis of the skinfold was measured at 45^0 angle directed down and towards the right side. The skinfold was grasped 1 cm above and medial to the site along axis (Labadarios and Haffejee, 1990).

- **Suprailliac skinfold**

Suprailliac skinfold was measured just above the iliac crest at the mid-axillary line. The skinfold was grasped about 2cm posterior to the iliac crest and measurement taken (Labadarios and Haffejee, 1990).

3.6.2. Dietary data collection

During the dietary data collection, two tools were used: the 24-hour-recall and the modified QFFQ

I. 24-hour-recall

The 24-hour-recall adapted and modified from the National Food Consumption Survey (NFCS) (2005) was used to collect food items consumed in the previous 24-hour period. The athletes were requested to recall in detail all the food and drinks consumed during a period of time in the past 24 hours. The researcher assisted the athletes to recall/remember all the food items consumed in the previous 24 hours through probing and the use of Nasco food model kit in estimating portion sizes of eaten food. Activities in which the athlete engaged in during the previous day were asked so as to assist in recalling particular food eaten at or before that time. The researcher recorded those food items eaten by the athlete using a pencil to allow for corrections during the recall process. The 24-hour-recall was collected three times, two weekdays: Mondays and Thursdays, and one weekend day: Sunday.

II. Food Frequency Questionnaire

The modified quantified Food Frequency Questionnaire from the National Food Consumption Survey study (2005) was used to compare the collected diets from the athletes. The FFQ was done a week after the 24-hour-recall data was collected. The researcher used the Nasco food model kit in order to assist athletes in estimating the portion sizes of the frequently consumed foods.

3.7. DATA ANALYSIS

3.7.1. Anthropometric data

I. BMI

The BMI of the athletes was calculated using the formula Weight (kg) /Height (m^2), and the WHO reference table (2004) was used to interpret the results. The reference cut-off points are given in table 3.1 below.

Table 3.1: BMI categories

CATEGORY (Kg/m^2)	INTERPRETATION

< 18.49	Underweight
18.5 – 24.9	Normal
25 – 29.9	Overweight
≥ 30	Obesity

(WHO, 2004)

II. Triceps skinfold

The triceps skinfold of the 51 athletes were measured and the values were compared to the standards by NHANES (2003-2006). Athletes were categorized as lean, below average, average, above average or having excess fat according to the cut-offs summarized in table .2.

Table 3.2: Categories for the Triceps skinfold

Skinfold percentile	**Skinfold category**
≤5th	Lean
>5th but ≤15th	Below average
>15th but ≤75th	Average
>75th but ≤85th	Above average
>85th	Excess fat

(Lee and Nieman, 2013)

III. Body fat percentages

The percentage body fat were determined by calculating the sum of all the four skinfold sites (triceps, biceps, iliac crest and subscapular) using the 1974 Siri equation/formula by Dumin and Womersley. The formula is given as: Percentage (%) Body Fat = [4.95/D - 4.5] x 100 (where D is the calculated body density of a specific gender by age). The obtained percentage from the formula was then compared to the standards by Lee and Nieman (2010) reference table 3.3 below.

Table 3.3: Ranges for the body fat percentages

Classification	Males	Female
Unhealthy (too low)	≤5%	≤8%
Acceptable (lower end)	6-15%	9-23%
Acceptable (upper end)	16-24%	24-31%
Unhealthy (too high)	≥25%	≥32%

(Lee and Nieman, 2013)

3.7.2. Dietary Data analysis

I. The 24-hour-recall

The data from the three 24-hour-recalls as well as the Quantified Food Frequency Questionnaire was coded, quantified and then loaded in the food finder version 3 in order to determine the nutrient intake. The average of the three 24-hour-recalls was taken and analyzed. The athlete's macronutrients intake was compared to the ISSN (2010) recommendations in table 3.5 expressed in kilocalorie and grams per kilogram per day. Dietary energy reported in kilocalories were converted to Kilojoules. That is; 1 kcal was equivalent to 4.2 kJ (van Heerden *et al.*, 2014). Intakes are reported as below, within or above the required recommendations.

Table 3.4: Macronutrients recommendation for strength athletes.

Macronutrient	Recommendation/day	Distribution
Energy	50 - 80 Kcal/kg (210 – 336 KJ/kg)	
Protein	1.4 - 2 g/kg	Up to 15%
Carbohydrates	8 – 10 g/day	55 - 65 % TE
Fat	0.5 – 1 g/day	<30% TE

(Kreider *et al.*, 2010)

The micronutrients intake (vitamins and minerals) of the athletes were analyzed and compared to the Dietary Reference Intakes (2003) as stipulated by NICUS. The Estimated Average Requirements (EAR) and the Tolerable Upper Intake levels (UL) tables were used in order to compare age and gender specific requirements (Tables 3.5a and 3.5b). Intakes that are within the EAR and UL were regarded as adequate, while intakes below or above the dietary reference were reported as inadequate or excessive respectively.

Table 3.5(a): EAR and UL of selected Vitamins

Vitamins	Age (years)	Gender	EAR per day	UL per day
Vitamin A	19-50	Male	625 µg	3000 µg
		Female	500 µg	3000 µg
Vitamin B_1	19-50	Male	1.0 mg	-
		Female	0.9 mg	-
Vitamin B_2	19-50	Male	1.1 mg	-
		Female	0.9 mg	-
Vitamin B_3	19-50	Male	12 mg	35 mg
		Female	11 mg	35 mg
Vitamin B_6	19-50	Male	1.1 mg	100 mg
		Female	1.1 mg	100 mg
Vitamin B_{12}	19-50	Male	2.0 mg	-
		Female	2.0 mg	-
Vitamin C	19-50	Male	75 mg	2000 mg
		Female	60 mg	2000 mg
Vitamin E	19-50	Male	12 mg	1000 mg
		Female	12 mg	1000 mg

Table 3.5(b): EAR and UL of selected minerals

Minerals	Age (years)	Gender	EAR (mg/day)	UL (mg/day)
Selenium	19-50	Male	45	400
		Female	45	400
Zinc	19-50	Male	9.4	40
		Female	6.8	40
Iron	19-50	Male	6.0	45
		Female	8.1	45
Magnesium	19-50	Male	330	350
		Female	255	350
Calcium	19-50	Male	800	2500
		Female	800	2500
Phosphorus	19-50	Male	580g	4.0 g
		Female	580g	4.0 g

(NICUS, 2003)

II. Food Frequency Questionnaire

The FFQ was used to compare nutrients intake from the 24-hour-recall with the frequency of consumption of certain foods.

3.7.3. Statistical analysis

Data was loaded on to the Statistical Package for Social Sciences (SPSS) version 23 and analyzed. All the descriptive variables were expressed as minimum, maximum, mean values and standard deviations (±SD). The numerical variables were described using minimum, maximum, mean and standard deviation, while percentages were used for categorical variables. The one-way ANOVA (for normal distribution) and the Kruskall Wallis (for non-normal distribution) tests were used to determine the association of the demographic data to both the anthropometry and dietary intake. A *P*-value below 0.05 was considered a criterion significant between the variables.

3.8. Reliability and Validity

Reliability refers to the extent to which results are consistent over time and an accurate representation of the total population under study, and validity determines whether the research truly measures that which it was intended to measure (Golafshani, 2003; Lee and Nieman, 2013). Reliability in this research was ensured by using the same brand of anthropometrical tools (electrical scales, stadiometer for measurement of weight and height, calliper and tape) for all the participating athletes. Equipment such as weighing scales were calibrated and zeroed before each measurement was taken. A pilot study was conducted on 20 soccer players at the University of Limpopo to test the tools that would be used during the research process. Modifications were done to tools and equipments as needed. Collection of dietary intake (24-hour-recall) was done three times (3x); two during week days (Tuesday and Thursday) and one on a Sunday and validated by using FFQ. Content validity in this research was ensured by using relevant/appropriate tools in collecting the required data. Some of the tools (24-hour-recall and FFQ) were adapted from pre-validated tools and instruments that are used worldwide.

3.9. Bias

Researcher bias was minimized as the researcher was the one who carried out all the measurements himself to ensure that the readings on bodyweight and height and skinfolds are yielding the same measurements. The measurements were collected during the same time period, i.e. in the afternoon, before commencement of training. Recall bias was minimized by repeating the 24-hour-recall twice during week days through the use of food models. The method for sampling used in this study (purposive sampling) also reduced bias as this method offered an opportunity to every athlete to participate in the study.

3.10. Ethical considerations

The researcher obtained approval from the University of Limpopo's senior degrees' committee within the school of Health Sciences and ethical clearance from the MEDUNSA Research committee (MREC) (Annexure 3). The researcher further obtained approval from the Polokwane bodybuilding gym centres through the coaches before engaging the athletes. Before the commencement of the study, the aims of the study and the objectives of the study were explained to the athletes and they were given consent forms to sign as proof that they were participating voluntarily in the study (Annexure 1 A and B). The participants were informed of their right to withdraw from the study at any time without any negative consequences to their participation in the bodybuilding sport, and were further allocated different codes in order to maintain anonymity of each athlete throughout the course of data collection. The athletes benefited information of their full anthropometrical assessment and the health implication of the diets they are currently adhering to.

3.11. Summary of research methodology

This chapter presented the research methodology used, study area and population, how sampling and data collection were done. The chapter highlighted the tools and explained the methods and procedures used to collect the data. The tests and statistical analysis tools used were explained in this chapter.

CHAPTER FOUR
RESULTS

Chapter four presents the results of the 51 athletes' demographic data, anthropometry status and dietary intakes. The results are reported using tables and graphs.

4.1. Demographic data

This section reports on the demography of the athletes. The demography reports on age, gender, duration of training, use of ergogenics and the period of athletes being a bodybuilder. Data is presented in both graphs and tables.

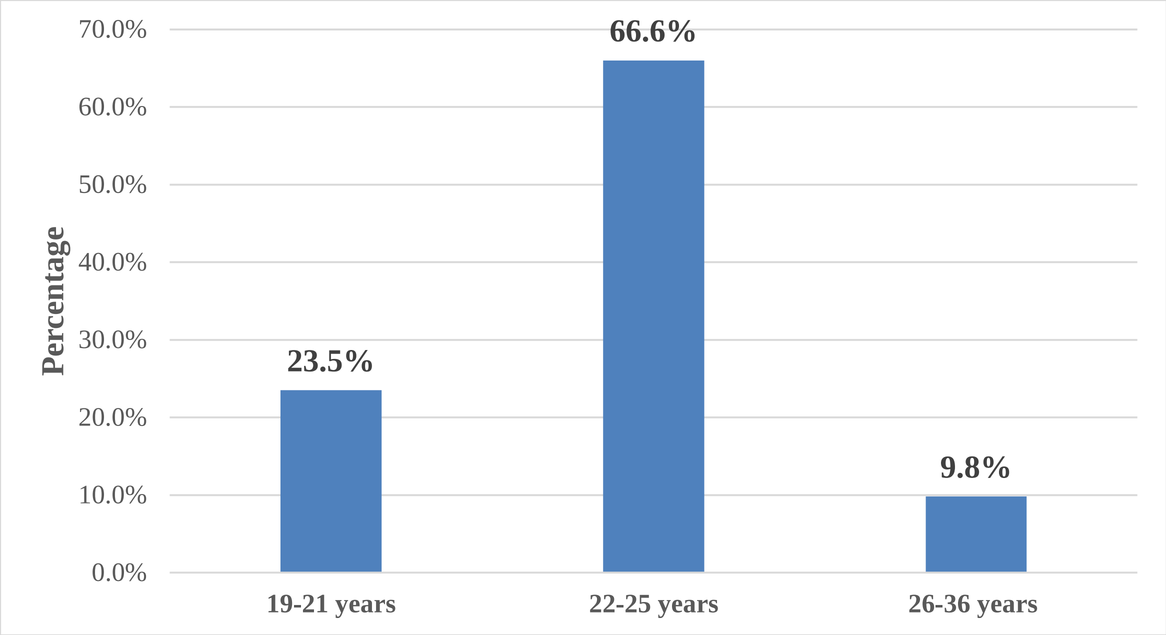

Fig 4.1. Age of the athletes

The graph above illustrates the age distribution of the athletes ranging from 19-36 years. The highest distribution (66.6%; n=34) according to age was seen in athletes aged 22 to 25 years, followed by (23.5%; n=12) athletes who were aged between 19 and 21 years. Mean age =23.6; SD = ±3.2

Table 4.1 below presents gender variation among the athletes. There were fewer females (5.9%; n=3) than males (94.1%; n=48).

Table 4.1: Gender of the athletes

Gender	Frequency (n=51)	Percent
Male	48	94.1
Female	3	5.9
Total	51	100.0

Information regarding the number of years in which the participants have been engaging in bodybuilding sport was collected and the results are presented in figure 4.2 below:

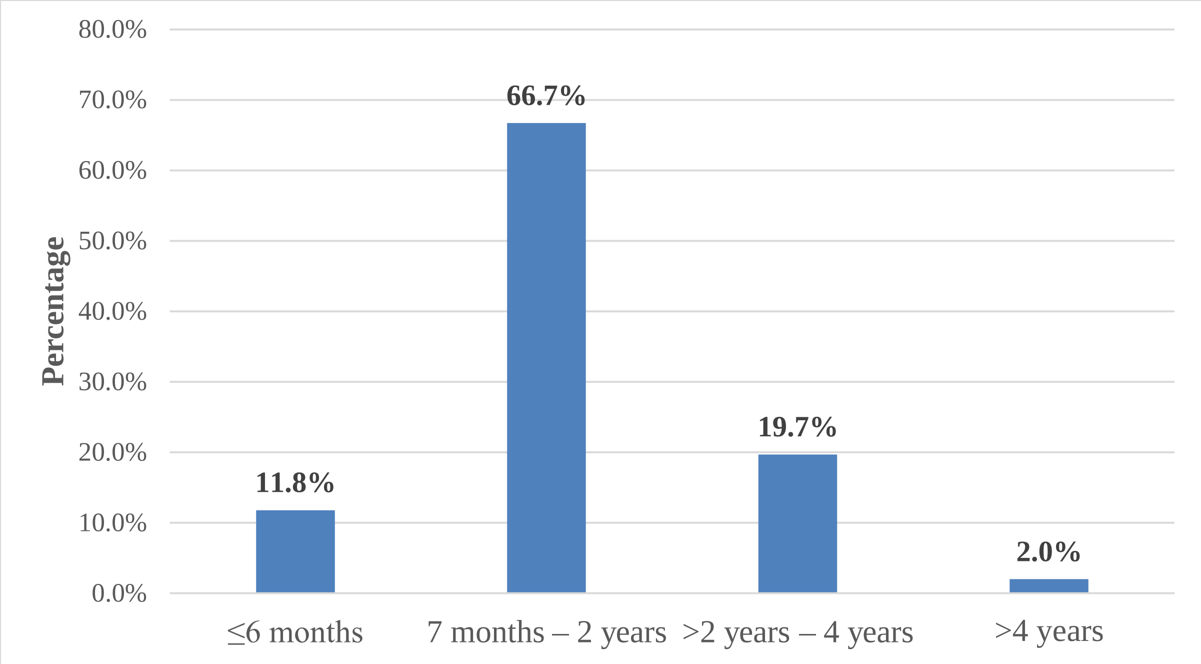

Figure 4.2. Number of years in bodybuilding

Few athletes (11.8%; n=6*)* have been training as bodybuilders for less than six months, while most athletes (66.7%; n=34*)* had been practising for >6 months to 2 years, followed by 19.7% (n=10) of those who have been training for >2 to 4 years.

The information regarding the duration that was spent by the bodybuilding athletes during the training sessions is presented in table 4.2 below.

Table 4.2: Duration spent by the athletes during each training session

Duration during each Training Session	Frequency (n=51)	Percent (100%)
30 - 45 min	1	2.0
45 min - 1 hr.	6	11.8
> 1 hour	44	86.3

Fewer athletes (2.0%; n=1*)* usually trained for 30-45 minutes, while 11.8% (n=6) trained for 45 minute to 1 hour respectively. The majority (86.3%; n=44*)* of the athletes trained for more than an hour.

The graph below reports about the use of ergogenic substances by the bodybuilding athletes.

