# THE NUTRITIONAL PROFILE OF HIGH-PERFORMANCE JUNIOR SOCCER PLAYERS IN WESTERN CAPE, SOUTH AFRICA

by
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## DECLARATION OF AUTHENTICITY

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**Date: 1 December 2012**

## ABSTRACT

**Background:** Very little data exists regarding the nutritional status of adolescent soccer players and there is no national data regarding this population.

**Aim**: The aim of this study was to investigate the dietary intake and anthropometric profile of *N*=39 male, high-performance, adolescent soccer players who are of mixed race (14 -18 years of age), during the competitive season.

**Methods:** The study design was a descriptive, observational study with an analytical component. A quantified food frequency questionnaire (QFFQ), which has been validated for athletes, was used to characterise their nutritional intake in terms of energy (kCal), macronutrient as well as micronutrient intake. Interpretation of anthropometric data included plotting and interpreting growth indicators such as height-for-age, body mass index (BMI)-for-age, tricep skinfold-for-age, subscapular skinfold-for-age, sum of skinfolds-for-age, arm muscle area (AMA)–for-age, arm muscle circumference (AMC)-for-age, arm fat area (AFA)-for-age and percentage body fat.

**Results:** The anthropometric data showed that most of the players had an adequate height-for-age (100%, *N*=39) and BMI-for-age (87.2%, *N*=34). The mean percentage body fat was 10.9±3.5%. The majority of players' skinfold thickness measurements were above the 85$^{th}$ percentile for triceps (56.4%, *N*=22), subscapular (59.0%, *N*=23) as well as the sum of two skinfolds (triceps and subscapular), (72.0%, *N*=28), AMA (82.1%, *N*=32), AMC (56.4%, *N*=22) and AFA (56.4%, *N*=22). Daily minimum and maximum mean energy expenditure was between 3146.9±213.4 and 3686.4±250.0 kcal while daily mean energy intake was 4374.0±1462.4 kcal. Protein (156±53 g/day), carbohydrate (CHO) (557±172 g/day), total fat (149±67.8 g/day) and cholesterol (546±230 mg/day) intake were all above levels recommended for athletes. The mean micronutrient intake met the estimated average requirement (EAR) or adequate intake (AI) for all nutrients. Players who were more physically active displayed more favourable anthropometric indices which included body weight, BMI, body fat indices as well as muscle mass indices, despite having a greater total energy intake (TEI). This difference did however not reach statistical significance. Supper was the most regularly consumed meal (97.4%, *N*=38). The majority of players (61.5%, *N*=24) ate breakfast daily with only 5.1% (*N*=2) who never ate breakfast. However, 20.5% (*N*=8) of the players only ate breakfast 3 days a week.

**Conclusion:** Although most of the players had a normal body weight and BMI, they were predominantly categorised as above average according to indices of body fat. Body muscle indices was categorised as above average for most players suggesting a beneficial finding in terms of sporting performance. The mean TEI, CHO, protein intake and fat intake were all

above the recommended levels for athletes. The mean intake of all vitamins and minerals met the EAR/AI. Players who were more physically active displayed more favourable anthropometric indices, despite having a higher TEI.

Although this study population exhibited no evidence of stunting, indicating that the players were well nourished (in terms of sufficient macronutrients and micronutrients), they are at risk of being over-nourished which may negatively impact sporting performance as well as overall health.

## OPSOMMING

**Agtergrond:** Daar is baie min studies wat die dieetinname van adolosent-sokkerspelers ondersoek het en daar is sover die navorser se kennis strek, geen nasionale data rakende dieetinname in hierdie studie populasie nie.

**Doel:** Die doel van die studie was om die dieetinname en antropometriese profiel van *N*=39 manlike hoë-prestasie adolosent-sokkerspelers van gemengde ras (14-18 jaar) gedurende die kompeterende seisoen te bepaal.

**Metodes:** 'n Kwantitatiewe voedselfrekwensie vraelys was gebruik om die totale energie (kcal), makronutriënt- en mikronutrientinname te bepaal. Die antropometriese data was geïnterpreteer met behulp van die volgende groei indikatore; lengte-vir-ouderdom, liggaamsmassa indeks (LMI)-vir-ouderdom, trisep velvou-vir-ouderdom, subskapulêre velvou-vir-ouderdom, som van velvoue-vir-ouderdom, arm spier area (ASA)-vir-ouderdom, arm spier omtrek (ASO)-vir-ouderdom, arm vet area (AVA)-vir-ouderdom en persentasie liggaamsvet.