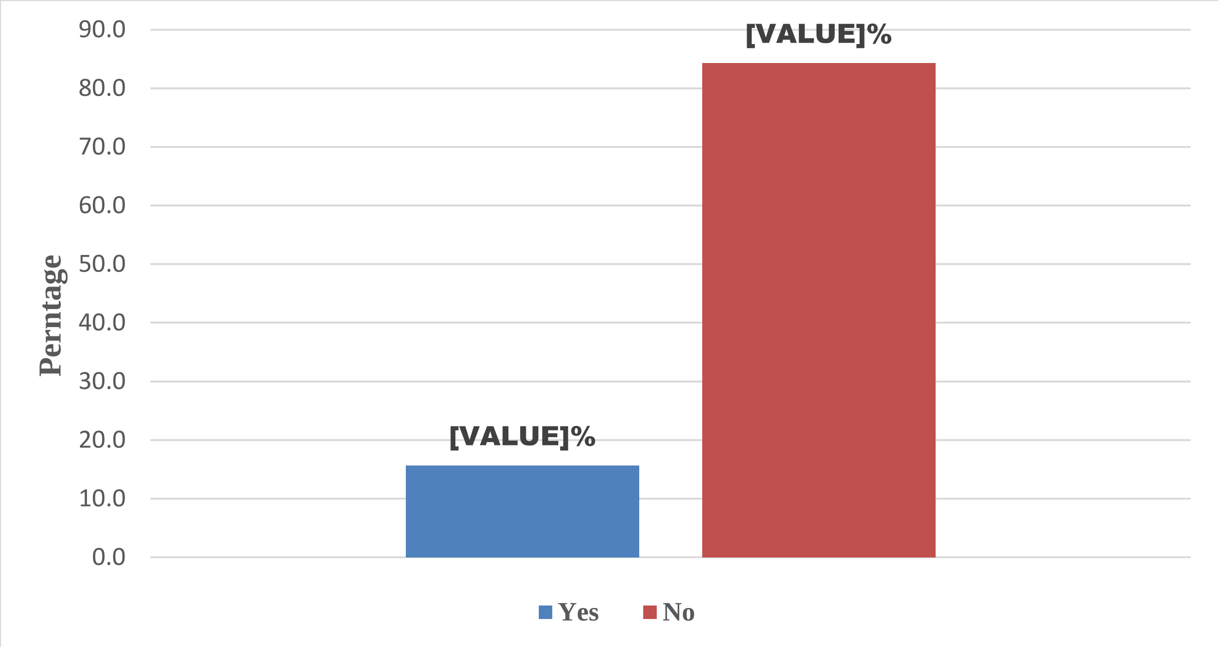

Figure 4.3. The use of ergogenic aids by the athletes

Most of the athletes (84.3%; n= 43) were not on ergogenic agents; only 15.7% (n=8) were on ergogenic agents.

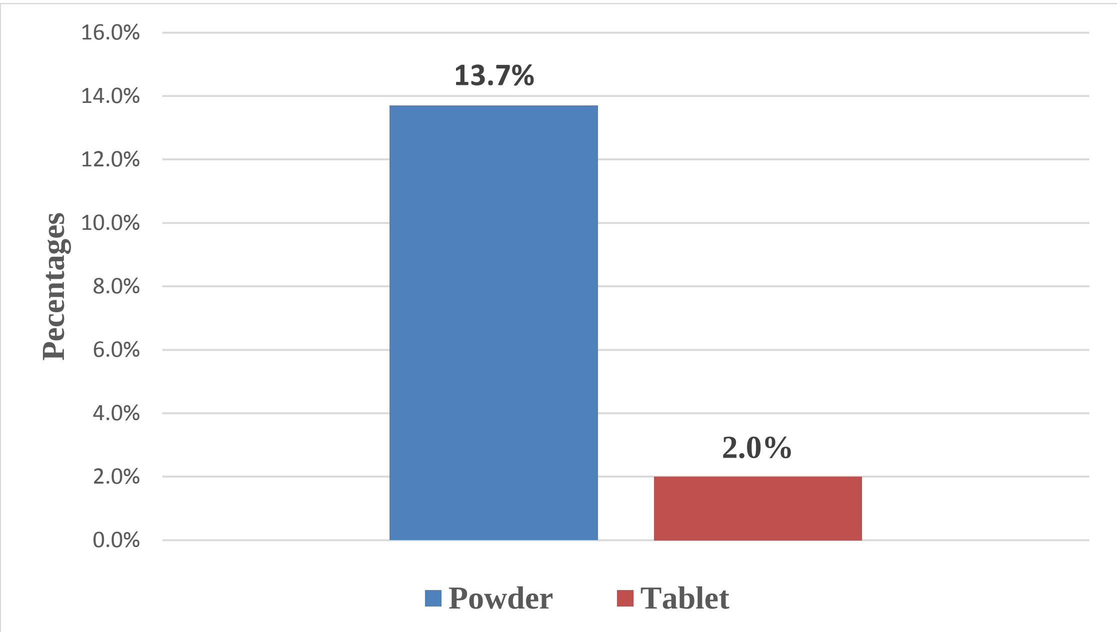

Figure 4.4. Type of ergogenics used

The figure above indicates that of those participants who utilised ergogenics, 13.7% (n=7) used powders, while 2.0% (n=1) used tablets.

The graph below illustrates the source of nutrition information used by the bodybuilding athletes.

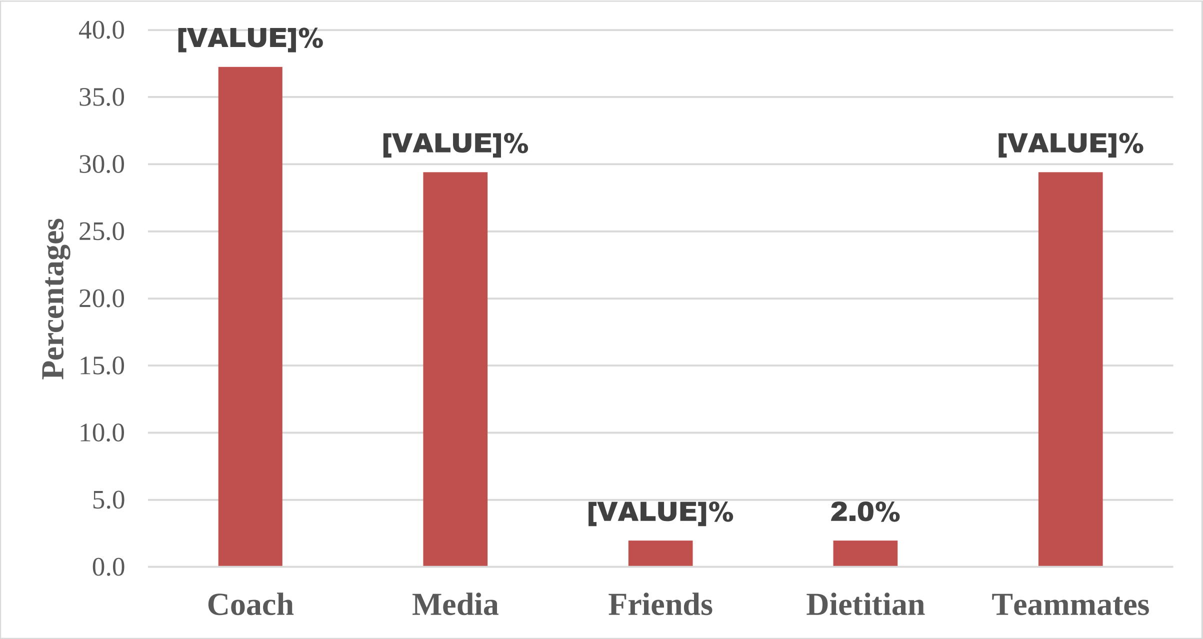

Figure 4.5. Source of nutrition information

Most of the athletes (37.3%; n=19) utilized coaches as their source of knowledge, while 29.4% (n=15) relied on media, and another 29.4% (n=15) of athletes relied on teammates. Only 4.0% (n=2) athletes received nutrition education from a dietitian and friends.

Athletes were asked about the amount of money they spent on protein food. The results are presented in Figure 4.6 below.

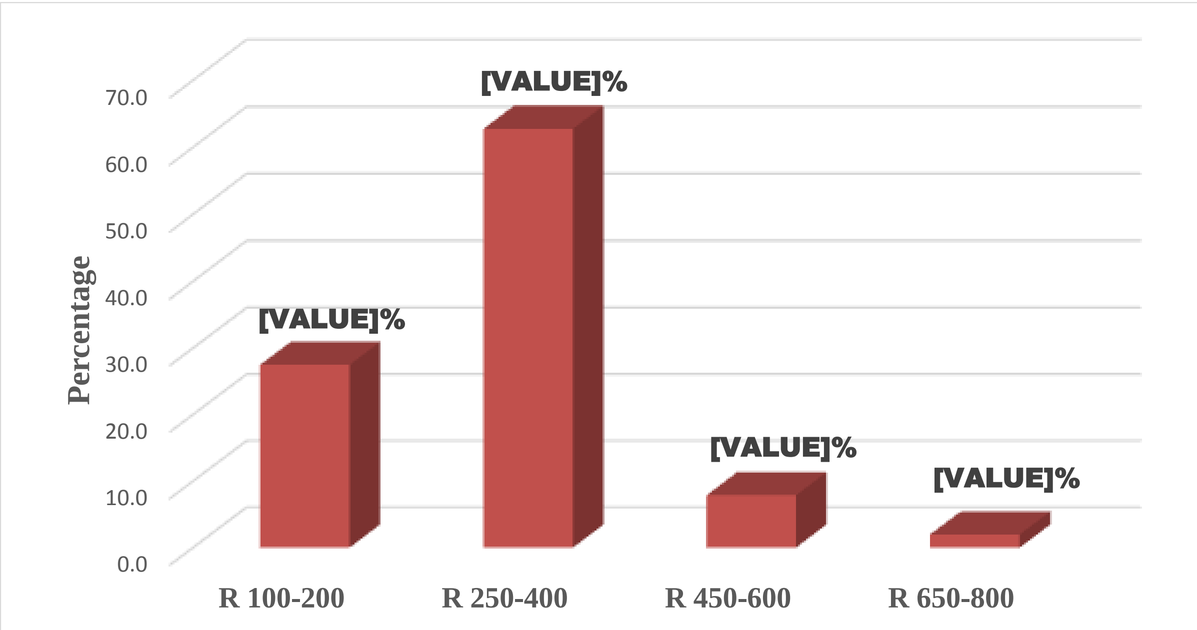

Figure 4.6. Amount of money used for protein rich foods per month

The graph above shows that 62.7% *(*n=32*)*, followed by 27.5% *(*n=14*)* of the athletes spent between R 250 and 400.00 and R100 and 200.00 of money respectively for the purchase of protein rich foods.

4.2. Anthropometric data

This section reports on the anthropometric status of the athletes. The weight and the height of the participants were measured in order to determine their mean weight and BMI. The mean weight was 70.5 kg, while the mean BMI was 23.8 kg/m^2. The data is summarized in table 4.3 below and individual anthropometric data is presented in figure 4.7- 4.9.

Table 4.3: Summary of athlete's anthropometric data

Analyte	Mean (SD) n=51	Minimum	Maximum
Weight (Kg)	70.5 (±9.7)	53.2	105.7
Height (m)	1.7 (±0.0)	1.5	1.9
BMI Reading (Kg/m^2)	23.8 (±3.2)	19.0	35.8
Triceps Skinfold (mm)	7.7 (±3.8)	3.0	20.0
Percentage of body fat	20.6 (±5.4)	15.0	41.0

The BMI of the athletes were classified according to the WHO standards and the results are presented in Figure 4.7 below.

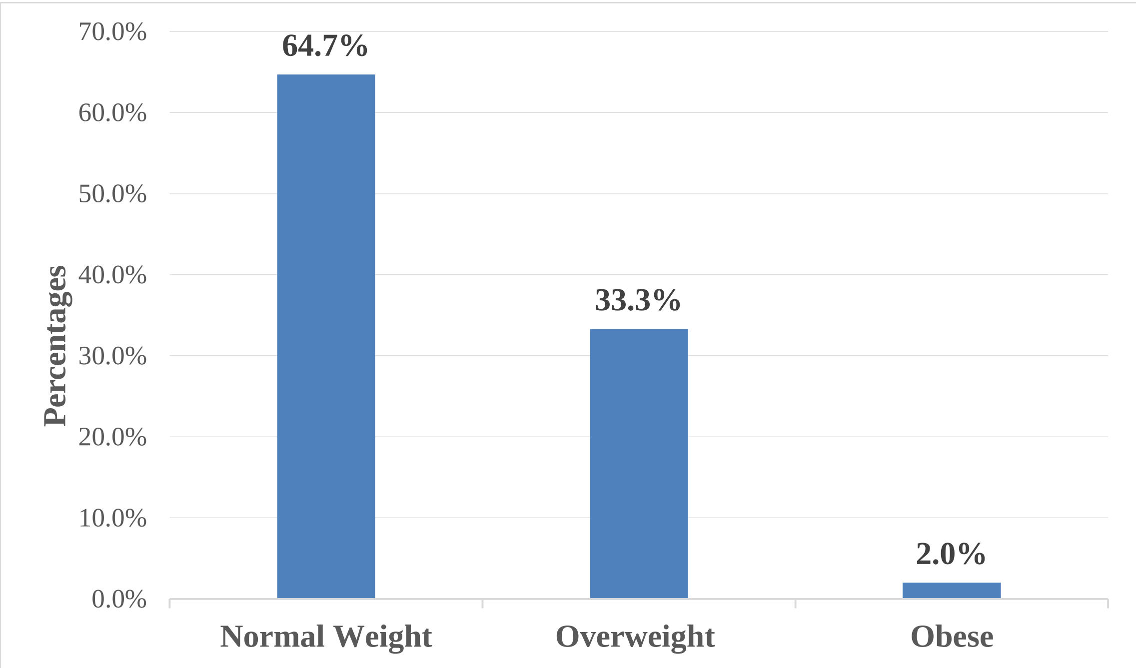

Figure 4.7. BMI Classification of athletes

Athletes with normal weight made 64.7% (n=33) of the whole group, while 33.3% (n=17) and 2.0% (n=1) were overweight and obese respectively.

The triceps skinfolds of the athletes were measured in determining the fat stores and the results are presented in Figure 4.8 below.

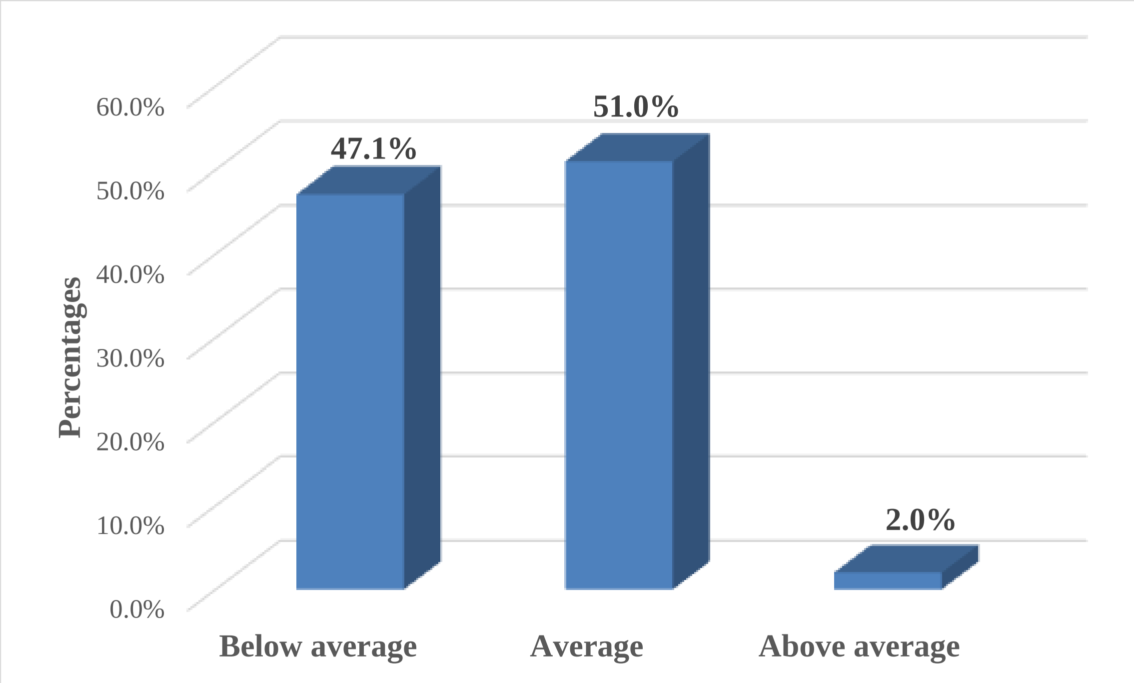

Figure 4.8. Triceps skinfolds of the athletes

Athletes with triceps skinfold below average were 47.1% (n=24) while 51.0% (n=26) and 2.0% (n=1) had average and above average fat respectively.

The body fat percentage was calculated from the sum of the four skinfolds. The results are presented in Figure 4.9 below.