**Resultate**: Die antropometriese data het getoon dat meeste van die spelers toepaslike lengte-vir ouderdom (100%, *N*=39) en LMI-vir-ouderdom (87.2%, *N*=34) het. Die gemiddelde persentasie liggaamsvet was 10.9±3.5%. Die meerderheid van die spelers se velvou metings was bo die 85$^{ste}$ persentiel vir die trisep (56.4%, *N*=22), subskapulêr (59.0%, *N*=23) sowel as die som van twee velvoue (trisep en subscapulêr), (72.0%, *N*=28), ASA (82.1%, *N*=32), ASO (56.4%, *N*=22) en AVA (56.4%, *N*=22). Die daaglikse maksimum en minimum gemiddelde energie verbruik was 3146.9±213.4 tot 3686.4±250.0 kcal en daaglikse energie inname was 4757.9±2121.2 kcal. Proteïen (155.6±53.3 g/day), koolhidraat (556.8±172.1 g/day), totale vet (148.8±67.8 g/day) en cholesterol (545.5±230.1 mg/day) inname was bo die aanbevelings. Die gemiddelde mikronutriënt inname was binne die geskatte gemiddelde aanbeveling of toereikende inname vir al die mikronutriënte. Die gemiddelde vloeistof inname gedurende 'n sokker wedstryd en 'n twee uur oefen sessie was 479.1±163 ml en 597.7±281 ml, onderskeidelik. Die meer aktief spelers het 'n meer geskikte antropometriese profiel, soos laer gewig, LMI en liggaamsvet waardes en hoër spiermassa waardes beskik, ten spite van 'n hoër energie inname. Die maal wat die mees gereeld geëet was is aandeete (97.4%, *N*=38). Meeste (61.5%, *N*=24) van die spelers het ontbyt daagliks geëet met net 5.1% (*N*=2) wat nooit ontbyt geëet. Alhoevel daar nogsteeds 20.5% (*N*=8) van spelers was wat net ontbyt 3 keer per week geëet het. Die maaltyd wat die minste ingeneem was, was ontbyt, met net 20.5% (*N*=8) wat onybyt 3 dae per week eet.

**Slot:** Alhoewel meeste van die spelers 'n normale gewig en LMI getoon het, is die meeste spelers gekatogoriseerd as bo gemiddeld in terme van liggaamlike vet waarde. Die meeste

van die spelers kan ook gekatogoriseer word as bo gemiddeld in term van spiermassa, wat voordelig is vir sport prestasie. Die gemiddlede energie, koolhidraat, proteïen, en vet innames was bo die aanbevole reikwydtes. Die gemiddelde mikronutriënt inname was binne die geskatte gemiddelde aanbeveling of toereikende inname vir al die mikronutriënte. Meer aktief spelers het ‘n meer geskikte antropometriese profiel getoon, ten spite van ‘n hoër energie inname.

Alhoewel hierdie populasie wel gevoed is, in terme van makronutriënt en micronutrient, draar hulle ‘n risiko om oor gevoed to wees. Dit mag hulle sport prestasie en algehele gesondheid negatief beïnvloed.

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## DEDICATIONS

I would like to dedicate this study to my loving and supportive husband and my children M Ashraf, Ruwayda and Imaan.

## CONTRIBUTIONS BY PRINCIPAL AND FELLOW RESEARCHERS

The principal researcher (Fatima Hoosen) developed the idea and the protocol. The principal researcher planned the study, undertook data collection, captured the data for analyses, analysed the data with the assistance of a statistician (Prof DG Nel), interpreted the data and drafted the thesis. Dr Amanda Claassen and Mrs Sunita Potgieter (study leaders) provided input at all stages and revised the protocol and thesis.

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# LIST OF ABBREVIATIONS

SD: Standard deviation

WHO: World Health Organisation

FM: Fat mass

FFM: Fat-free mass

TBW: Total body water

FFDM: Fat-free dry mass

BMI-for-age: Body mass index-for-age

YRBS: Youth risk behaviour survey

EER: Estimated energy requirement

EAR: Estimated average requirement

PAL: Physical activity level

CHO: Carbohydrates

Kcal: Kilocalories

RDA: Recommended dietary intake

GI: Glycemic index

AMDR: Adequate macronutrient distribution range

EFA: Essential fatty acids

AI: Adequate intake

IOC: International Olympic committee

WADA: World anti-doping agency

UK: United Kingdom

SADHS: South African Demographic and Health Survey

HREC: Health Research Ethics Committee

ISAK: International Society for the Advancement of Kinanthropometry

BMI: Body mass index

MUAC: Mid-upper arm circumference

AMA: Arm muscle area

QFFQ: Quantitative food frequency questionnaire

DAEK: Dietary Assessment and Education Kit

% BF: Percentage body fat

AMC: Arm muscle circumference

AFA: Arm fat area

MRC: Medical Research Council

REE: Resting Energy Expenditure

TE: Total energy

DRI: Dietary Reference Intake

MUFA: Monounsaturated fatty acids

PUFA: Polyunsaturated fatty acids

SFA: Saturated fatty acids

PAL: physical activity level

FBDG: Food based dietary guidelines

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# CHAPTER 1: LITERATURE REVIEW AND STATEMENT OF THE RESEARCH QUESTION

## 1.1 Introduction

There have previously been many studies which have reported on the dietary practices and habits of high-performance adult soccer players (1, 2, 3, 4). There are however few studies which have investigated the nutritional status and dietary habits of developing soccer players and youth soccer players (<18 years of age).

During a soccer match, the players perform intermittent, high-intensity exercise (5). Further metabolic demands are placed on the players by accelerating and stopping, turning, jumping and tackling, and irregular movements (6). Thus the nutritional needs of these athletes will vary considerably depending on the level of their participation and position within the team. Mohr *et al.,* (2003), also found that within each playing position, there were significant differences in the physical demands which were dependent on physical performance as well as the playing style of players (7).