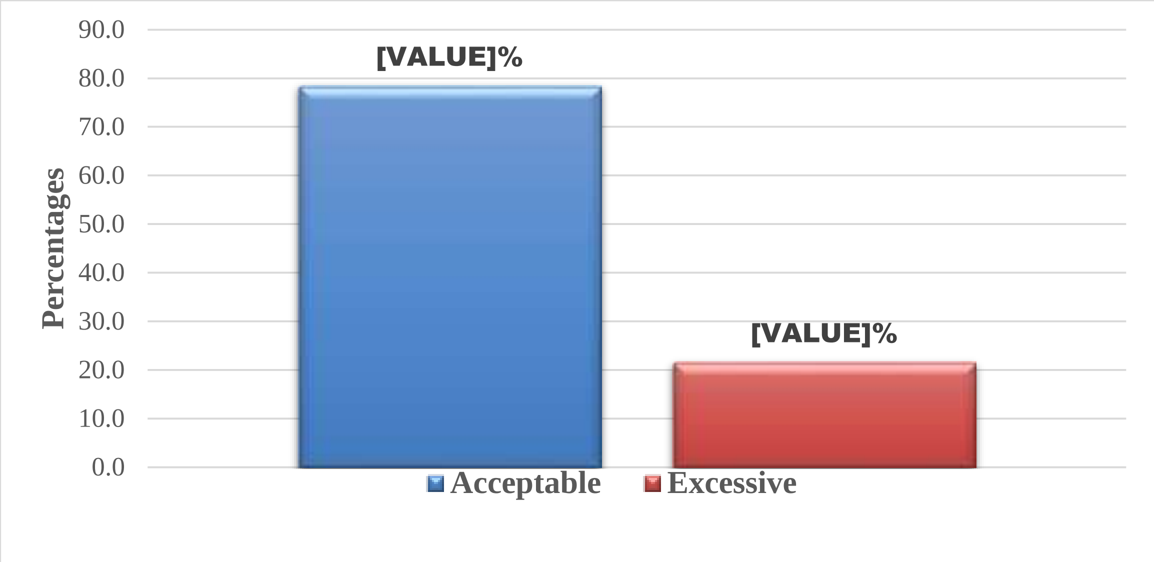

Figure 4.9. Body fat percentages of the athletes

Most athletes (78.4%; n=40) had acceptable body fat percentages and only 21.6% (n=11) had excessive body fat percentage.

4.3. DIETARY INTAKE

This section gives a report on the dietary intake of the athletes. The dietary intake analysis covered both the macronutrients and the micronutrients intake of the athletes. The minimum, maximum, mean intake and standard deviations for energy, carbohydrates, fat and protein for the 51athletes were determined. The summary of results is reported in Table 4.4 below and the intakes of individual macronutrients and micronutrients are presented in Figures 4.10-13.

Table 4.4: Summary of macronutrients of the athletes

Analyte	Mean/kg/day(±SD)	ISSN (2010) Recommendation	Prevalence of inadequate intake (n=51)	**Min**	**Max**
Energy (KJ)	129.7 (±36.7)	210-336 KJ/kg/day	98%	150.7	212.1
Protein (g)	1.3 (±0.5)	1.4-2g/kg/day	78.4%	0.1	2.5
CHO (g)	3.9 (±0.9)	8-10g/kg/day	100%	0.7	5.9
Fat (g)	0.8 (±0.4)	0.5-1g/kg/day	94.1%	0.2	2.1

The minimum and maximum intake of the athletes for the energy was 150.7 kJ/kg/day and 212.1 kJ/kg/day respectively, giving a mean of 129.7 kJ/kg/day (±36.7). The minimum and the maximum protein intake for the athletes was 0.1 g/kg/day and 2.5 g/kg/day respectively, giving a mean intake of 1.3 g/kg/day (±0.5). The minimum and maximum intake of the athletes for the CHO was 0.7 g/kg/day and 5.9 g/kg/day respectively, giving a mean of 3.9 g/kg/day (±0.9). The minimum and maximum intake of the athletes for the fat was 0.20g/day and 2.1 g/kg/day respectively, giving a mean of 0.8 g/kg/day (±0.4).

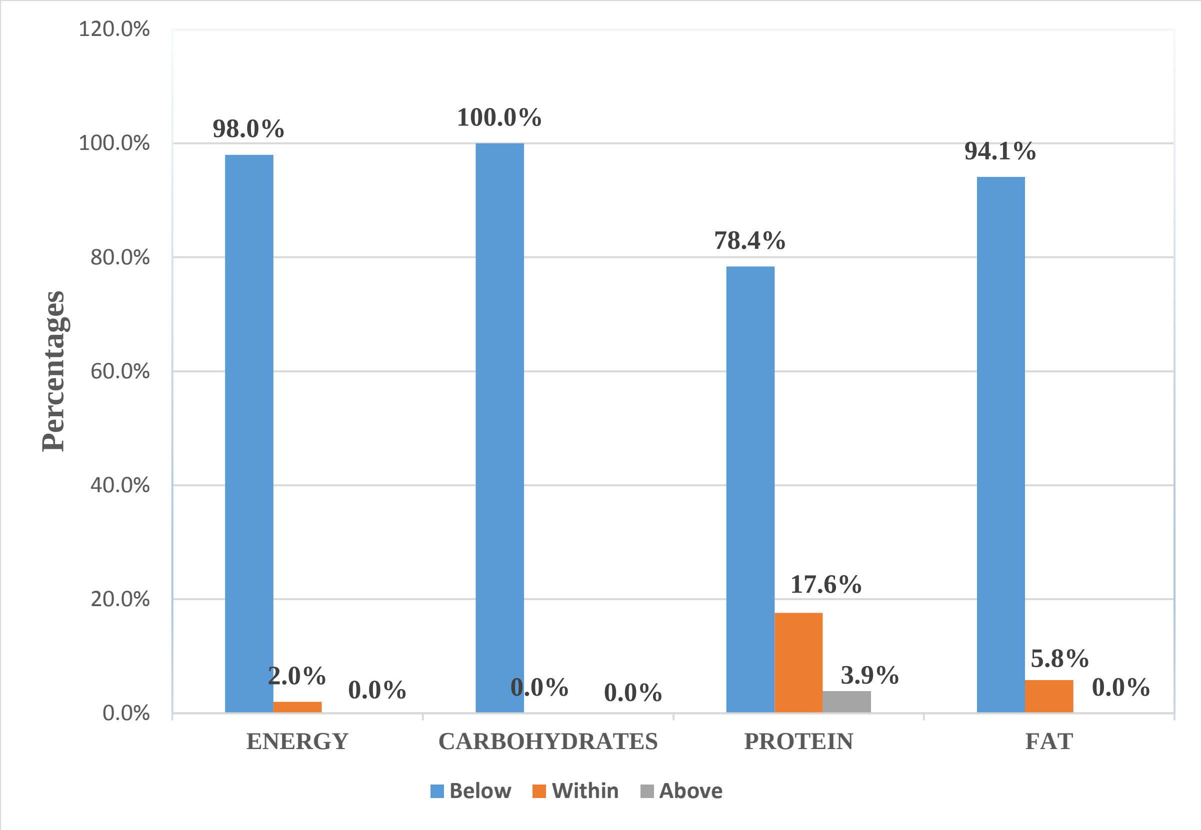

Figure 4.10. Classification of adequacy of macronutrients intake by the athletes

Most of the athletes consumed energy (98%; n=50) and CHO (100%; n=51) within the ISSN recommendations, while 17.6% (n=9) and 5.8% (n=4) of athletes respectively consumed protein and fat within the recommendations. The majority and of the athletes had protein (78.4%; n=40) and fat (94.1%; n=48) intakes below the ISSN recommendations.

The micronutrient intake of the athletes was analysed. The minimum, maximum and mean intake of vitamins and minerals for the 51athletes were determined. The summary of results is reported in Table 4.5 below and the individual vitamin and minerals intake are reported in Figure 4.11.

Table 4.5: Summary of vitamins intake by the athletes

Vitamin Recommendations							
Analyte	Gender	Mean (±SD)	*EAR	**UL	Prevalence of inadequate intakes (%) (n=51)	Min	Max
Vitamin A (mcg)	Male	791.6 (±1651.2)	625	3000	68.6	53.0	11525.0
	Female	303.0 (±80.5)	500	3000			
Thiamine (mg)	Male	1.6 (±1.6)	1.0 mg	-	11.6	0.5	12.0
	Female	1.0 (±0.2)	0.9 mg	-			
Riboflavin (mg)	Male	1.5 (±0.9)	1.1 mg	-	41.1	0.2	4.9
	Female	1.0 (±0.3)	0.9 mg	-			
Niacin (mg)	Male	27.4 (±15.8)	12 mg	35	15.6	1.1	82.4
	Female	23.7 (±15.4)	11 mg	35			
Vitamin B_6 (mg)	Male	1.8 (±1.5)	1.1 mg	100 mg	17.6	0.6	10.8
	Female	1.4 (±0.8)	1.1 mg	100 mg			
Vitamin B_{12} (mcg)	Male	13.5 (±37.9)	2.0 mg	-	0.0	0.5	239.0
	Female	5.2 (±4.0)	2.0 mg	-			
Vitamin C (mg)	Male	85.2 (±68.3)	75	2000	47.0	2.0	277.0
	Female	112.3 (±101.8)	60	2000			
Vitamin E (mg)	Male	10.9 (±7.3)	12	1000	72.5	2.1	36.7
	Female	7.9 (±3.1)	12	1000			

*__EAR__= Estimated Average Requirement; **__UL__= Upper Intake Level

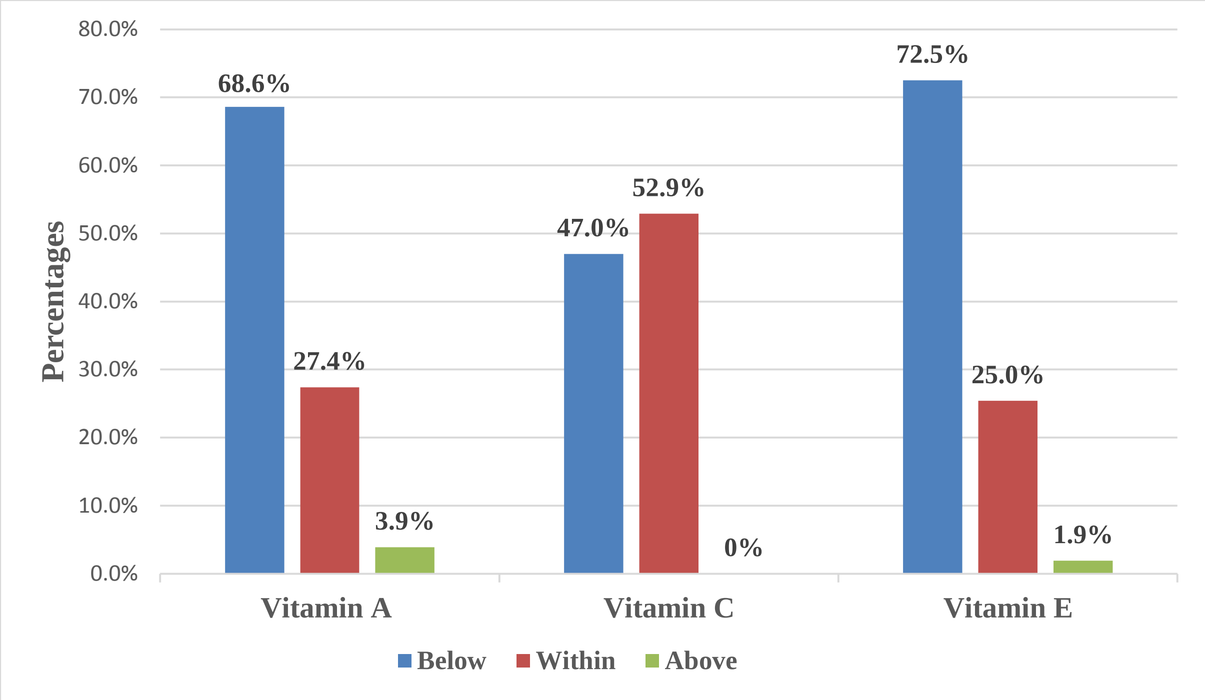

Figure 4.11. Classification of adequacy of Vitamins intake by the athletes

The majority of the athletes (68.6%; n=35 and 72.5%; n=37) had intakes below the EAR for Vitamin A and for Vitamin E respectively, while 52.9% (n=27) and 27.4% (n=14) had adequate intakes of Vitamin C and A respectively. The remaining 3.9% (*n=2*) and 1.9% (n=1) had intakes above the UL for Vitamin A and E respectively.

The B vitamin intake (B_1, B_2, B_3, B_6, B_{12}) of the athletes were also analysed. The athletes who were taking within, below and above the EAR are reported in Figure 4.12 below.

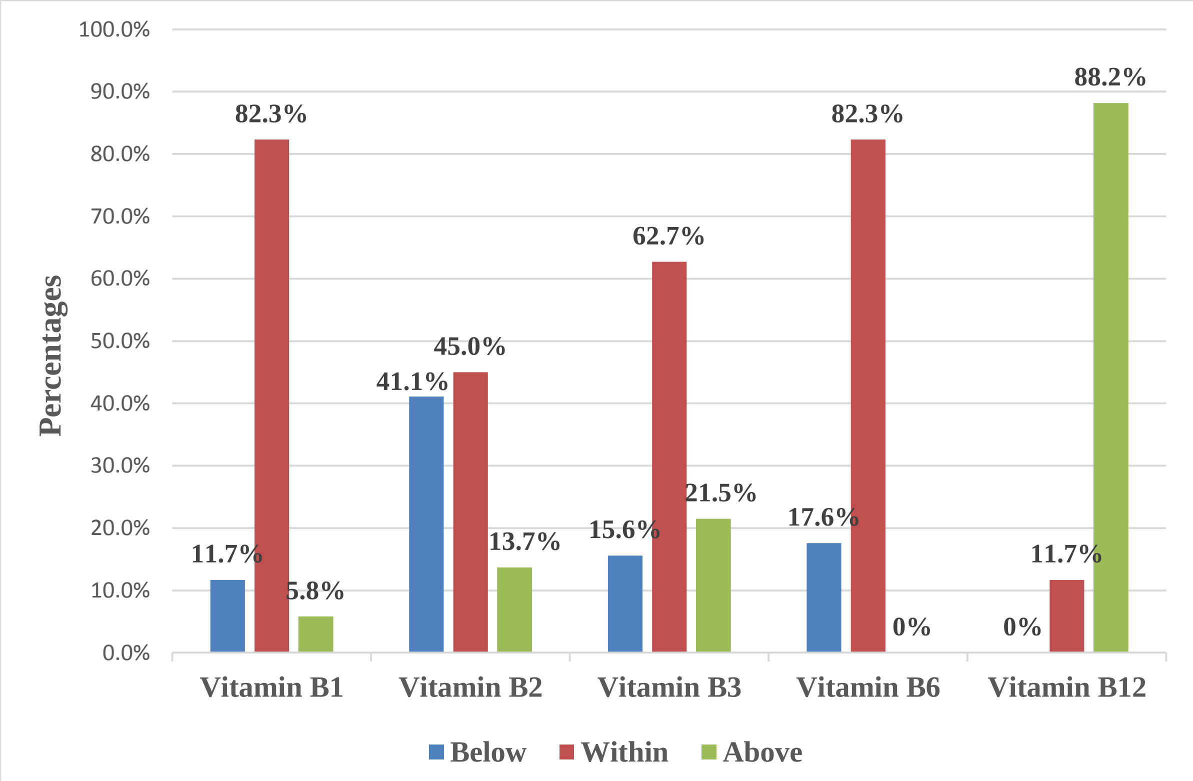

Figure 4.12. Classification of adequacy of B-Vitamin intake by the athletes

The majority of the athletes (n=42) had adequate intakes of vitamin B_1 (82.3%) and B_6 (82.3%) respectively. On the contrary, 88.2% (n=45) of the athletes consumed above the UL for vitamin B_{12}. Few athletes (41.1%; n=21 and 17.6%; n=9) consumed vitamin B_2 and B_6 above the UL.

Table 4.6 below presents a summary of mineral intake by the athletes. The minimum and the maximum intakes were considered.

Table 4.6: Summary of mineral intake by the athletes

Mineral Recommendation							
Analyte	Gender	Mean (±SD)	*EAR	**UL	Prevalence of inadequate intakes (%) (n=51)	Min	Max
Calcium (mg)	Male	580.1 (±355.3)	800	2500	86.3	0.10	1601.00
	Female	477.6 (±146.1)	800	2500			
Iron (mg)	Male	17.3 (±4.1)	6.0	45	9.8	4.30	295.00
	Female	9.9 (±2.6)	8.1	45			
Magnesium (mg)	Male	382.9 (±103.2)	330	350	23.5	3.80	532.00
	Female	357.6 (±134.7)	255	350			
Phosphorus (mg)	Male	1455.7 (±489.8)	580g	4.0 g	3.9	395.0	2487.00
	Female	1315.0 (±451.0)	580g	4.0 g			
Zinc (mg)	Male	19.8 (±52.5)	9.4	40	19.6	4.72	375.00
	Female	10.0 (±2.0)	6.8	40			
Selenium (mcg)	Male	52.1 (±26.1)	45	400	37.3	6.00	120.60
	Female	47.8 (±2.3)	45	400			

*__EAR__= Estimated Average Requirement; **__UL__= Upper Intake Level

The mineral intakes of the athletes were assessed using the EAR's and the UL. Most of the athletes are reported to be within the limits or taking 100% recommended intakes but 86.3% and 37.3% of athletes had inadequate intakes of calcium and selenium respectively. The results are presented in Figure 4.13 below.