During adolescence, the body experiences a period of rapid growth and development which results in a marked increase in energy- and nutrient requirements (8). Adolescent athletes therefore require an even higher energy supply in order to maintain adequate growth and maturation as well as perform optimally in their respective sporting activities. An inadequate nutritional intake in adolescents may delay pubertal development, alter growth and muscle development and affect exercise performance (9, 10, 11). It has been shown that regular physical activity increases the demand for energy resulting in additional protein, mineral and vitamin requirements (particularly those which are important for growth such as zinc, copper, iron, and folate) (12).

To our knowledge, there are no data available on nutritional intake and status of youth participating in soccer in South Africa. This is of a great concern if one considers the huge risks associated with young, high-performance players who have poor nutritional knowledge, dietary behaviour and practices (13) coupled with how popular soccer is in the South African setting. It is thus imperative to understand the nutritional needs of these athletes to enable one to develop effective programs that will improve the athlete's dietary intakes and ultimately their growth and development, health and sporting performance.

## 1.2 The physiological and nutritional needs of children and adolescents

After birth, the human body grows most rapidly during childhood and adolescence, with the exception of infancy (14). Children may gain up to 20% of their final adult height during early puberty (14). Researchers estimate that approximately 45% of adult skeletal volume is formed during adolescence (15). This rapid rate of growth during childhood and adolescence exerts a profound effect on nutritional requirements. If children and adolescents are unable to meet their nutritional requirements, they may suffer irreversible, harmful effects on growth and development (16). Some of these harmful effects may include a depressed immune system, greater disease severity and permanent disability due to the physical and mental effects of a poor nutritional intake during the initial stages of life (17, 18, 19, 20). Mild and moderate under-nutrition before the age of two years can cause irreversible physical and cognitive damage which adversely impacts on future health. The consequences can thus continue into adolescence and adulthood (17, 18, 19, 20).

Undernutrition is manifested by underweight (weight-for-age below -2SD), wasting (weight-for-height below -2SD) and stunting (height-for-age below -2SD), as classified on the World Health Organisation (WHO) growth charts, as well as specific micronutrient deficiencies (19, 21). The most prevalent micronutrient deficiencies in South African adolescents, according to the 2003 South African Health and Demographic Survey (SADHS), include calcium, magnesium, folate, iron, niacin, Vitamin E and thiamine, where more than 50% of adolescents were shown to have an intake of below 67% of the recommended dietary intake (RDA) (153). There is unfortunately limited data regarding the macronutrient intake of South African adolescents, especially those engaged in high levels of physical activity.

## 1.3 The nutritional habits of adolescents

The (WHO) has globally recognised adolescents as a nutritionally at-risk group (31). Thus the combination of poor eating behaviour during adolescence and the increased nutritional requirements for adequate growth and development as well as an inclination for risk-taking behaviour are all threats to an adequate nutritional intake (31, 32, 33). Inadequate nutrition at this stage of the lifecycle, which is characterised by the adolescent growth spurt, can be associated with stunting (chronic undernutrition), underweight (chronic negative energy balance) or being overweight or obese (chronic positive energy balance) (31).

The food consumption patterns of learners in Cape Town were investigated by Temple *et al.* (2006) and found that 77% had breakfast before school, 70% of learners who bought food at school did not buy any healthy items, with 73% purchasing two or more unhealthy items (41)). Interestingly only 47-61% of learners knew that cola drinks, pies and samosas were unhealthy snacks. Also, the knowledge the learners had about healthy food was unrelated to whether they purchased healthy food items or not (41). Packed lunches were twice as likely in schools of higher socio-economic status (64% *vs*. 31% in lower socio-economic schools) (41). In summary, the large majority of foods eaten by adolescent students in Cape Town are considered unhealthy, irrespective of whether it was brought to school or purchased at school. The knowledge the students had regarding healthy and unhealthy options did not influence their choices.

Another study performed on adolescent learners in the Cape Town area in 2010 found that most of the learners (61%) followed a high fat diet (40). This study was in contrast to the findings from Temple *et al.,* (2006), where the learners' interest in nutrition and their reliable knowledge regarding fat intake (which was obtained in a subject at school), positively affected their fat intake (40).

International data investigating the intake of adolescents found similar findings to the South African studies. The diets of French and American adolescents where shown to lack variety with a high intake of fast foods which are typically rich in fat and low in carbohydrates (34, 35, 36). There is a high intake of sweetened beverages and energy-dense nutrient-poor foods as well as frequent meal skipping, breakfast in particular (33, 37, 38, 39). The dietary habits of South African adolescents appear to be no different (40, 41).

### 1.4 The nutritional demands for adolescent athletes

Physical activity during childhood and adolescence is widely recommended for short- and long-term physiological, sociological and psychological benefits (22). Healthy, well-nourished children require regular physical activity for normal skeletal and muscle growth as well as for the development of cardiovascular fitness, neuromuscular co-ordination and cognitive function (22).

The level of physical activity greatly influences nutritional requirements, at any age. Higher intensity and volume of physical activity, increases nutritional demands (23). Participating in and training for any type of sport adds additional stress to the already existing high nutritional demands of rapid growth, such as during childhood and adolescence (14). When young athletes are exposed to exercise and diet regimes which are too rigorous for their age, their individual capabilities or their level of maturation, the benefits of participating in sport can be reduced and the effects can even be negative (24).

Individuals may also vary in the tempo and timing of maturation (25). This explains why some children who are at the same chronological age but at a different stage of maturation have different abilities to train and compete (25). During puberty, the rapid increase in sex hormones and growth factors accelerates the development of physiological characteristics, leading to increased trainability for athletic potential (26). Consequently, the many anthropometric changes that occur during puberty directly influence the sporting performance of young athletes. It is thus plausible that a player's nutritional intake during this vital period may be an important factor in determining whether optimal sporting ability is attained (27, 28).

It has been found that many young athletes are unable to meet the nutritional requirements for normal growth and development, maturation as well as the rigors of an intense training programme (29). Largo, (1993), showed that puberty, a period of accelerated growth, may be largely influenced by poor nutrition (30).

## 1.5 Body composition of adolescents

### 1.5.1 Measurement of body composition

Body composition can be described as a 2-, 3- or 4- compartment model. The 2-compartment model divides the body into fat-free mass (FFM) and fat-mass (FM). A limitation of this model is that the FFM includes water, protein, glycogen and mineral in bone and soft tissue. The 3-compartment model consists of FM and FFM which is separated into total body water (TBW) and fat-free dry mass (FFDM). The 4-compartment model further divides FFDM into bone mineral and the residual (42). Thus FM is a constant in each model.

Skinfold measures, the thickness of a double fold of skin and compressed subcutaneous fat tissue, is the most commonly used indirect method to estimate body fat percentage (42). This method has been validated in adolescents, it is inexpensive, it is easy and quick to take the measurements and if the measurements are taken correctly it correlates well with estimates of body composition derived from body density measurements (accuracy within 2-3%) (43). The accurate measurement of skinfolds is dependent on careful site selection and using standardised techniques (43). Lohman *et al*., (1984) investigated 5 skinfold sites on athletes and found that the triceps and subscapular skinfolds measured with a Harpenden skinfold calliper showed the least amount of variation among investigators (44). Slaughter and Lohman (1988) have recommended a multi-component body composition model to evaluate the body composition of children and youth (45). The formulas which they have developed use the triceps and subscapular skinfold measures and have been validated for these specific populations. However, it must be remembered that these equations have not been validated against high-performance athletes.

According to the WHO guidelines, the recommended measures for the evaluation of growth in adolescents include height-for-age, body mass index (BMI)-for-age, triceps-for-age and subscapular-for-age (46).

### 1.5.2 Body composition status of adolescents

In a developing country such as South Africa, one is faced with the "double burden of malnutrition" where both over- and under-nutrition are common (47). In the 2003 South African Human Development Report, it was estimated that almost 50% of the population lived in poverty, with the largest numbers of the poor being the African population group (48). The relationship between poverty, undernutrition and under-development in terms of milestone development has been acknowledged and understood for many years (49, 18).

The THUSA BANA study found that in schoolchildren (10-15 years) in the Western Province, South Africa, smaller households and physical inactivity were determinants which influenced the development of overweight/obesity (50).

Results from the (SADHS) (2003), for adolescent males (15-19 years) for the Western Province, found the mean BMI to be 20.4±0.43 kg/m$^2$, with 21.6% being underweight, 73.8% of normal weight, 2.3% were overweight and 2.3% were obese. The mean weight was 56.9±1.58 kg and the mean height was 1.67±0.01 m.

The South African National Youth Risk Behaviour Survey (YRBS) in 2002, 2008 and 2012 showed that during adolescence, overnutrition was more of a concern than undernutrition (51, 52, 188). There was a national increase in the prevalence of overweight and obesity from 2002 to 2008 (21% to 25%). The increase was especially marked in the mixed ancestry population group (17% to 22%) (51, 52). Interestingly, the prevalence of overweight and obesity was higher in females nationally, in the Western Cape Province as well as the mixed ancestry population group (51, 52).

Naude *et al*., (2011) investigated the nutritional status of adolescents (ages 12 to 16 years) from schools within a 25 km radius of Tygerberg Hospital, located in the greater metropolitan area of Cape Town, South Africa. The sample consisted of English or Afrikaans speaking adolescents of low socio-economic status (53). The results of this study showed that the prevalence of stunting (8.9%) was similar to the 2008 YRBS prevalence in the Western Cape Province (9.7%). When the results from Naude *et al.,* (2011) was further compared to the 2008 YRBS, the prevalence of stunting (8.9%) and underweight (7.6%) in the Western Cape, was somewhat lower than the national prevalence (13.1% and 8.4%, respectively). In addition to this, Naude *et al.,* (2011) also found a lower prevalence of stunting and underweight in the mixed ancestry population (13.6% and 9.4%, respectively). The prevalence of overweight and obesity (22.8%) was similar to the YRBS (25.0%) with a higher prevalence in females in both surveys (52, 53). Results from the YRBS, 2008 and Naude *et al*., (2011) are consistent with the global trend where the prevalence of overweight adolescent females exceeds that of underweight adolescent females in more than half of the world's developing countries (54).

A study was done in Gran Canaria (Spain) which investigated the effects of extracurricular physical activities on fat mass accumulation and physical fitness during growth in 42 early pubertal males (9.4±1.4 years). Results showed that without any dietary intervention, children who participate regularly in sports activities (at least 3 hours per week), are more protected against total and regional fat mass accumulation than those who are more inactive. In addition, physically active children increase their total lean and bone mass and are able to maintain their fitness during growth while it deteriorates in the non-physically active children (55). The above is of particular importance if one considers the increasing obesity rates world-wide as well as in the South African setting (47).