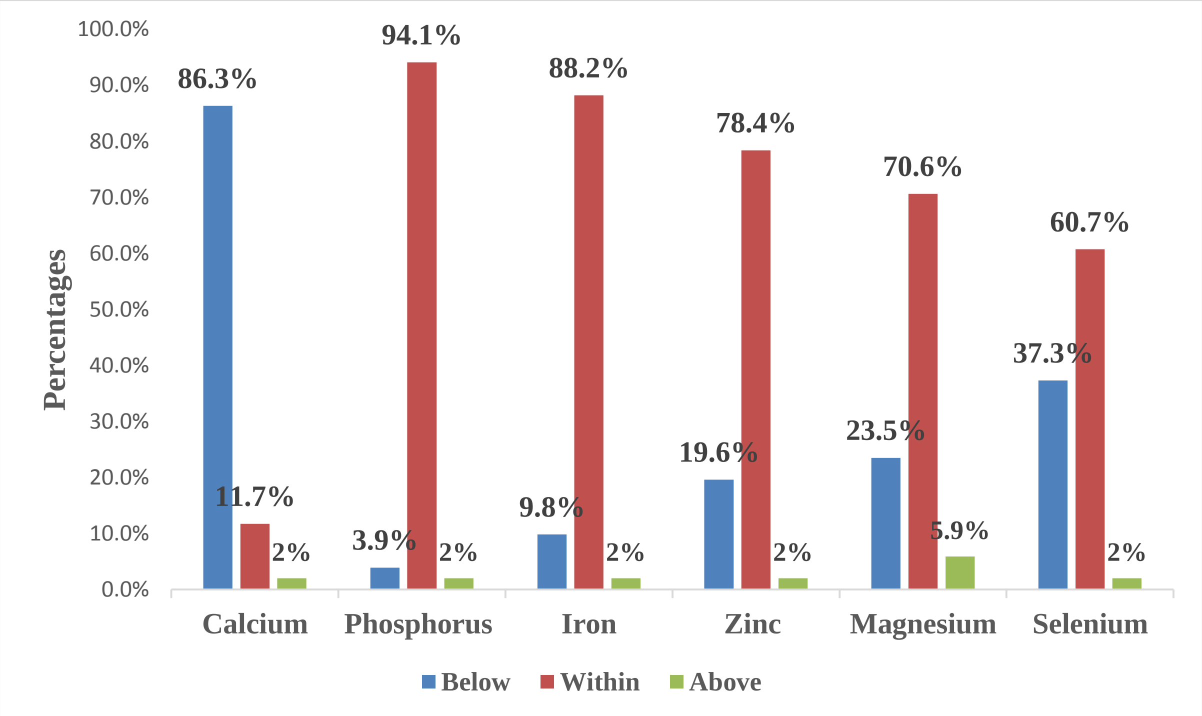

Figure 4.13. Classification of adequacy of Mineral intake by the athletes

Athletes consuming minerals within the EAR's are 94.1% (n=48) for phosphorus, 88.2% (n=45) iron, 78.4% (n=40) zinc, 70.6% magnesium, and 60.7 % (n=36) selenium. The athletes consuming minerals below the EAR are 86.3% (n=44) for calcium, 3.9% (n=2) phosphorus, 9.8% (n=5) iron, 19.6% (n=10) Zinc, 23.5% (n=12) magnesium and 37.3% (n=19) in selenium. The athletes consuming minerals above the UL are 2% (n=1) for calcium, phosphorus, iron, zinc and selenium respectively and 5.9% (n=3) for magnesium.

4.4. Analysis of Variants

4.4.1. Demography and Anthropometry

This section reports on the relationship between the demographic data and anthropometry. The data is presented in tables.

The test for normality was conducted and the histogram showed that the variables were normal. Therefore, the one-way ANOVA test was used in order to determine the relationship between the demography and anthropometry of the athletes (table 4.7 below).

Table 4.7: Association between the demographic data and anthropometry

Analyte	Category	BMI	*P-value	Triceps	*P-value	Percentage body fat	*P-value
Gender	**Male** **Female**	23.7 (±3.2) 24.2 (±3.6)	0.43	7.4 (±3.4) 12.3 (±6.8)	0.29	28.8 (±6.4) 36.3 (±14.4)	0.07
Period being a bodybuilder	**<6 months** **7 months- 2 years** **>2 years - 4 years** **>4 years**	22.0 (±2.1) 23.9 (±2.7) 23.2 (±3.0) 35.8 (±0.0)	**0.00	9.0 (±3.3) 7.9 (±4.0) 6.1 (±2.80) 10.0 (±0.0)	0.43	27.3 (±2.0) 29.9 (±8.4) 28.5 (±2.1) 24.7 (±0.0)	0.76
Duration of training	**30 – 45 min** **45min – 1 hr** **>1hr**	25.0 (±0.0) 23.8 (±2.9) 23.8 (±3.3)	0.93	5.0 (±0.0) 7.0 (±2.4) 7.8 (±3.9)	0.68	26.0 (±0.0) 33.1 (±13.1) 28.8 (±6.0)	0.34
Frequency per week	**<3 times** **3-4 times** **>4 times**	20.3 (±0.4) 22.7 (±2.2) 24.2 (±3.3)	0.12	6.0 (±1.4) 7.7 (±3.6) 7.8 (±3.9)	0.815	29.9 (±1.4) 27.6 (±3.0) 29.6 (±7.8)	0.75
Amount of money used for Protein foods (R)	**100 - 200** **250 - 400** **>450 - 600** **>650 - 800**	23.5 (±3.2) 23.4 (±2.5) 24.8 (±3.1) 35.8 (±0.0)	**0.00	7.5 (±2.2) 7.7 (±4.1) 7.2 (±3.6) 10.0 (±0.0)	0.936	32.0 (±10.8) 28.5 (±5.1) 27.4 (±2.0) 24.7 (±0.0)	0.38

*One-way ANOVA test **post-hoc testing

A higher BMI was significantly associated with a longer period being a bodybuilder and spending more money on protein rich foods.

4.4.2. Demography and Dietary Intake

Table 4.8: Association between the demography and macronutrient intake

Analyte	Category	Energy Mean (±SD)	*P-value	Protein Mean (±SD)	*P-value	Fats Mean (±SD)	**P-value	CHO Mean (±SD)	*P-value
Gender	**Male** **Female**	8943.6 (±2307.0) 10072.7 (±2450.3)	0.41	96.3 (±35.7) 84.2 (±29.1)	0.41	57.2 (±28.6) 90.2 (±23.3)	0.03	277.1 (±60.9) 284.0 (±106.2)	0.85
Period being a bodybuilder	**<6 months** **7 months - 2 years** **>2 years - 4 years** **>4 years**	8655.5 (±2145.1) 9081.0 (±2457.9) 9072.4 (±2207.7) 8943.0 (±0.0)	0.97	92.4 (±40.3) 95.6 (±35.7) 100.3 (±34.0) 80.5 (±0.0)	0.94	45.0 (±25.8) 62.2 (±30.2) 63.0 (±30.1) 37.1 (±0.0)	0.30	290.7 (±58.5) 275.3 (±66.7) 268.5 (±56.1) 326.0 (±0.0)	0.76
Duration of training	**30 – 45 min** **45min – 1 hr** **>1hr**	9955.0 (±0.0) 6862.2 (±2996.7) 9281.5 (±2096.8)	0.04	101.2 (±0.0) 82.2 (±56.3) 97.3 (±32.3)	0.61	63.5 (±0.0) 41.8 (±13.3) 61.4 (±30.4)	0.30	305.0 (±0.0) 219.9 (±85.9) 284.7 (±56.3)	0.05
Frequency per week	**<3 times** **3-4 times** **>4 times**	9336.5 (±1337.1) 8009.3 (±1788.9) 9218.9 (±2414.8)	0.36	122.8 (±8.9) 82.9 (±37.9) 97.1 (±34.9)	0.30	62.1 (±11.1) 42.8 (±17.6) 62.7 (±30.9)	0.12	263.4 (±59.7) 266.9 (±52.9) 280.6 (±657)	0.80
Amount of money used for Protein foods (R)	**100 - 200** **250 - 400** **>450 - 600** **>650 - 800**	8829.4 (±3549.2) 9256.1 (±1707.1) 7888.0 (1069.2) 8153.0 (±0.0)	0.68	91.7 (±44.4) 97.0 (±32.5) 97.4 (±33.4) 99.5 (±0.0)	0.97	61.6 (±29.5) 62.1 (±29.7) 35.6 (±9.2) 24.2 (±0.0)	0.79	272.7 (±96.3) 281.2 (±47.5) 261.1 (34.5) 293.4 (±0.0)	0.91
Ergogenic use	**Yes** **No**	9750.0 (±1442.2) 8872.4 (±2420.2)	0.32	105.8 (±22.5) 93.7 (±37.0)	0.37	59.7 (±17.8) 59.1 (±31.0)	0.53	304.9 (±50.0) 272.5 (±63.9)	0.18
Source of nutrition knowledge	**Coach** **Media** **Friends** **Dietitian** **teammates**	8732.4 (±2184.4) 8618.6 (±2591.2) 9955.0 (±0.0) 6173.0 (±0.0) 9879.3 (±2101.8)	0.34	91.0 (±36.8) 94.2 (±35.2) 101.2 (±0.0) 71.8 (±0.0) 104.0 (±36.1)	0.80	50.2 (±23.0) 61.3 (±25.4) 63.5 (±0.0) 52.7 (±0.0) 68.5 (±38.9)	0.53	283.6 (±57.7) 258.1 (±75.2) 305.0 (±0.0) 155.5 (±0.0) 295.6 (±46.4)	0.49
Income Source	**Employer** **Parents** **Bursary** **Other**	9893.5 (±2461.4) 8857.7 (±2375.1) 9457.1 (±2471.1) 8934.0 (±1751.0)	0.85	100.9 (±1.9) 93.9 (±37.4) 90.8 (±29.4) 119.5 (±33.5)	0.55	90.7 (±94.1) 58.2 (±25.9) 62.7 (±29.7) 44.2 (±8.7)	0.39	256.6 (±52.0) 273.8 (±66.8) 295.5 (±54.8) 281.0 (±54.1)	0.78
Who prepares meals for you?	**Self** **Spouse** **Cafeteria** **Other**	8693.2 (±2375.4) 9812.6 (±1471.9) 9637.4 (±23.9) 8934.0 (±1751.0)	0.85	91.6 (±37.0) 118.5(±22.3) 96.0 (±32.1) 119.5 (±33.5)	0.55	56.2 (±25.9) 66.5 (±47.5) 52.7 (±29.7) 44.2 (±8.7)	0.05	256.6 (±52.0) 273.8 (±66.8) 295.5 (±54.8) 281.0 (±54.1)	0.78

*One –away ANOVA test ** Kruskall Wallis test

Females consumed significantly more fat than males. Participants that train for 45 – 60 min had a significantly lower intake of energy compared to those that train for a shorter duration (30 – 45 min) or those that train >1hr.

Table 4.9 (a): Association between the demography and specific micronutrients

Analyte	Category	Ca Mean (±SD)	**P-value	Iron Mean (±SD)	**P-value	Vitamin A Mean (±SD)	**P-value	Vitamin C Mean (±SD)	*P-value
Gender	**Male** **Female**	580.1 (±355.3) 477.6 (±146.1)	0.89	17.3 (±41.2) 9.9 (±2.6)	0.66	791.6 (±1651.2) 303.0 (±80.5)	0.34	85.2 (±68.3) 112.3 (±101.8)	0.51
Period being a bodybuilder	**<6 months** **7 months - 2 years** **>2 years - 4 years** **>4 years**	497.6 (±216.6) 606.4 (±378.1) 542.1 (±350.7) 406.0 (±0.0)	0.60	9.0 (±2.5) 20.3 (±49.5) 12.5 (±5.3) 6.8 (±0.0)	0.72	485.7 (±493.4) 907.0 (±19410) 429.7 (±315.9) 978.0 (±0.0)	0.45	115.4 (±51.6) 86.8 (±72.0) 71.5 (±73.7) 24.0 (±0.0)	0.72
Duration of training	**30 – 45 min** **45min – 1 hr** **>1hr**	1125.0 (±0.0) 435.5 (±312.0) 580.4 (±344.3)	0.25	13.9 (±0.0) 56.2 (±116.9) 11.6 (±5.1)	0.47	462.0 (±0.0 538.8 (611.9) 800.2 (±1715.2)	0.62	61.0 (±0.0) 75.7 (±19.0) 88.9 (±74.5)	0.85
Frequency per week	**<3 times** **3-4 times** **>4 times**	398.0 (±91.9) 462.3 (±203.4) 608.0 (±373)	0.54	11.8 (±4.5) 8.9 (±1.9) 19.0 (±45.0)	0.25	340.0 (±108.8) 439.4 (±442.8) 856.7 (±1794.6)	0.42	146.5 (±184.5) 115.7 (±56.8) 77.3 (±64.9)	0.15
Amount of money used for Protein foods (R)	**100 - 200** **250 - 400** **>450 - 600** **>650 - 800**	587.5 (±485.2) 564.1 (±281.4) 606.2 (±400.4) 575.0 (±0.0)	0.13	31.1 (±76.1) 11.7 (±4.9) 11.2 (±6.3) 7.6 (±0.0)	0.72	444.9 (±492) 932.7 (±1989.7) 507.7 (±350) 798.0 (±0.0)	0.95	90.8 (±69.9) 90.8 (±73.5) 56.2 (±31.6) 24.0 (±0.0)	0.91
Ergogenic use	**Yes** **No**	761.3 (±382.5) 539.2 (±332.7)	0.17	15.8 (±4.9) 17.1 (±43.6)	0.00	2019.3 (±3858.2) 529.0 (±479.5)	0.07	89.2 (±76.5) 86.3 (±69.2)	0.91
Source of nutrition knowledge	**Coach** **Media** **Friends** **Dietitian** **teammates**	605.3 (±358.7) 564.8 (±428.8) 1125.0 (±0.0) 178.0 (±0.0) 533.4 (±208.8)	0.51	10.6 (±5.9) 31.2 (±73.1) 13.0 (±0.0) 8.2 (±0.0) 11.3 (±3.7)	0.37	697.6 (±628.0) 1183.0 (±2878.0) 462.00 (±0.0) 53.0 (±0.0) 492.6 (±311.9)	0.25	94.3 (±67.7) 85.0 (±80.9) 61.0 (±0.0) 2.0 (±0.0) 86.4 (±65.0)	0.77
Income Source	**Employer** **Parents** **Bursary** **Other**	534.5 (±57.2) 561.8 (±360.3) 580.5 (±374.5) 689.2 (±303.1)	0.39	9.1 (±2.1) 19.2 (±47.5) 11.4 (±5.1) 12.6 (±5.2)	0.89	585.0 (±301.2) 906.36 (±1892.5) 321.5 (±216.4) 553.2 (±305.1)	0.79	18.5 (±7.7) 95.3 (±72.7) 69.5 (±72.8) 83.2 (±5.7)	0.39

*One –away ANOVA test ** Kruskall Wallis tests

There is a significant association (P<0.05) between the iron intake of the athletes and the use of ergogenic agents by the same athletes. However, there is a negative association (P>0.05) between the calcium, vitamin A and vitamin C intake by the athletes to the demography.