A cross-sectional study which focused on the body composition and the nutritional profile of 44 male adolescent tennis players (aged 10 -13 years and 14-18 years) in Brazil found that 32% of the participants in the study had an inadequate energy intake, which was obtained from a non-consecutive 4-day food record (56). Body fat was shown to be appropriate in 71% of these participants and BMI was appropriate in 89% of participants. (56). The discrepancy between the number of players with an inadequate energy intake (32%) and the number of players with an inappropriate BMI (11%) was explained by under-reporting which seems to be common amongst athletes (57, 58, 59).

Rico-Sanz *et al*., (1998) considered the characteristics of male junior soccer players from various developing countries and found that the mean body weight and body fat of players aged between 14 and 18 years are between 62.5 to 72.3 kg and 7.6 to 12.1%, respectively. It has been found that there is a negative correlation between percentage body fat and sporting performance, where body mass has to be moved against gravity (60). Thus the energy demands of an athlete during exercise will be progressively reduced as his percentage body fat decreases. However, a percentage body fat which is too low may adversely affect the overall health, growth and development as well as performance of young athletes (61).

A study performed on under-14 year-old youth soccer players in Hong Kong demonstrated a physiological benefit for players based on key anthropometric analysis (183). The study showed that players with a higher BMI were able to shoot a soccer ball at a greater speed and run faster over 30 metres. This is due to a high BMI with an equivalent higher lean body mass and thus higher muscular mass. The study also indicated that taller players were able to jump higher (superior performance in vertical jump tests), perform better at high intensity intermittent bouts of exercise and had greater endurance. Interestingly, goalkeepers were found to be heavier and taller than players in other positions (defender, midfielder and forward) and had the fastest 10 metre running times (183).

## 1.6 Nutritional considerations for adolescent athletes

### 1.6.1 The role of fluid and hydration in adolescent athletes

Soccer is an intermittent-, endurance-type team sport which results in large increases in metabolic heat production, an elevation in body temperature and sweating (62). The length of a soccer match varies with each age group. The U-14 teams play for 50 minutes, the U-15 and U-16 teams play for 60 minutes, the U-17 teams play for 70 minutes and the U-18 teams play for 80 minutes. Dehydration may adversely affect performance by affecting the cardiovascular system, thermoregulation and central fatigue (perception of effort) (63, 64). A decrease in body weight from dehydration of 2% in adults (65) and 1% in children (67) have been shown to decrease endurance performance. The extent of dehydration which affects endurance performance of adolescents remains unclear but it is expected to follow a pattern similar to that of the adult (67).

Fluid balance may be affected by many factors which can include clothing, differences in body composition, physical activity, drinking palatability and the intensity and duration of exercise (73, 74). In addition to this, environmental factors such as temperature, humidity and wind speed significantly affect the sweating response (75).

Young athletes have been advised to follow fluid intake recommendations which are similar to that given to adult athletes (68). Athletes should be encouraged to drink at regular intervals during exercise (69). For intense or intermittent activity lasting more than an hour, athletes are advised to consider a carbohydrate energy drink which also contains sodium/electrolytes, during as well as after exercise (69).

The US Soccer Federation issued guidelines in 2002 to prevent young soccer players suffering from heat illness (181). Before an activity, players should be well hydrated. During an activity, they should commence drinking early on, sports drinks are better than water and for every 20 minutes they should consume between 150ml to 260ml, regardless of thirst. After an activity players should drink every 20 minutes, for one hour. Drinks which should be avoided during as well as post-exercise include alcoholic beverages, carbonated beverages and caffeinated energy drinks (181).

During a match, players have few drinking opportunities to replace fluid lost and it is not uncommon to observe body mass losses of more than 1-3% (71, 72). Thus, fluid intake rarely matches fluid lost. In 2007, Noakes postulated that meeting fluid recommendations during exercise, where fluid intake meets fluid lost, held no benefit over drinking to thirst (184). He therefore recommended that athletes could avoid dehydration by drinking to thirst, with no adverse effects on sporting performance.

A post-exercise meal or snack, which consists of a savoury component as well as a portion of fruit or vegetables, should contain an adequate amount of electrolytes to replace losses. Water intake should be encouraged along with the post-exercise meal (99).

In summary, dehydration of as little as 1-2% has been shown to negatively affect sporting performance. Players are encouraged to pre-hydrate and drink at regular intervals during exercise. For activity lasting more than an hour, players should preferably use a carbohydrate (CHO)-containing energy drink which also contains sodium or electrolytes.

### 1.6.2 The energy requirements of adolescent athletes

‘The Estimated Energy Requirement (EER), a new term, which is similar to the Estimated Average Requirement (EAR), was defined as the average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a given age, gender, weight, height and level of physical activity, consistent with good health’ (76). In addition to the above, the EER of children includes the deposition of tissues consistent with good health (76). The EER of adolescent males (14-18 years) who are considered to have an active physical level of activity (PAL) is 3152 kcal/day (76). An active PAL equates to 60 minutes of daily moderate intensity activity (76).

There have been very few studies which have specifically addressed the energy- and nutrient intakes of young soccer players. An inadequate nutritional intake can have both short- and long-term consequences such as delayed pubertal development, disturbed growth and muscle development and it can affect exercise performance (14, 67, 82, 83, 84). The energetic demands of training and competition at the elite level require that athletes, both youth and adults, ingest a well-balanced diet sufficient in energy, particularly rich in carbohydrates (CHO) as well as adequate amounts of protein and fat (85). This ensures that energy balance is achieved and maintained resulting in the maintenance of lean tissue and immune function and the promotion of optimal athletic performance (85).

The estimated mean daily energy requirement for senior male players has been estimated at approximately 4000 kcal on training days and 3800 kcal on match days (61, 86). The limited available data regarding the nutritional status of adolescent athletes has shown that the estimated mean daily energy demand for 13 to 16 year old male soccer players range between 3819 and 5185 kcal/day (87). A French study was carried out on young male athletes who underwent intensive elite sports training at a facility in France. There were 180 male subjects with ages ranging from 13 to 16 years participating in a 3-year dietary survey. The volunteers were weekly boarders and therefore ate breakfast and supper at the centre while lunch was eaten in the school canteen. On the weekends, all meals were eaten at home (87). The total energy intake of the players was found to be below the estimated energy demand level ranging from 2352±454 to 3395±396 kcal/day (87). It is unfortunate that the impact that the insufficient energy intake may have had on training and performance ability and body composition of the participants was not investigated.

Ruiz *et al*., (2005) investigated the nutritional intake of 81 young soccer players who played for a soccer club in Getxo, Spain (81). Four teams of different age categories were selected. The mean age of each team was 14.0, 15.0, 16.6 and 20.9 years. The three younger teams trained 3 times a week while the older team trained 4 times a week. Each training session lasted 90 minutes and each athlete played one match a week in addition to the training sessions. The caloric intake per kilogram body mass (BM) was found to be significantly higher among the younger players than the adult players. The intake in the 14.0, 15.0, 16.6 and 20.9 year old groups were 3456±309, 3418±182, 3478±223 and 3030±141 kcal/day, respectively. The average energy intake in all the age groups was below the recommended range of 3819 to 5185 kcal as recommended by Leblanc *et al*. (2002), (87).

From the limited data it has been found that adolescent soccer players do have higher energy requirements than their non-active counterparts, but these requirements are not always met when looking at the data obtained from the few available dietary survey studies.

It must be remembered that determining dietary intake data is quite complex and can be difficult. The studies above differed in the methods used to determine dietary intake. Each method has its own limitations, which may include under-reporting or over-reporting. A recent study in 2011, investigated the relative validity of reported energy intake derived from multiple 24-hour recalls against estimated energy expenditure, in South African adolescents (182). This study demonstrated that the 24-hour recalls offered poor validity between energy intake and estimated energy expenditure (182). In addition to this, there is limited data on the actual energy intake of South African adolescents as well as the energy requirements for high-performance adolescent athletes.

### 1.6.3 The role of carbohydrate (CHO) in adolescent athletes

The EAR for CHO in adolescent males (14 to 18 years) is 100 g/day while the recommended dietary allowance (RDA) is 130 g/day (76). The RDA value was derived from the average amount of glucose utilised by the brain (76). It is advised that these recommendations be increased according to the extended periods of exercise, as experienced by high-performance athletes (76).

Literature from adults has shown that soccer is a glycogen-depleting activity and therefore it is imperative to ensure an adequate CHO supply to support and maintain exercise capacity (88, 89).

During an adult soccer match intramuscular glycogen can be depleted by halftime which may translate into a decrease in speed and distance covered during the second half of a match (92). Rico-Sanz *et al*., (1999) investigated muscle glycogen stores in adolescent athletes and reported 35% depletion in glycogen stores after a simulated soccer match of approximately 42 minutes. A positive association was also found between the glycogen utilised and time to exhaustion (61). Thus, the quicker glycogen stores became depleted, the quicker exhaustion would occur. A subsequent study then reported that a CHO intake of 4.8 g/kg BM/day was sufficient to almost restore glycogen levels to pre-exercise values (93). The suggestion from these studies is that in young athletes, CHO plays an important role in optimizing athletic performance as well as in recovery. Petrie *et al.,* (2004) recommended that adolescent athletes consume a diet where at least 50% of total energy intake comes from CHO (67).

When muscle glycolytic enzymes in adolescents were compared to those of adults, there was very little or no difference seen (91), which may indicate that the difference in muscle enzymatic capacity between the two groups may disappear in the adolescent period (67).

Generally, CHO-containing foods are important to include in the diet of young athletes as it maintains general health (67). Complex carbohydrates are also associated with a lower risk of chronic diseases of lifestyle. Burke *et al.,* (2007) reported that the ingestion of refined CHO (e.g. sports drinks, bars and gels) to support energy intake during training and competition may be useful for young athletes as well as adults (94).

The study of Ruiz *et al*., (2005), investigated the dietary intake of 81 adolescent players at a soccer club in Spain (81). This study found that the contribution of CHO to total energy intake (44%) was below the recommended 50% of total energy intake per day to maintain muscle glycogen stores during intense training (5, 71, 95).