Table 4.9 (b): Association between the demography and specific micronutrients

Analyte	Category	Vitamin E Mean (±SD)	**P-value	Thiamine Mean (±SD)	**P-value	Riboflavin Mean (±SD)	**P-value	Cyanocobalamin Mean (±SD)	**P-value
Gender	**Male** **Female**	10.9 (±7.3) 7.9 (±3.1)	0.55	1.6 (±1.6) 1.0 (±0.2)	0.20	1.5 (±0.9) 1.0 (±0.3)	0.47	13.5 (±37.9) 5.2 (±4.0)	0.86
Period being a bodybuilder	**<6 months** **7 months - 2 years** **>2 years - 4 years** **>4 years**	9.7 (±9.6) 10.3 (±6.6) 12.4 (±7.1) 19.2 (±0.0)	0.29	1.3 (±0.53) 1.69 (±1.8) 1.5 (±0.5) 1.9 (±0.0)	0.59	1.0 (±0.6) 1.5 (±0.9) 1.6 (±1.1) 1.4 (±0.0)	0.49	4.7 (±0.9) 16.9 (±44.7) 6.1 (±5.3) 2.1 (±0.0)	0.66
Duration of training	**30 – 45 min** **45min – 1 hr** **>1hr**	10.9 (±0.0) 10.7 (±11.0) 10.7 (±7.1)	0.60	1.2 (±0.0) 3.0 (±4.4) 1.4 (±0.5)	0.87	1.4 (±0.0) 1.1 (±0.7) 1.5 (±1.0)	0.54	28.0 (±0.0) 43.9 (±95.7) 8.5 (±36.8)	0.32
Frequency per week	**<3 times** **3-4 times** **>4 times**	9.7 (±2.5) 8.7 (±8.4) 11.2 (±7.0)	0.20	1.4 (±0.4) 1.3 (±0.4) 1.7 (±1.7)	0.65	1.3 (±0.2) 1.0 (±0.5) 1.5 (±1.0)	0.16	3.1 (±0.3) 4.0 (±5.0) 15.6 (±41.3)	0.24
Amount of money used for Protein foods (R)	**100 - 200** **250 - 400** **>450 - 600** **>650 - 800**	9.2 (±4.4) 11.2 (±7.9) 10.8 (±8.9) 19.2 (±0.0)	0.56	2.0 (±2.9) 1.4 (±0.4) 1.5 (±0.8) 1.9 (±0.0)	0.58	1.3 (±0.8) 1.5 (±1.0) 1.5 (±1.3) 1.4 (±0.0)	0.82	25.1 (±62.7) 8.9 (±21.1) 6.8 (±7.8) 2.1 (±0.0)	0.71
Ergogenic use	**Yes** **No**	11.9 (±5.4) 10.5 (±7.4)	0.30	1.6 (±0.5) 1.6 (±1.6)	0.13	2.5 (±1.5) 1.2 (±0.6)	0.01	23.4 (±40.1) 11.1 (±36.4)	0.08
Source of nutrition knowledge	**Coach** **Media** **Friends** **Dietitian** **teammates**	10.5 (±9.3) 11.3 (±6.7) 10.9 (±0.0) 4.5 (±0.0) 11.0 (±4.7)	0.47	1.3 (±0.6) 2.0 (±2.7) 1.2 (±0.0) 1.3 (±0.0) 1.5 (±0.3)	0.76	1.3 (±0.9) 1.7 (±1.2) 1.4 (±0.0) 0.7 (±0.0) 1.3 (±0.6)	0.66	5.4 (±5.0) 32.0 (±65.0) 28.0 (±0.0) 3.9 (±0.0) 3.5 (±2.7)	0.15
Income Source	**Employer** **Parents** **Bursary** **Other**	13.5 (±8.0) 10.8 (±7.6) 9.2 (±5.1) 12.3 (±7.4)	0.56	1.5 (±0.5) 1.6 (±1.8) 1.3 (±0.5) 1.7 (±0.6)	0.58	1.3 (±0.0) 1.4 (±0.9) 1.3 (±0.9) 1.8 (±1.1)	0.82	2.8 (±1.0) 15.7 (±43.5) 7.5 (±9.2) 6.7 (±7.8)	0.71

** Kruskall Wallis test

Athletes who used ergogenic aids had a significantly higher intake of riboflavin. There were no other significant associations (P>0.05) between demography and selected micronutrients (vitamin E, thiamine, riboflavin and vitamin B_{12}).

CHAPTER FIVE
DISCUSSION OF RESULTS

In this chapter, results of the 51 bodybuilding athletes are discussed. The chapter reports on the demographic, anthropometric and the dietary data. The demographic data covers the socioeconomic status, and the duration of training including the sources used for knowledge of nutrition by the athletes. On the anthropometric data the study reports on the BMI, triceps and total body fat percentages of the athletes. The dietary discussion covers the macronutrient and micronutrient intake of the athletes. The results are presented in graphs and tables.

5.1. DEMOGRAPHY

The number of bodybuilding athletes in this study was 51. This number is low, which indicates that bodybuilding sport around Polokwane Municipality may not be a popularly known sport, or if known, there is less interest for participation in this sport. The highest registered group was seen in men 94.1% (n=48) than women 5.8% (n=3). Results of the current study are divergent to those by Brill and Keane (1994) who, in their study, obtained a larger sample of 309 bodybuilding athletes. However, a smaller sample of 33 athletes with gender distribution of 54.5% and 45.5% for men and women bodybuilders respectively was used in a study by Monteiro and colleagues (2012). Again, in a study by Gaines (2001), comparing the anthropometry of competitive bodybuilders to judge's score had a total sample of 37 athletes, 78.3% (n=29) males and 21.6% (n=8) females respectively. Other researchers (van Marken Lichtenbelt *et al.*, 2004; Ogita, 2010 and Trabelsi *et al.*, 2012), attained fewer bodybuilders samples of 27 or less for their studies. Even lower samples (n=≤ 18) of athletes were used by Walberg Rankin *et al.* (1993), van der Ploeg (2001) and Trabelsi *et al.* (2012) in studies on body composition and anthropometry of bodybuilders. It is therefore not unusual for bodybuilding studies to have smaller samples because of its unpopularity.

The current study further revealed that most of the athletes (66.8%) have been participating in bodybuilding sport for a period of 6 months to 2 years. In total 86.3% athletes train for a duration of an hour or more and a much lower percentage (15.7%) of the athletes in our study used ergogenic aids when compared to the 57.0% (Slatter and Phillip, 2011) and 61.0% (Monteiro *et al.,* 2012) reported by others. Monteiro *et al.* (2012) further reported that the most commonly used supplement by the athletes (33.0%) was creatine monohydrate while only 13.7% of our sample reported using creatine. Guardia *et al.* (2015) cited that 90% of the athletes are using supplements mainly because supplements are freely available to purchase. Fewer athletes reported using supplements in the current study, suggesting that the socioeconomic status of the athletes might be the limiting factor to the rate at which supplements are used by the athletes. Creatine supplementation is said to provide an inexpensive and efficient means of increasing dietary availability of creatine without excessive fat and/or protein (Helms and colleagues, 2014). The use of protein powders was further reported by Brill and Keane (1994) in their study at 57.5% among bodybuilding athletes in Florida. These powders are believed to be most effective in supporting muscle mass and growth (Pramukova *et al.,* 2011) and that amino acids will produce maximum strength and increased muscle size (Brill and Keane, 1994). The major reason mentioned for supplement use as indicated was health-related issues followed by enhancement of the immune system and improvement of athletic performance (Karimian and Esfahani, 2011). Nevertheless, ADA (2009) emphasizes that athletes should try to obtain adequate nutrition from the healthy diet rather than supplements as issues relating to supplements safety are of a great concern. Despite few reports associating creatine supplementation with weight gain, muscle distress and renal distress (ADA/AC/ACSM, 2006), nutritional supplementation of creatine with established guidelines (e.g. 2-3g/day) is said to be safe and ethical (Buford *et al.,* 2007). Supplementation of creatine powder in healthy bodybuilders is reported to have no adverse effects on liver or kidney functioning.

In terms of nutritional information/guidance, the current study showed that 37.3% of athletes relied mostly on coaches for nutritional advice and 29.4% on both media and team mates respectively. These coaches offered training guidance to athletes during training sessions and thus possibly making athletes count on them for nutritional guide/recommendations. Jazayeri and Amani (2004) found that 47% of the trainers/coaches in Ahwaz (Iran) prescribed diet programmes for the athletes. They further showed that 65.6% of coaches were able to realize that some specific macronutrients (such as protein and CHO) are essential in bodybuilding athletes, while minerals and water were not. Similar to our results, Slatter and Phillips (2011) found that coaches, magazines and fellow athletes are the most commonly used sources of nutritional information by the athletes. These sources at times offer inconsistent information. Therefore, relying on media and/or coaches who are not experts or do not have adequate knowledge in nutrition or nutrition programmes or guidance will ultimately pose a negative impact on health of athletes, sooner or later in life. It is therefore recommended that nutrition and pharmaceutical experts be involved in bodybuilding in order to offer support and/or guide in healthy eating choices and ergogenic use by these athletes respectively.

5.2. ANTHROPOMETRY

5.2.1. Body Mass Index (BMI)

The results of this study indicated that 64.7% of the athletes have normal body weight, while 33.3% and 2.0% are classified as overweight and obese respectively. Similar anthropometry results were reported by Zaccagni *et al*. (2014) in a study on bodybuilding athletes' body composition and physical activity, where most males (71.7%) and females (80.9%) were of normal body weight/BMI. Similarity of results are further shown in another study by Kyle *et al.* (2003), where only 3.3% of the participants were reported obese by BMI, leaving the majority in a normal BMI range. However, it should be indicated that the focus of the former and latter studies were not solely on bodybuilders, but were focused on different/general sports codes and healthy individuals respectively.

BMI is associated with body fatness and consequent morbidity and mortality. Some individuals might be misdiagnosed for overweight and/or obesity if caution is not taken (Gallagher *et al.,* 2000). In bodybuilding sport, attention is given to the bulking of muscles with decreased body fat. This practice often results in increased weights, thus resulting in increased BMI. Therefore, caution must be taken when interpreting BMI in this group of athletes as BMI does not distinguish fat mass from lean mass and the distribution of fat over the body is not accounted for (Snijder *et al.,* 2006). However, Helms *et al.* (2014) highlighted that in order for athletes to create weight loss, more energy must be expended and this is achieved by increasing energy expenditure while decreasing intake. It was reported earlier that there are very few athletes that were classified as overweight and obese in the current study. The researcher therefore postulates that these few athletes that are reported to be overweight and obese could be linked to the duration spent by the same athletes during training (up to 1 hour) and/or the number of years (1-2 years) of athletes being in this sport.

5.2.2. Body fat storage

The findings of the present study revealed that most of the athletes (51.0 %) had average triceps skinfold, while 47.1% and 2.0% presented with triceps skinfold below average and above average respectively. The current study further showed that most of the athletes (78.4%) had acceptable body fat percentage with only 21.6% having excessive body fat. This adequate storage of body fat is associated with better health. These findings, however, are contrary to those reported by Kyle *et al*. (2003), where 83% of participants (45% men and 38% women) had body fat storage above desirable levels. The researcher postulates that the increase in athletes who have body fat stores that fall within acceptable range could be due to the fact that the current study is dominated by males who are generally known to be more muscular than women who generally have increased body fat. The results of the fat stores in the current study are also in line with the fact that the majority of the athletes had a normal BMI.

5.3. DIETARY INTAKE

5.3.1. Macronutrients Intake

5.3.1.1. Energy and Carbohydrates

The results of the current study found that almost all of the athletes were consuming carbohydrates and energy below the ISSN bodybuilding recommendations. The mean energy intake by the athletes was 9010 kJ/day (2145kcal/day). The mean carbohydrates intake of the athletes was 277.5g/day with the minimum and maximum intake of 47.3g/day and 401.6g/day respectively. Similar results of low energy intakes below the ISSN recommendations among bodybuilders are reported by Steen (1991) and Monteiro *et al.* (2012). The findings of the current study are contrary to the study by Manore *et al.* (1993), Kim & colleagues (2011) and Lankford and Campbell (2012). These researchers reported higher intakes of energy approximately up to 23940 kJ/day. Spendlove *et al.* (2015) also reported higher intakes of CHO and energy among women and men bodybuilders respectively. Those energy intakes were, however, still found to fall within the bodybuilding recommendations as stipulated by the ISSN (2010). The researchers believe that the reason for low energy intakes in this group is lack of proper nutrition education, the myth that low energy intakes increase body mass and low socioeconomic status. Energy and carbohydrate intakes that are lower than recommended amounts are generally associated with decreased performance as they result in increased glycogen depletion (Slatter and Philips, 2011). The decrease in energy intake can also contribute to weight loss, compromised immune system and endocrine functions (ADA/DC/ACSM, 2009) and ultimately low bone mineral density

(Potgieter, 2013). The consumption of adequate energy, particularly from carbohydrates is important in preventing oxidation of amino acids, so that amino acids cannot be used for protein synthesis (ADA/DC/ACSM, 2009).

It is very unlikely that all the athletes' intake could fall below the bodybuilding recommendations, as such the researcher in the current study speculates that the intakes of energy and carbohydrates of athletes that fall below the recommendations could have resulted from the under-reporting of the athletes' intakes during the dietary data collection. It is generally known that starchy foods (which most of the energy and carbohydrates are obtained from) are a common staple food around the area because of the contributing cultural norms. According to Burke *et al.* (2001), there is speculation that athletes under-report their food intake as participants tend to report intakes that are similar to the expectations of the general population. The other contributing factor in the current study, additional to under-reporting of food by the athletes to lower intakes of energy and carbohydrates, could be the socioeconomic background of the athletes, given that they come from historically disadvantaged communities.

5.3.1.2. Protein

The current study reports that the majority (78.4%) of the athletes had intakes below ISSN protein recommendations. Only 17.6% of the athletes consume protein within bodybuilding recommendations, while 3.9% consume protein above the recommendations. The mean protein intake for the athletes was 95.6g/day with the minimum and maximum intake of 4.0 g/day and 177.7g/day respectively. The current study illustrated that the majority of athletes consume protein below bodybuilding recommendations, which might result in a negative nitrogen balance (Wilson and Wilson, 2006). When athletes are in a negative nitrogen balance, this can lead to muscle catabolism, thus causing loss of muscle mass and ultimately affecting the athlete's performance. In contrast Monteiro *et al.*, (2012) reported that male bodybuilders had an excessive consumption of protein, through diet. In the current study, the researcher speculate that the varying amount of protein intakes could be due to under-reporting during the dietary data collection or a fear of disclosure by some athletes who might be using protein supplements. The other contributing factor to the low intake of protein than the recommendations could be the athletes' socioeconomic status, especially illustrated by the amount of money allocated for purchase of protein. A higher percentage of athletes (62.7%)

are using between R250.00 and R400.00 for protein purchases. This amount is little, especially for a bodybuilding athlete.

5.3.1.3. Fat

The results of the current study show that athletes consuming fat below recommendations are 94.1%, while only 5.8% of athletes consume fat within the bodybuilding guidelines. The mean fat intake of the athletes was 59.2g/day with the minimum and maximum intake of 24.0g/day and 157.3g/day respectively. These intakes (59.2g/day) of fat equated to 25% of total energy which are in line to the ISSN (2010) recommendation (Kreider *et al.,* 2010). These results are different from those reported in a review by Spendlove *et al.* (2015) who reported intakes ranging from 19g/day to 241g/day by athletes. Fat is necessary in providing energy as well as essential elements of cell membranes. Fat also regulates the absorption of fat soluble vitamins (ADA/DC/ACSM, 2009). A lower intake of dietary fat may result in hormonal disturbances (Helms *et al.,* 2014), essential fatty acids deficiencies (Pramuková *et al.,* 2011) and fat soluble vitamin deficiencies (Potgieter, 2013), thus having a negative impact on the athlete's health. According to the FFQ collected from the athletes, fat and oil were consumed less than in other foods in a week.

5.3.2. Micronutrients Intake

1. Vitamins

Most of the athletes in the current study consumed inadequate amounts of vitamin E and C (72.5% and 47.0%). The inadequate intake of vitamins in the current study might be influenced by the insufficient intake of fat and oils (from nuts, margarine and vegetable oil), fruit and vegetables (from citrus fruits). The source of nutrition information used by the athletes as a guide for daily dietary intake may also have influenced these lower intakes, as most these sources usually focus much on macronutrients, especially protein and CHO and less on micronutrients. Contrary results to the current study are reported by Lukaski (2004). He reported that physically active adults generally consume adequate amounts of vitamin C. Lukaski (2004) reported in his review results similar to the current study about Vitamin E intake in the literature review of the 22 surveys conducted on the micronutrient intake among athletes. His results showed adequate intake of Vitamin E by the athletes. Athletes' Vitamin E supplementation at levels that do not exceed the upper tolerable intake levels has been associated with reduced lipid peroxidation and may attenuate exercise induced DNA damage (ADA/AC/ACSM, 2006). Due to increased losses of micronutrients during routine exercise, it is emphasised that micronutrient intake should be adequate as the micronutrients are required for energy production, haemoglobin synthesis, maintenance of bone health, adequate immune function, and protection against oxidative damage (ADA, 2009).

In the current study, the athletes were found to consume less of fat in their diets in an attempt to reduce their body fat percentage. This reduced intake of fat might be contributing factors, contributing to a higher percentage of intakes of fat soluble vitamins below the recommended amounts. The QFFQ further revealed that, fat and oil containing foods such as margarine and cocking oil mostly appeared last on the list of the food items on the QFFQ and were consumed less than three times in a week.