Studies investigating the effect of consuming CHO drinks during exercise are not as well studied in children as it is in adults. Riddell *et al*., (2000) found that adolescents can utilise as much as 1–1.5 g/kg BM/hour of CHO during heavy exercise (96). It has been found that as the duration of exercise increases, there is a greater reliance upon blood glucose, with a gradual decline in blood glucose levels (96). Riddell *et al.,* (2001a) investigated the effect of intermittent exogenous glucose ingestion on substrate utilization during prolonged exercise on adolescent boys between the ages of 13 and 17 years (97). The amount of glucose solution provided was approximately equal to the amount of CHO expended by the subjects during the exercise session. The glucose solution was found to have a sparing effect on endogenous CHO by 16% and endogenous fat by 45%. The glucose solution contributed to about 25% of the total energy demand of the exercise session and lowered the rating of perceived exertion of the subjects (97). In other words, the use of an exogenous glucose solution was associated with a reduction in exercise-induced fatigue during prolonged exercise, which could be beneficial to exercise performance. Another study by Riddell *et al.,* (2001b) showed that CHO ingestion during exercise can improve performance of boys aged 10-14 years by 40% (98). Both studies were performed on athletes while cycling in an exercise laboratory setting (98).

The American College of Sports Medicine (2009) recommended that adults ingest a 6-8% CHO drink during exercise lasting more than an hour (99). Meyer *et al*., (2007) recommended that adolescents limit the concentration of the CHO drink they ingest to 6% concentration as evidence shows it may be better tolerated than an 8% concentration drink (69). When 18 adolescents were given an 8% CHO drink during intermittent high-intensity exercise, it was associated with a higher prevalence of gastrointestinal discomfort when compared to a 6% drink (100).

Investigations regarding post-exercise CHO intake in youth athletes are limited. Studies in adults show that the amount of CHO consumed is a major factor involved in post-exercise refuelling (101). The studies in adults show that during the first few hours post-exercise, recovery can be optimised by ingesting 1–1.2 g/kg BM/hour of moderate to high CHO-rich foods (towards 5-10 g CHO/kg BM/24 hour) (101). Burke *et al.,* (1993) demonstrated that when recovery time is limited to less than 12-24 hours, food with a higher glycemic index (GI) may promote glycogen synthesis better than food with a lower GI (102). Thus, the ingestion of CHO, particularly high GI CHO, immediately post-exercise is of particular benefit when recovery time between exercise sessions is limited (4–8 hours). When the recovery time is not limited, the immediate timing or type of CHO is of less importance, as long as the total daily CHO requirement (5-10 g/kg BM/day) is met (103). Therefore, the immediate consumption of CHO in the post-exercise period appears to be most beneficial where young athletes have a limited (<24 hours) recovery period. This typically occurs during tournaments where the duration between matches are usually short. Whilst this study appears to shed light on the potential benefit of CHO in the immediate post-exercise period, its direct applicability to young athletes should be taken with caution due to the physiological differences that exists between the two groups.

### 1.6.4 The role of protein in adolescent athletes

An adequate protein intake for children and adolescents is imperative to ensure the provision of essential amino acids to support growth and development (67). The EAR of protein for male adolescents is 0.73 g/kg BM/day while the RDA is 0.85 g/kg BM/day (76).In order to maintain a positive nitrogen balance it is essential to have adequate intakes of both protein and energy. An inadequate energy intake causes protein to be used as a substrate for energy and thus cannot be used to synthesise lean tissues (104). Data regarding the protein intake of South African adolescents are limited. The 2008 YRBS did however find that 66.6% of male high school learners in the Western Cape consumed meat frequently (four or more days in the week preceding the study) of which 64.8% consumed one or more cups at a time (52). Although the national percentage of male adolescent learners consuming meat frequently (51.6%) was lower than the Western Cape, the national portion size was slightly higher (66.0%) (52). As meat alternatives were not investigated, it is difficult to comment on their total protein intake.

Limited data exist regarding the protein requirements of young athletes. One of the few studies available investigated protein turnover in non-athletic children who walked 45-60 min/day for 6 weeks (105). The exercise training resulted in a decrease in protein synthesis and breakdown to conserve protein. This could perhaps be an attempt to meet the increased requirements due to the training as the children did not adequately increase intake to meet requirements (105).

Meyer *et al*., (2007) postulated that if energy requirements are met, it is likely that protein requirements will also be met (69). Bass and Inge (2006) researched the intake of young athletes in Western countries and found that young athletes who typically restricted energy intake still managed to have adequate protein intakes (106). Tipton *et al*., (2007) recommended that adult athletes ingest 1.2-1.7 g/kg BM/day of protein (104) and Meyer *et al.,* (2007) recommended this amount to be sufficient for physically active children and adolescents as well (69).

The study of 81 adolescent male soccer players by Ruiz *et al.* (2005), found that players met their protein requirements in their respective age group of 14.0, 15.0, 16.6 and 20.9 years (2.0, 2.1, 2.0 and 1.8 g/kg BM/day) (81). In 2007, Boisseau *et al*., performed a study on 14 year old male soccer players to determine protein requirements in a nitrogen balance study. The diets provided proteins ranging from 1.4, 1.2 and 1.0 g/kg BM/day. It was found that nitrogen balance increased with both protein intake and energy balance. The EAR required to balance nitrogen losses for the athletes was 1.2 g/kg BM/day and the RDA was 1.4 g/kg BM/day. This study therefore suggests that the RDA for 14 year old male soccer players is higher than for non-active 14-year old males (0.8–1.0 g/kg BM/day) (107).