2. Minerals

Most of the athletes in the current study consumed mineral within the recommended dietary intakes. These adequate intakes were reported for phosphorus (94.1%), iron (88.2%), zinc (78.4%), magnesium (70.6%), and selenium (60.7 %). Of all the minerals, calcium was the least consumed by the athletes. In a review for sports requiring weight classifications by Lukaski (2004), 30-50% of the athletes were reported consuming magnesium in inadequate amounts. The latter results are incomparable to the current study due to variations in use of comparison categories (RDA's and EAR's). However, Williams (2005) highlighted that minerals play an important physiological role in athletes like muscle contraction, antioxidant activity and bone health, as such adequate intake should be obtained.

The low intake of calcium in the current study can be related to the infrequent intake of milk and other dairy products by the athletes. Milk as a food source in particular, rarely appeared on the athletes' foods that are frequently taken. The intake in some of the athletes who took milk was inadequate.

5.4. ASSOCIATION TESTS

5.4.1. Demography to both anthropometry and dietary intake

Association tests revealed a significant association between BMI to both the period of being a bodybuilder and income amount used by athletes. Females consumed significantly more fat than males and that participants training for 45–60 min had a significantly lower intake of energy compared to those that train for a shorter duration (30 – 45 min) or those that train >1hr. Post-hoc test shows that these participants differ significantly (P=0.04). Athletes who used ergogenic aids had a significantly higher intake of riboflavin. There were no other significant associations (P>0.05) between demography and selected micronutrients (vitamin E, thiamine, riboflavin and vitamin B_{12}).

5.5. Development of meal plans for athletes

Diet plans for the athletes were developed, analysed and drawn in to meal plans using the commonly consumed foods by the athletes as informed by the athletes' dietary data. The researcher attempted to align the athletes' meal plans to the ISSN (2010) bodybuilding recommendations and the South African Food Based Dietary Guidelines (SAFBDG). These SAFBDG are brief scientific based dietary recommendations that are meant to guide the consumers of food to attempt to obtain adequate nutrition (Vorster *et al.,* 2013). Both the ISSN and SAFBDG state that attempts should be made to obtain both the macronutrients and micronutrients from whole foods than supplements and incorporating a variety of foods respectively.

During the meal plan process for the athletes the categories of weight as stipulated by the International Federation for Bodybuilding society (IFBB) (Table 5.17) were used as a guide to determine the amounts of macronutrients. Both the upper and lower limits of macronutrient recommendations (Table 5.16) in bodybuilding were calculated in order to determine classification ranges or a particular macronutrient. The weight categories (Table 5.17) and nutrients recommendation doses used to develop the meal plan for the athletes are illustrated in Table 5.1.

Table 5.1: Energy requirements by ISSN (2010)

Macronutrient	Recommendation/day
Energy	50 - 80 Kcal/kg
Protein	1.4-2 g/kg
Carbohydrates	50-65 % TE
Fat	<30% TE

(Kreider *et al.,* 2010)

Table 5.2 below gives a classification of weights according to the BBSA/IFBB categories. This is a criterion used during the competition.

Table 5.2: Weight categories of the athletes

Description	**Category (up to and including)**
Flyweight	60 kg
Bantamweight	65 kg
Lightweight	70 kg
Welterweight	75 kg
Light middleweight	80 kg
Middleweight	85 kg
Light heavyweight	90 kg
Heavyweight	95 kg
Super heavyweight	Over 100 kg

(IFBB/BBSA, 2013)

The recommended macronutrients intake was calculated using the IFBB weight classification (Table 5.2) and the ISSN macronutrients recommendations (Table 5.1). The estimated lower and upper ranges were calculated in Table 5.3 below.

Table 5.3: Summary of Macronutrient recommendations for athletes

Description & Category (up to)	Macronutrients	Recommendation per day
Flyweight **60 kg**	**Energy**	12600 -20160 KJ
	Protein	90 – 120 g
	Fat	99 – 159 g
	Carbohydrate	430 – 771 g
	Fluids	2300 ml
Bantamweight **65 kg**	**Energy**	13650 – 21840 KJ
	Protein	98 – 130 g
	Fat	107 – 172 g
	Carbohydrate	433 – 835 g
	Fluids	2400 ml
Lightweight **70 kg**	**Energy**	14700 – 23520 KJ
	Protein	105 – 140 g
	Fat	116- 186 g
	Carbohydrate	501 – 899 g
	Fluids	2500 ml
Welterweight **75 kg**	**Energy**	15750 – 25200 KJ
	Protein	112 – 150 g
	Fat	124 – 199 g
	Carbohydrate	537 – 964 g
	Fluids	2600 ml
Light middleweight **80 kg**	**Energy**	16800 – 26880 KJ
	Protein	120 – 160 g
	Fat	132 – 212 g
	Carbohydrate	622 – 949 g
	Fluids	2700 ml
Middleweight **85 kg**	**Energy**	17850 – 22560 KJ
	Protein	127 – 170 g
	Fat	140 – 225 g
	Carbohydrate	662 – 1008 g

	Fluids	2800 ml
Description & Category (up to)	**Macronutrients**	**Recommendation per day**
Light heavyweight **90 kg**	**Energy**	18900 – 30240 KJ
	Protein	135 – 180 g
	Fat	149 – 238 g
	Carbohydrate	700 – 1121 g
	Fluids	2900 ml
Heavyweight **95 kg**	**Energy**	19950 – 31920 KJ
	Protein	142 – 190 g
	Fat	158 – 252 g
	Carbohydrate	704 – 1182 g
	Fluids	2900 ml
Super heavyweight Over 100 kg	**Energy**	21000 – 33600 KJ
	Protein	150 – 200 g
	Fat	166 – 265 g
	Carbohydrate	741 – 1245 g
	Fluids	3100 ml

CHAPTER SIX
CONCLUSION AND RECOMMENDATIONS

6.1. CONCLUSION

The aim of this study was to determine the anthropometric status and dietary intake among bodybuilding athletes around Polokwane Municipality. The following conclusions are made from the current study:

6.1.1. The anthropometric status (BMI) and body composition of the bodybuilding athletes around Polokwane Municipality are within normal ranges.

6.1.2. The dietary intakes among athletes are not in line (mostly below) with the bodybuilding dietary recommendations.

6.1.3. A longer period being a bodybuilder and the amount used for protein food were significantly associated with a higher BMI, while athletes training for <60 minutes had significantly lower intake of energy than those training for a shorter duration (>1 hour) minutes.

6.2. RECOMMENDATIONS

The following are recommendations by the researcher:

6.2.1. Bodybuilding society/committee at Polokwane Municipality should appoint either a visiting or permanent nutrition expert in order to assist athletes regarding required nutritional services. These nutrition services should further be integrated with other health professional services offered by a multidisciplinary team (e.g. Physiotherapy and pharmaceutical services).

6.2.2. Currently the ISSN recommendations are silent about the group of athletes who are at neither low (recommended at 25-35kcal/kg/day) nor high (recommended at 50-80kcal/kg/day) category, as such the researcher suggests that moderate energy of 40-50kcal/kg/day be used in order to cover this gap that literature is silent about. Therefore, the sport nutrition dietitians should in conjunction with the ISSN, develop dietary guidelines for the athletes who are neither low nor high intensity bodybuilders (45min to 1 hour).

6.2.3. Bodybuilding coaches should receive formal training on nutrition and the use of nutritional supplements in this kind of sport.

6.2.4. Further research on the anthropometric assessment and dietary intake of bodybuilding athletes conducted on a larger population/sample size is recommended.

6.3. Limitations of the study

6.3.1. It should be highlighted, however, that the researcher observed that the bodybuilding athletes around Polokwane municipality are neither involved in a very high intense nor low intense training, but moderate intense training programme. As such, the latter posed a serious concern to the researcher regarding the macronutrient recommendations to be used in determining the athletes' diets, especially that of energy.

6.3.2. A small sample was used in this study as the sporting code (bodybuilding) is not as popular as other sporting codes such as soccer, cricket and hockey.

6.3.3. The limitation of 24-hour-recall could have also possibly lead to lower intakes among this group as athletes may report to give the researcher expected feedback.

REFERENCE

ADA/DC/ACSM (2006): Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance; *Journal of American Dietetic Association* (ADA)*;* 100:1543-1556.

ADA/DC/ACSM (2009): Position of the American Dietetic Association Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance: *Journal of American Dietetic Association.* 109:509-527.

Barnard R (2012): Bodybuilding; Bodybuilders -Health and hygiene; Dissertation (*Sports and Exercise Medicine)* University of the Free State.

Bilsborough, S and Mann, N (2006): A Review of Issues of Dietary Protein Intake in Humans; *International Journal of Sport Nutrition and Exercise Metabolism*; 16, 129-152

Block, G (1982): Validations of Dietary Assessments: *American Journal of Epidemiology*; 11 (4) 492-493.

Bountziouka, V, Bathrellou, E, Giotopoulou, A, Katsagoni, C, Bonou, M, Vallianou, N, Barbetseas J, Avgerinos, PC and Panagiotakos, D.B (2012): Development, repeatability and validity regarding energy and macronutrient intake of a semiquantitative food frequency questionnaire: Methodological considerations; Nutrition, Metabolism and Cardiovascular disease: (22) 659-667.

Buford, TW, Kreider, RB, Stoud, JR, Greenwood, M, Campell, B, Spano, M, Ziegenfuse, T, Lopez, H, Landis, J, Antonio, J (2007): *International Society of Sports Nutrition* position stand: Creatine supplementation and exercise. 4:6 DOI: 10.1186/1550-2783-4-6.

Burke, LM, Cox, GR, Cummings, NK and Desbrow, B (2001): Guidelines for Daily Carbohydrate Intake: Do Athletes Achieve Them? Sports Medicine; 31 (4): 267-299.

Campbell, B, Kreider, RB, Ziegenfuss, T, Bounty, PL, Roberts, M, Burke, D, Landis, J, Lopez, H and Antonio, J (2007): International Society of Sports Nutrition position stand: protein and exercise; *Journal of the International Society of Sports Nutrition*, 4:8 DOI: 10.1186/1550-2783-4-8.

Coleman, E (2011): Carbohydrate Requirements for Exercise: Nutrition Dimension, Gannett Education Inc.; 1-7.

Cotugna, N, Vickery, CE and McBee, S (2005): Sports Nutrition for Young Athletes; *Journal of School Nursing*; 21 (6). 323-326

Degu, G and Yigzaw, T (2006): Research Methodology (Lecture Notes for Health Science), Ethiopian Public Health Initiative: 29 & 63.

Dehghan, M, Jaramillo, PL, Due~nas, R, Anaya, L.L, Garcia, RG, Zhang, X, Islam, S and Merchant, A.T (2012): Development and Validation of a Quantitative Food Frequency Questionnaire among Rural- and Urban-dwelling Adults in Colombia; *Journal of Nutrition Education and Behaviour*; 44 (6): 609-613.

Eric, GB (2003): Use and effectiveness of performance enhancing substances; *Journal of Pharmacy Practice;* 16:22.

Gaines, RP (2001): Comparison of Anthropometric Measures of Competitive Bodybuilders to Judges' Scores and a Comparison of Judges' Scores; Research dissertation.

Gallagher, D, Heymsfield, SB, Heo, M, Jebb, SA, Murgatroyd, PR and 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.

Garthe, I, Raastad, T, Refsnes, PE and Sundgot-Borgen, J (2013): Effect of nutritional intervention on body composition and performance in elite athletes: *European Journal of Sport Science*, 13 (3): 295-303.

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

Grimes, DA and Schulz, KF (2002): Descriptive studies: What they can and cannot do?*: The Lancet*; 359: 145–49.

Guardia, D, Maurizio, C and Hellas, C (2015): The risks of self-made diets: The case of an amateur bodybuilder; *Journal of the International Society of Sports Nutrition* (ISSN): 12:16 DOI 10.1186/s12970-015-0077-8.

Hass, CJ, Garzarella, L, De Hoyo, D and Pollock, M (2000): Single versus multiple set in long-term recreational weightlifters. Medicine and science in sports and exercise; 235-242.

Helms ER, Aragon, AA and Fitschen, P (2014): *Journal of the International Society of Sports Nutrition*; 11: 20.

Hernández-Avila, M, Romieu, I, Parra, S, Hernández-Avila, J, Madrigal, H and Willett, W: (1998): Validity and reproducibility of a food frequency questionnaire to assess dietary intake of women living in Mexico City; 40:133-140.

Jazayeri, SMHM and Amani, R (2004): Nutritional Knowledge, Attitudes and Practices of Bodybuilding Trainers in Ahwaz, Iran; *Pakistan Journal of Nutrition* 3 (4): 228-231.

Kerksick, C, Harvey, T, Stout, J, Campbell, B, Wilborn, C, Kreider, R, Kalman, D, Ziegenfuss, T, Lopez, H, Landis, J, Ivy, J, and Antonio, J (2008): International Society of Sports Nutrition position stand: Nutrient timing (Review): 5:17 doi:101186/1550-2783-5-17

Karimian, J and Esfahani, PS (2011): Supplement consumption in body builder athletes: *Journal Resistant Medical Sciences*; 16 (10): 1347.

Kim, H, Lee, S, and Choue, R (2011): Metabolic responses to high protein diet in Korean elite bodybuilders with high-intensity resistance exercise; *Journal of the International Society of Sports Nutrition*, 8:10

Klungland, TM and Sundgot-Borgen, J (2011): Are Under- and Overweight Female Elite Athletes Thin and Fat? A Controlled Study; *American College of Sports Nutrition*. 949-953.

Kreider, BR, Wilborn, DC, Taylor, L, Campbell, B, Almada, LA, 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, Zingenfuss, TN and Antonio, J (2010): Exercise & Sport Nutrition Review; Research & recommendations: ISSN, 7:7.

Kyle, UG, Schultz, Y, Dupertuis, YM and Pichard, C (2003): Body Composition Interpretation: Contributions of the Fat-Free Mass Index and the Body Fat Mass Index; *Nutrition* 19:597–604, DOI: 10.1016/S0899-9007(03) 00061-3.

Labadarios, D and Haffejee, A (1990): A pocket Manual of Clinical Nutrition; South African Society of Parenteral and Enteral Nutrition (SAPEN) publication (1): 5, 14 & 49.

Labadarios, D, Steyn, NP, Maunder, E, MacIntryre, U, Gericke, G, Swart, R, Huskisson, J, Dannhauser, A, Vorster, HH, Nesmvuni, AE and Nel, JH (2005): The National Food Consumption Survey (NFCS): South Africa; Public Health Nutrition: 8 (5), 533–543.

Lambert, PL, Frank, LL, and Evans, WJ (2004): Macronutrient Considerations for the Sport of Bodybuilding. *Sports Medicine*; 34 (5): 317-327.

Lankford, B and Campbell, IB (2012): Self-reported energy intake of male & female bodybuilders in the scientific literature; *Journal of the International Society of Sports Nutrition* (ISSN), 9 (1): 19.

Latunde-Dada, GO (2012): Iron metabolism in athletes – achieving a gold standard; *European Journal of Haematology*; 90: 10–15.

Lee, DR and Nieman, CD (2013): Nutritional Assessment, 3rd edition. McGraw-Hill companies, Inc.:77-82 & 185-195.

Lee, DR and Nieman, CD (2010): Nutritional Assessment, 5th edition. McGraw-Hill companies, Inc.:160-165.

Lukaski, HC (2004): Vitamin and Mineral status: Effects on physical performance; Review article, 20: 632-644.

Malina, MR and Geithner, AC (2011): Body composition of young athletes: *American Journal of Lifestyle Medicine*, 5: 262.

Manore, MM, Thompson, J and Ruso, M (1993): Diet and exercise strategies of world class bodybuilder; *International Journal of sports nutrition*: 3, 76-86.

Marefat, S and Meysam, H (2010): Correlations of Anthropometric and Body Composition Variables with the Performance of Young Elite Weightlifters: *Journal of Human Kinetics*. (25), 125-131.

Masedu, F, Ziruolo, S, Valent, M and Di Giulio, A (2012): Resistance training and protein intake: Muscular mass and volume variations in amateur bodybuilders; *International SportMed Journal*, 13 (2): 58-68.

Maughan, RJ (1999): Nutritional ergogenic aids and exercise performance, *Nutrition Research Reviews*, 12: 255-280.

Maughan, RJ, and Shirreffs, SM (2011): Nutrition for sports performance: issues and opportunities; Proceedings of the Nutrition Society (2012), 71, 112–119.

McArdle, W, Katch, F and Katch, V (2013): Sports & Exercise Nutrition, 4th Edition; Lippincott Williams & Wilkins; Philadelphia: 434-435.

Mohamad, S, Mosavi, JH and Amani, R (2004): Nutritional Knowledge, Attitudes and Practices of Bodybuilding Trainers in Ahwaz, Iran; *Pakistan Journal of Nutrition*; 3 (4): 228-231.

Monteiro, JCV, Pimentel, GD, Sousa, MV (2012): Relationship between Body Mass Index with dietary fiber intake and skinfolds-differences among bodybuilders who train during morning and nocturne period**;** Nutricia Hospital.; 27 (3): 929-935.

Nande, V Mudafale, P and Vali, S (2009): Micronutrient Status of Male & Female Players Engaged in Different Sports Disciplines; *Journal of Exercise Science and Physiotherapy*, Vol. 5 (1): 1-13.

Norton, K and Olds, T (1996): Anthropometrica, 1st edition. New wales Press Australia, Ltd: Pg. 44-50.

NOSCA, G (2010): Bodybuilding Ethics Code: *Body Building Science Journal*, 2 (1). Pg.91.

Nutrition Information Centre University of Stellenbosch (NICUS) (2003): Dietary Reference Intakes; Pg. 39-98.

Ogita, S (2010): The Effects of Body Composition Differences on Placement at Bodybuilding Competition Among Male Amateur Bodybuilders. *Research Papers.* Paper 26. Pg. 22

Okorodudu, DO, Jumean, MF, Montori, VM, Romero-Corral, A, Somers, VK, Erwin, PJ and Lopez-Jimenez, F (2010): Diagnostic performance of body mass index to identify obesity as defined by body adiposity: A systematic review and meta-analysis*: International Journal of Obesity*, 34:791–799.

Phillips, SM (2012): Dietary protein requirements and adaptive advantages in athletes. *British Journal of Nutrition*, 108, S158S167 DOI: 10.1017/S0007114512002516.

Phillips, SM and Van Loon, LJC (2011): Dietary protein for athletes: From requirements to optimum adaptation, *Journal of Sports Sciences*, 29:sup1, S29-S38.

Phillips, SM, Moore, DR and Tang, JE (2007): A critical examination of dietary protein requirements, benefits and exercise in athletes: *International Journal of sports nutrition and exercise metabolism;* 17: 58-76.

Pickett, TC, Lewis, RJ and Cash, TF (2005): Men, muscles, and body image: comparisons of competitive bodybuilders, weight trainers, and athletically active controls: *British Journal of Sports Medicine;* 39:217–222.

Potgieter, S (2013): A review of the latest guidelines for exercise and sport nutrition from the American College of sport Nutrition, The international Olympic Committee & the International Society for sports Nutrition; *South African Journal of Clinical Nutrition*; 26 (1):6-16.

Pramukova, B, Szabadosova, V, Šoltesova, A (2011): Current knowledges about sports nutrition. *Australian Medicine Journal;* 4, 3, 107-10.

Rossow, LM, Fukuda, DH, Fahs, CA, Loenneke, JP and Stout, JR (2013): Natural Bodybuilding Competition Preparation and Recovery: A 12-Month Case Study; *International Journal of Sports Physiology and Performance:* 8, 582-592.

Schroder, H, Covas, MI, Marrugat, J, Villa, J, Pena, A, Alcantara, M and Masia, A (2001): Use of a three day estimated food record, a 72-Hour-recal and food frequency questionnaire for dietary assessment in Mediterranean Spanish population: *Clinical Nutrition*: 20 (5): 429-437.

Shai, I, Rosner, B.A, Shahar, DR, Vardi, H, Azrad, AB, Kanfi, A, Schwarzfuchs, D, and Fraser, D (2005): Dietary Evaluation and Attenuation of Relative Risk: Multiple Comparisons between Blood and Urinary Biomarkers, Food Frequency, and 24-Hour Recall Questionnaires: the DEARR Study; *Journal of American Society for Nutritional Sciences;* 135: 573–579.

Shinji, O (2010): The effects of body composition difference on placement at bodybuilding competition among male amateur bodybuilders. Research paper. Paper 26.

Smith, JW, Holmes, ME and McAllister, MJ (2015); Nutritional Considerations for Young Athletes (Review article): *Journal of sports medicine:* 1-8.

Silva, AM, Minderico, CS, Teixeira, PJ, Pietrobelli, A and Sardinha, LB (2006): Body fat measurement in adolescent athletes: Multicompartment molecular model comparison; *European Journal of Clinical Nutrition*: 60, 955–964.

Slatter, G and Phillips, MS (2011): Nutrition guidelines for strength sports: Sprinting, weightlifting, throwing events, and bodybuilding, *Journal of Sports Sciences,* 29: Sup1, S67-S77.

Snijder, MB, van Dam, RM, Visser, M and Seidell, JC (2006): What aspects of body fat are particularly hazardous and how do we measure them? Reviews: *International Journal of Epidemiology*; 35:83–92.

Spendlove J, Mitchell, L, Gifford, J, Hackett, D, Slater G, Cobley, S and O'Connor, H (2015): Dietary intake of competitive bodybuilders. Sports Medicine: 45 (7) 1041-1063.

Steen, SN (1991): Preconcert strategies of male bodybuilder: *International Journal of Sports Nutrition*; 1: 69-78.

Stellingwerff, T, Maughan, JR and Burke, ML (2011): Nutrition for power sports: Middle-distance running, track cycling, rowing, canoeing/kayaking, and swimming, *Journal of Sports Sciences*, 29: (1), S79-S89.

Teddlie, C and Yu, F (2007): Mixed Methods Sampling: A typology with examples. *Journal of Mixed Method Research*; 1 (1): 77-100.

Tokish, JM, Kocher, MS & Hawkins R.J (2004): Ergogenic aids: A review of basic science, performance, side effects and status in sports; 32 (6) 1543-1553.

Trabelsi, K, Stannard, SR, Maughan, R J, Jammoussi, K, Zeghal K, and Hakim A (2012): Effect of Resistance Training During Ramadan on Body Composition and Markers of Renal Function, Metabolism, Inflammation, and Immunity in Recreational Bodybuilders; *International Journal of Sport Nutrition and Exercise Metabolism;* 22, 267 -275.

Van Heerden, IV, Hall, N and Schonfeldt, HC (2014): *Red Meat in Nutrition and Health* (Supplementary chapter, red meat and sports): 2-18.

Va´zquez, C, Alonso, R, Garriga, M, de Cos, A, de la Cruz, J.J, Fuentes-Jime´nez, F, Salas-Salvado, J and Mata, P (2011): Validation of a food frequency questionnaire in Spanish patients with familial hypercholesterolemia; Nutrition, *Metabolism and Cardiovascular disease:* (22) 836-842.

Van der Ploeg, GE, Brooks, AG, Withers, RT, Dolman, J, Leaney, F and BE Chatterton (2001): Body composition changes in female bodybuilders during preparation for competition; *European Journal of Clinical Nutrition: 55, 268-277.*

Vînturis, S (2009): Nutrition for Bodybuilding Competition Preparation; *Body Building Science Journal;* 1: 2.

Vorster, HH, Badham, JB & Venter, CS (2013): An introduction to the revised food-based dietary guidelines for South Africa. *South African Journal of Clinical Nutrition*: 26 (3) S1-S164.

Walberg-Rankin, J, Edmonds, EC and Gwazdauskas, FC (1993): Diet and weight changes of female bodybuilders before and after competition; *International Journal of Sports Nutrition*; 3, 87-102.

Wang, C, Xu-hong, H, Ming-liang, Z, Yu-qian Bao, Wen-hong, Z, Kun-san, X, and Wei-ping, J (2010): Comparison of Body Mass Index with Body Fat Percentage in the Evaluation of Obesity in Chinese: *Journal of Biomedical & Environmental Sciences*; 23: 173-179.

Williams, AM, William, LH, Philip AA, Ezra, AA, Bittner, V, Franklin, BA, Gulanick, M, Laing, ST and Stewart, KJ (2007): Resistance Exercise in Individuals with and without cardiovascular disease; *Circulation;* 116:572-584.

Williams C and Rollo, I (2005); Carbohydrate Nutrition and Team Sport Performance, Review article: *Sports Medicine:* 45 (Suppl 1): S13–S22. DOI 10.1007/s40279-015-0399-3

Williams, MH (2005): Dietary Supplements and Sports Performance: Minerals. *Journal of the International Society of Sports Nutrition*; 2(1):43-49.

Wilson J & Wilson G (2006): Contemporary Issues in Protein Requirements and Consumption for Resistance Trained Athletes; *Journal of the International Society of Sports Nutrition*; 3(1):7-27.

Witt, KA and Bush, EA (2005): College Athletes with an Elevated Body Mass Index Often Have a High Upper Arm Muscle Area, but Not Elevated Triceps and Subscapular Skinfolds; Research briefs (Paper)1-2.

World Health Organisation (2004): Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies; *Lancet*; 363: 157–63

Wright, HH (2005): The glycaemic index and sports Nutrition" *South African Journal of Clinical Nutrition*. December edition; 18 (3).

Wright, HH, Claassen, A and Davidson, J (2004): Dietary macronutrient recommendations for optimal recovery post-exercise (Part II): Review article sports medicine (16): 2.

Yunsheng MA, Olendzki, BC, Pagoto, SL, Hurley, TG, Magner, RP, Ockene, IS, Schneider, KL, Merriam, PA and Hébert JR (2009): Number of 24-Hour Diet Recalls Needed to Estimate Energy Intake: *Annals of Epidemiology*: 19 (8); 553-559.

Zaccagni L, Barbieri D, Gualdi-Russo E (2014): Body composition and physical activity in Italian university students; *Journal of Translational Medicine:* 12:120.

ANNEXURE 1 A: Consent Form (English) **Athlete's Code**

ENGLISH CONSENT FORM

Assessment of Anthropometric status and Dietary intake of Adults Engaging in Bodybuilding Programme around Polokwane Municipality in Limpopo Province

Declaration

I have read the information on the aims and objectives of the study and was provided the opportunity to ask questions and given adequate time to rethink the issue. The aim and objectives of the study are sufficiently clear to me. I have not been pressurized to participate in any way.

I understand that participation in this study is completely voluntary and that I may withdraw from it at any time and without supplying reasons.

I hereby give consent to participate in this practical.

…………………….. ....

Athlete's Signature Signature

....

Place Date Witness

Statement by the researcher

I provided written information regarding this research

I agreed to answer any future questions concerning the research as best as I am able.

I will adhere to the approved protocol.

....…………………

Name of the researcher   Signature   Date

APPENDIX 1 B: Consent Form (Sepedi)   **Athlete's Code**

(SEPEDI CONSENT FORM)

Leina la Dinyakišišo:

Assessment of Anthropometric status and Dietary intake of Adults engaging in bodybuilding programme around Polokwane Municipality in Limpopo Province

Ke badile/ke kwele ka ga tshedimošo mabapi le maikemišetšo le morero wa dinyakišišo tšeo di šišintšwego gomme ke ile ka fiwa monyetla wa go botšiša dipotšišo kaba ka fiwa nako yeo e lekanego gore ke naganišiše ka ga taba ye. Ke tloga ke kwešiša maikemišetšo le morero wa dinyakišišo tše gabotse. Ga se ka gapeletšwa go kgatha tema ka tsela efe goba efe.

Ke a kwešiša gore go kgatha tema Dinyakišišong tše tša Teko ya Klinikhale ke ga boithaopo gomme nka tlogela go kgatha tema nakong efe goba efe ntle le gore ke fe mabaka. Se se ka se be le khuetšo efe goba efe go kalafo yaka ya ka mehla ya maemo a ka gape e ka se huetše le ge e ka ba tlhokomelo yeo ke e humanago go ngaka yaka ya ka mehla.

Ke a tseba gore Dinyakišišo tše di dumeletšwe ke Medunsa Research Ethics Committee (MREC), Yunibesithi ya Limpopo (Khamphase ya Medunsa) .Ke tseba gabotse gore dipoelo tša Dinyakišišo tše di tla dirišetšwa merero ya saense gomme di ka phatlalatšwa. Ke dumelelana le se, ge fela bosephiri bja ka bo ka tiišetšwa.

Mo ke fa tumelelo ya go kgatha tema Dinyakišišong

....   ___________________________________

Leina la moithaopi   Mosaeno wa molwetši goba mohlokomedi.

....

Lefelo.   Letšatšikgwedi.   Tlhatse

Setatamente ka Monyakišiši

Ke fana ka tshedimošo ka molomo le/goba yeo e ngwadilwego Dinyakišišo
Ke dumela go araba dipotšišo dife goba dife tša ka moso mabapi le Dinyakišišo ka bokgoni ka moo nka kgonago ka gona.
Ke tla latela melao yeo e dumeletšwego.

....….   ……………..

Leina la Monyakišiši	Mosaeno	Letšatšikgwedi	Lefelo

ANNEXURE 2

Athlete's Code

A: Demographic Data

1. Age (years)

2. Gender

M	1	F	2

3. How long have you been a bodybuilder? ______________________________

4. Duration during Training

<30 min	30-45 min	45min-1 hr	>1 hour
1	2	3	4

5. Frequency per week

< 3 times	1	3-4 times	2	>4 times	3

6. Are you using any ergogenic agents?

Yes	No
1	2

7. If yes, which type?

Powders	Tablets	Injections	Other (specify)
1	2	3	4

8. Source of nutrition knowledge

Coach	Media	Friends	Dietitian	Teammates	Other (specify)
1	2	3	4	5	6

9. Source of income for food

Employer	Parents	Bursary	Other (specify)
1	2	3	4

10. Who prepares your food?

Self	Spouse	Cafeteria	Other (specify)	
1	2	3	4	

11. How much do you use monthly for protein foods? R____________________

12. How do you use much use monthly to buy protein supplements? R ________________

13. How much do you use monthly to buy other foods? R ______________________

Athlete's Code

B: Anthropometric Data

Analyte		**Value**			
Height (m)					
Weight (kg)					
BMI (Kg/m^2)	**Reading**	**<18.5**	**18.5-24.9**	**25-29.5**	**>29.6**
		1	2	3	4
Triceps skinfold (mm)		**<15th**	**15th-75th**	**>75th**	
		1	2	3	
Biceps skinfold (mm)		**<15th**	**15th-75th**	**>75th**	
		1	2	3	
Supra iliac skinfold (mm)		**<15th**	**15th-75th**	**>75th**	
		1	2	3	
Subscapular (mm)		**<15th**	**15th-75th**	**>75th**	
		1	2	3	
Sum (Triceps, Biceps, Suprailliac, subscapular) (mm)		**<15th**	**15th-75th**	**>75th**	
		1	2	3	
% of body fat					

Athlete's Code

C: The 24-Hour-Recall (Modified)

Food Item	Exchange	Amount	Protein (g)	CHO (g)	Fat (g)	Energy (KJ)
Total per Day						

Percentage						
Recommendations/UL						

Athlete's Code

D: Food Frequency Questionnaire (Modified)

	FOOD	DESCRIPTION	CODE	QUANTITY (g/ml)	AMOUNT USUALLY EATEN (HHM)	AMOUNT USUALLY EATEN (g)	P/D	D/W	P/M	SEL/NEV
PORRIDGE	**Maize-meal Porridge**	Stiff (Pap) – Plain	**3400**	1c stiff = 250 g 1T = 75g						
		-Enriched	**4278**							
		Soft (Slappap) – Plain	**3399**	1c soft = 250g 1T = 75g						
		Enriched	**4277**							
		Crumbly (Phutu) – Plain	**3401**	1c soft = 250g 1T = 75g						
		Enriched	**4279**							
	Sour Porridge	Maize with Vinegar	**P0001**	½c = 125g 1c = 250g						
		Maize Fermented	**P0002**							
		Mabella with Vinegar	**P0003**							
		Mabella Fermented	**P0004**							
	Maltabella Porridge	Stiff	**3241**	½ c = 125g						
		Soft	**3241**							
	Oats Porridge	Brand Name:	**3239**	2c = 125g						
	Other Cooked Cereals:	Specify Type								
	Milk on Porridge	None		little = 30g med = 60g much = 125g						
		Whole/Fresh	**2718**							
		Sour	**2787**							
		2%	**2772**							
		Fat Free / Skim	**2775**							
		Milk Blend	**2771**							
		Soy Milk	**2737**							
	Is fat added to porridge?	None		1t Marg/oil = 5g						
		Animal Fat (Butter)	**3479**							
		Hard Margarine	**3484**							
		Soft Margarine (PM)	**3496**							
		Soft Margarine (Med)	**3531**							

		Sunflower Oil	**3507**							
		Peanut Butter **3**	**485**	1t = 12g						

	FOOD	**DESCRIPTION**	**CODE**	**QUANTITY (g/ml)**	**AMOUNT USUALLY EATEN (HHM)**	**AMOUNT USUALLY EATEN (g)**	**P/D**	**D/W**	**P/M**	**SEL/NEV**
STARCHES	**Samp and Peanuts**	Specify Ratio:	**P0013**	1T = 50g 1SP = 125g ½ c = 125g						
	Samp and Peanuts	Specify Ratio:	**P0013**							
	Rice: Specify Brands Names	White	**3247**	1T = 50g 1SP = 125g ½ c = 125g						
		Brown	**3315**							
	Pastas	Macaroni	**3262**	1T = 35g; 1SP = 70g; ½ c = 90g						
		Spaghetti Plain	**3262**							
		Spaghetti and Tomato Sauce	**3258**	1T =45g; 1SP =80g; ½ c=125g						
		Other: Specify								
	Do you add fat to any of these starchy foods?	No ____								
		Yes ____ If yes, specify types								
BREAD & SPREADS	**BREAD AND ROLLS**	White	**3210**	Wh+Br 10mm = 30g Wh + Br 20mm = 60g Wh + Br 30mm = 100g ½ loaf = 400g						
		Brown	**3211**							
	Pizza)	(Specify Toppings								
	Are any of the following spreads on the Bread? Fat Spreads: (Tick box)	Butter	**3479**	1t = 5g						
		Butro	**3523**							
		Animal Fat (Beef Tallow)	**3494**							
		Hard Margarine	**3484**							
		Soft Margarine (Med)	**3531**							
		Soft Margarine (PM)	**3496**							
	Peanut Butter		**3485**	1t = 12g						
	Sweet Spreads	Jam	**3985**	1t = 15g						
		Syrup	**3988**							
		Honey	**3984**							
	Paste	Fish Paste	**3109**	Thin = 5g; med = 7g;						
		Meat Paste	**2917**							

				Thick = 10g						
CHICKEN		Boiled with skin	**2926**	Breast + skin = 125g Thigh =80g Drumstick = 42g Foot = 30g Wing = 30g						
		Boiled without skin	**2963**							
		Fried in batter/crumbs	**3018**							
		Fried – not coated	**2925**							
		Roasted/grilled with skin	**2925**							
		Roasted/grilled without skin	**2950**							
	Chicken Stew	With Vegetables	**3005**	1SP = 90g; ½ c = 125g						
		With Tomato & Onion	**2985**							
	BEEF	Roasted with Fat	**2944**	120 x 60 x 5 = 35g 120 x 60 x 10 = 70g						
		Roasted, Fat Trimmed	**2960**							
		Stewed/Boiled With Fat (Cabbage)	**3006**	1SP = 105g ½ c = 125g						
	Wors/Sausage	Fried	**2931**	Thin x 200mm = 45g; Thick x 165mm = 90g						
EGGS		Boiled/Poached	**2867**	egg = 50g						
		Scrambled in Oil	**2889**	1T = 35g; 1SP = 80g; ½c=115g (approx. 2eggs)						
		In Butter	**2886**							
		In Margarine	**2887**							
		Fried in Oil	**2869**	1 egg = 52g						
		In Butter	**2868**							
		In Margarine	**2877**							
VEGETABLES & FRUITS										
VEGETABLES	**Beetroot**	Cooked (No Sugar)	**3698**	1T=40g; 1SP = 70g; ½ c = 80g						
		(With Sugar)	**3699**							
		Salad (Grated)	**3699**	1T = 25g; 1SP = 65g						
	Potatoes	Mashed (WM)	**3876**	1T=50g; 1SP = 115g; ½ c = 125g						
		Salad	**3928**	1T = 45g; 1SP = 105g; ½ c = 120g						
	Sweet Potatoes	Boiled/Baked with Skin	**3748**	1T = 50g; 1SP = 110g; ½ c =						
		Without Skin	**3903**							
		Mashed (With Sugar)	**3749**							
	Other	Specify:								
Fruits										

Supplements	**Creatine**							

	Steroids							
	Whey protein							
	Other (Specify):							

ANNEXURE 3: MREC APPROVAL LETTER

UNIVERSITY OF LIMPOPO
Medunsa Campus

MEDUNSA RESEARCH & ETHICS COMMITTEE

CLEARANCE CERTIFICATE

MEETING:	**06/2014**
PROJECT NUMBER:	**MREC/HS/251/2014: PG**
PROJECT:	
Title:	The Anthropometric status and dietary intake of adults engaging in bodybuilding programme around Polokwane Municipality in Limpopo Province
Researcher:	Mr S Masoga
Supervisor:	Ms SHM Makuse
Co-supervisor:	Ms MM Bopape
Department:	Nursing & Human Nutrition
Degree:	Master in Dietetics

DECISION OF THE COMMITTEE:

MREC approved the project.

DATE: 21 August 2014

UNIVERSITY OF LIMPOPO
Medunsa Campus
2014 -08- 21
MEDUNSA RESEARCH ETHICS COMMITTEE
MREC CHAIRPERSON

PROF GA OGUNBANJO
CHAIRPERSON MREC

The Medunsa Research Ethics Committee (MREC) for Health Research is registered with the US Department of Health and Human Services as an International Organisation **(IORG0004319)**, as an Institutional Review Board **(IRB00005122)**, and functions under a Federal Wide Assurance **(FWA00009419)**
Expiry date: **11 October 2016**

Note:
i) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.**
ii) **The budget for the research will be considered separately from the protocol.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

ANNEXURE 4: ATHLETE'S MEAL PLAN

Category: Under (Up to) 60 kg

PERIOD	Item	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full Cream Milk	1 cup
	Cereals	180 g	2	Oats/Mabela	1 cup
	Bread	120 g	4	Brown Bread	4 slices
	Egg	52 g	1	Boiled egg	1 medium
	Spread	10 g	2	Margarine	2 teaspoons
		10 g	1	Jam	2 teaspoons
	Tea (with sugar)	250 ml	1	Rooibos Tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
Lunch (13H00-14H00)	Starch	375 g	3	Porridge	1 ½ cups
	Meat/Fish/Poultry	84 g	2	Beef/ Chicken	2 pieces (medium)
	Vegetables	80-90 g	1	Spinach/ Cabbage	½ cup (125 ml)
	Drink	250 ml	1	Fruit Juice	1 glass
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	250 ml	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
Supper (18H30-19H30)	Starch	195 g	3	Rice	1 ½ cups (250 ml)
	Meat/Fish/Poultry	250 g	2	Beef/ Chicken	2 pieces (medium)
	Vegetables	180 g	2	Spinach/Pumpkin	½ cup (125 ml)
	Drinks	250 ml	1	Fruit juice	1 glass (250ml)
Late night snack	Starch	60 g	2	Brown Bread	1 slices
	Spread	10 g	2	Margarine	2 teaspoons
	Drink	250 ml	1	Rooibos Tea with sugar	1 cup with 2 tsp. sugar)

Category: Under (Up to) 65 kg

PERIOD	Item	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full cream milk	1 cup
	Cereals	90 g	1	Oats/Mabela	½ cup (125 ml)
	Bread	120 g	4	Brown Bread	4 slices
	Egg	52 g	1	Boiled egg /Scrambled	1 medium
	Spread	10 g	2	Margarine	2 teaspoons
		15 g	1	Jam	1 teaspoon
	Drink	250 ml	1	Rooibos Tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
Lunch (13H00-14H00)	Starch	375 g	3	Porridge/ Rice/Samp	1 ½ cups
	Meat/Fish/Poultry	55-84 g	2	Chicken drum/ thigh	2 pieces (medium)
	Vegetables	80-90 g	1	Spinach/ Cabbage	½ cup (125 ml)
	Fluids	250 ml	1	Fruit juice	1 glass
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	250 ml	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
Supper (18H30-19H30)	Starch	195 g	3	Rice /Samp/ porridge	1 ½ cups (250 ml)
	Meat/Fish/Poultry	125 g	1	Beef Stew	½ cup (medium)
	Vegetables	180 g	2	Spinach/Pumpkin	1 cup (250 ml)
	Dressing	10 g	1	Salad dressing/ Mayonnaise	1 teaspoon
	Drinks	250 ml	1	Orange juice	1 cup (250ml)
Late night snack	Starch	60	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Egg	52	1	Boiled egg	1 medium
	Drink	250 ml	1	Tea with sugar	1 cup with 2 tsp. sugar

Category: Under (Up to) 70 kg

PERIOD	Food Group	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full cream milk	1 up
	Cereals	180 g	2	Oats/Mabela/Meal rice	1 cup
	Bread	120 g	4	Brown Bread	4 slices
	Egg	52 g	1	Boiled egg	1 medium
	Spread	20 g	2	Margarine	2 teaspoons
				Jam	
	Tea (with sugar)	250 ml	1	Rooibos tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
Lunch (13H00-14H00)	Starch	500 g	4	Porridge	2 cups
	Meat/Fish/Poultry	42-55 g	2	Chicken (Drum/Thigh)	2 pieces (medium)
	Vegetables	180 g	2	Spinach/ Cabbage	1 cup (250 ml)
	Fluids	250 ml	1	Fruit Juice	1 glass
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	250 ml	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
Supper (18H30-19H30)	Starch	260 g	4	Rice	2 cups (500 ml)
	Meat/Fish/Poultry	250 g	2	Beef stew	2 pieces (medium)
	Vegetables	180 g	2	Spinach/Carrots	1 cup (125 ml)
	Dressing	10 g	1	Mayonnaise	1 teaspoon
	Drinks	250 ml	1	Fruit juice	I glass (250ml)
Late night snack	Starch	90	3	Brown Bread	3 slices
	Spread	10 g	2	Margarine	2 teaspoons
	Drink	250 ml	1	Tea with sugar	1 cup (2 tsp. sugar)

Category: Under (Up to) 75 kg

PERIOD	Food Group	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full Cream Milk	1 cup
	Cereals	180 g	2	Oats/Mabela	1 cup
	Bread	120 g	4	Brown Bread	4 slices
	Egg	52 g	1	Boiled egg	1 medium
	Spread	20 g	2	Margarine	2 teaspoons
				Jam	
	Tea (with sugar)	250 ml	1	Rooibos tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
Lunch (13H00-14H00)	Starch	500 g	4	Porridge	2 cups
	Meat/Fish/Poultry	84 g	2	Chicken (Drum/Thigh)	2 pieces (medium)
	Vegetables	250 g	2	Spinach/ Cabbage	1 cup (250 ml)
	Fluids	250 ml	1	Fruit Juice	1 glass
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	250 ml	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
Supper (18H30-19H30)	Starch	260 g	4	Rice	2 cups (500 ml)
	Meat/Fish/Poultry	250 g	2	Beef stew	2 pieces (medium)
	Vegetables	180 g	2	Spinach/Carrots	1 cup (125 ml)
	Dressing	10 g	1	Mayonnaise	1 teaspoon
	Drinks	250 ml	1	Fruit juice	I glass (250ml)
Late night snack	Starch	90	3	Brown Bread	3 slices
	Spread	10 g	2	Margarine	2 teaspoons
				Jam	
	Drink	250 ml	1	Tea with sugar	1 cup (2 tsp. sugar)

Category: Under (Up to) 80 kg

PERIOD	Food Group	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full Cream Milk	1 cup
	Cereals	180 g	2	Oats	1 cup
		50 g		Polycose	½ cup
	Bread	90 g	3	Brown Bread	3 slices
	Egg	52 g	1	Boiled egg	1 medium
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Tea (with sugar)	250 ml	1	Rooibos tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
	Brown Bread	**60 g**	**2**	**Bread**	**2 slices**
Lunch (13H00-14H00)	Starch	375 g	3	Porridge	1 ½ cups
	Meat/Fish/Poultry	84 g	2	Chicken (Drum/Thigh)	2 pieces (medium)
	Vegetables	250 g	2	Spinach/ Cabbage	1 cup (250 ml)
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	500 g	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
	Fluids	250 ml	1	Fruit Juice	1 glass
Supper (18H30-19H30)	Starch	260 g	4	Rice	2 cups (500 ml)
	Meat/Fish/Poultry	250 g	2	Beef stew	2 pieces (medium)
	Vegetables	180 g	2	Spinach/Carrots	1 cup (125 ml)
	Dressing	10 g	1	Mayonnaise	1 teaspoon
	Drinks	250 ml	1	Fruit juice	I glass (250ml)
Late night snack	Starch	90	3	Brown Bread	3 slices
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Drink	250 ml	1	Milk	1 cup

Category: Under (Up to) 85 kg

PERIOD	Food Group	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full Cream Milk	1 cup
	Cereals	180 g	2	Oats	1 cup
		100 g		Polycose	1 cup
	Bread	90 g	3	Brown Bread	3 slices
	Egg	52 g	1	Boiled egg	1 medium
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Tea (with sugar)	250 ml	1	Rooibos tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
	Bread	**60 g**	**2**	**Brown Bread**	**2 slices**
Lunch (13H00-14H00)	Starch	375 g	3	Porridge	1 ½ cups
	Meat/Fish/Poultry	84 g	2	Chicken (Drum/Thigh)	2 pieces (medium)
	Vegetables	250 g	2	Spinach/ Cabbage	1 cup (250 ml)
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	500 g	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
	Fluids	250 ml	1	Fruit Juice	1 glass
Supper (18H30-19H30)	Starch	260 g	4	Rice	2 cups (500 ml)
	Meat/Fish/Poultry	250 g	2	Beef stew	2 pieces (medium)
	Vegetables	180 g	2	Spinach/Carrots	1 cup (125 ml)
	Dressing	10 g	1	Mayonnaise	1 teaspoon
	Drinks	250 ml	1	Fruit juice	I glass (250ml)
Late night snack	Starch	90	3	Brown Bread	3 slices
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Drink	250 ml	1	Milk	1 cup

Category: Under (Up to) 90 kg

PERIOD	Food Group	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full Cream Milk	1 cup
	Cereals	180 g	2	Oats	1 cup
		100 g		Polycose	1 cup
	Bread	90 g	3	Brown Bread	3 slices
	Egg	52 g	1	Boiled egg	1 medium
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Tea (with sugar)	250 ml	1	Rooibos tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
	Bread	**60 g**	**2**	**Brown Bread**	**2 slices**
Lunch (13H00-14H00)	Starch	375 g	3	Porridge	1 ½ cups
	Meat/Fish/Poultry	84 g	2	Chicken (Drum/Thigh)	2 pieces (medium)
	Vegetables	250 g	2	Spinach/ Cabbage	1 cup (250 ml)
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	500 g	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
	Fluids	250 ml	1	Fruit Juice	1 glass
Supper (18H30-19H30)	Starch	260 g	4	Rice	2 cups (500 ml)
	Meat/Fish/Poultry	250 g	2	Beef stew	2 pieces (medium)
	Vegetables	180 g	2	Spinach/Carrots	1 cup (125 ml)
	Dressing	10 g	1	Mayonnaise	1 teaspoon
	Drinks	250 ml	1	Fruit juice	I glass (250ml)
Late night snack	Starch	90	3	Brown Bread	3 slices
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Drink	250 ml	1	Milk	1 cup
	Supplement	100g		Polycose	1 cup

Category: Under (Up to) 95 kg

PERIOD	Food Group	Amount	Serving(s)	FOOD ITEM	Measure
BREAKFAST (07H00-08H00)	Milk	250 ml	1	Full Cream Milk	1 cup
	Cereals	180 g	2	Oats	1 cup
		100 g		Polycose	1 cup
	Brown Bread	90 g	3	Bread	3 slices
	Egg	52 g	1	Boiled egg	1 medium
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Tea (with sugar)	250 ml	1	Rooibos tea	1 cup tea (2 tsp. sugar)
Snack (10H00-10H30)	**Fruit**	**150 g**	**2**	**Apple**	**1 medium**
	Bread	**60 g**	**2**	**Brown Bread**	**2 slices**
Lunch (13H00-14H00)	Starch	375 g	3	Porridge	1 ½ cups
	Meat/Fish/Poultry	84 g	2	Chicken (Drum/Thigh)	2 pieces (medium)
	Vegetables	250 g	2	Spinach/ Cabbage	1 cup (250 ml)
Snack (15H30-16H00)	Bread	60 g	2	Brown Bread	2 slices
	Spread	10 g	2	Margarine	2 teaspoon
	Starch	500 g	2	Spaghetti	1 cup (250 ml)
	Fruit	180 g	1	Orange	1 medium
	Fluids	250 ml	1	Fruit Juice	1 glass
Supper (18H30-19H30)	Starch	260 g	4	Rice	2 cups (500 ml)
	Meat/Fish/Poultry	250 g	2	Beef stew	2 pieces (medium)
	Vegetables	180 g	2	Spinach/Carrots	1 cup (125 ml)
	Dressing	10 g	1	Mayonnaise	1 teaspoon
	Drinks	250 ml	1	Fruit juice	I glass (250ml)
Late night snack	Starch	90	3	Brown Bread	3 slices
	Spread	10 g	1	Margarine	2 teaspoons
				Jam	
	Drink	250 ml	1	Milk	1 cup
	Supplement	150g		Polycose	1 cup