In summary, it seems that a level of 1.2-1.7 g/kg BM/day should be sufficient to meet protein needs in active adolescents.

### 1.6.5 The role of fat in adolescent athletes

Fat is necessary for good health as it provides a store of energy, it insulates, it is required for the transportation of fat-soluble vitamins and stored fat can provide energy during endurance events (87). Currently there is no EAR or RDA for fat intake. There is however an adequate macronutrient distribution range (AMDR) which is 25 to 35% for 14- to 18-year-old males (76). It has been reported that during exercise, children oxidise relatively more fat than carbohydrates compared to adults (108). Studies in children have found that during periods of prolonged exercise, there is an increase in plasma free glycerol (109) and free fatty acid concentrations (110), indicating a higher degree of fat oxidation. It has consistently been shown that lactate levels are lower in children than adults after exercise (111, 112, 113). Lactate is a by-product of carbohydrate metabolism and an inhibitor of fatty acid mobilisation and uptake (114). Evidence from Stephens, Cole & Mahon (2006) support the theory that adult-like metabolic patterns begin between mid- to late-puberty and completes by the end of puberty. Thus, by the end of puberty, adolescents have similar fat oxidation as adults (115).

Burke *et al.,* (2007) found that there is no evidence to support the theory that young athletes involved in sport may benefit from a higher fat intake in their diet, despite children relying more on fat as an energy source during exercise (94). In fact, Galassetti *et al.,* (2006) found that children who ingested a lipid-rich shake (0.8 g fat/kg BM) 45 min before cycling intermittently for 30 min, had a reduced magnitude (by 40%) of growth hormone secretion during exercise (116). Meyer *et al.,* (2007) postulated that a reduction in growth hormone secretion during exercise, in response to a high fat intake, will negatively affect muscle growth and adaptation (69). Thus a fat intake which is too high will negatively affect sporting performance.

The current recommendation for fat intake during adolescence is in accordance with adult dietary guidelines (67). Wolmarans and Oosthuizen (2001) recommended a fat intake of 30% of total energy intake (TEI) of which saturated fats should not provide more than 10% TEI/day (117, 118). Unsaturated fats should provide most of the fat-derived energy with monounsaturated fats providing >10% TEI/day and polyunsaturated fats providing no more than 10% TEI/day (117). Dietary guidelines further emphasize that trans fats (<1% TEI) and cholesterol (<300 mg/day) should also be limited (117). Healthy non-obese children and young athletes should not overly restrict energy and fat intake as it may impair growth and development (119). Fat restriction may also negatively affect nutritional status due to an insufficient intake of essential fatty acids (EFA) and fat-soluble vitamins (67).The two main EFA are linoleic and alpha-linolenic acids. The fat recommendation for adolescents (30%), according to Petrie *et al.,* (2004) is less than the upper limit of the AMDR (25 to 35% TEI/day) (67).

International studies investigating dietary intake of adolescent athletes have shown that fat intake typically more than meets requirements (80, 81, 87). Ruiz et al., (2005) reported on the dietary intake of 81 adolescent soccer players at a soccer club in Spain. The participants were divided into 4 age groups with a mean age of 14.0, 15.0, 16.6 and 20.9 years. The respective age groups had an excess amount of fat in their diet namely, 38.3%, 39.1%, 38.4% and 38.0% TEI/day, when compared to the RDA of 30% TEI/day (81). Leblanc et al., (2002) performed a study on 180 male adolescent soccer players (13–16 years) living at a training facility in France (87). They found that their participants had a fat intake above the recommendation (35% TEI/day *vs*. the recommended 30% TEI/day). Eglesias-Gutierrez *et al*., (2005) performed a study in Spain investigating the dietary intake of 33 adolescent male soccer players (14-16 years) while living in their home environment (87). This study too found that the players had too high a fat intake which contributed 38% TEI/day. These studies showed that adolescent athletes had a fat intake which exceeded their requirements (87). However, it was performed in developed countries and results could differ in a developing country, such as South Africa. In the SADHS (2003), the quality of the fat intake of sedentary adolescent males in the Western Cape was rated as low (2.2±0.1), which indicated a low fat intake but the actual intake in grams was not assessed (153).

### 1.6.6 The role of micronutrients in adolescent athletes

The functions of micronutrients are the same for athletes as they are for non-athletes (67). Readers are referred to the following references for more comprehensive literature on the functions of micronutrients and the importance for health (120, 121, 122,). The role of specific micronutrients in the production of energy, reduction of oxidative stress and the maintenance of haemoglobin, bone mass and immune function has been well documented (125, 83). There are no specific recommendations for athletes and thus it is assumed that their intake should be the same as for non-athletes (56).

In the 2003 SADHS, the quality of the micronutrient intake of adolescent males in the Western Cape was investigated and was rated as being average (26.0±1.41).(153). The findings of specific micronutrients in the 2003 SADHS are discussed below.

The 2008 YRBS investigated the frequency of consumption of fruit, uncooked and cooked vegetables amongst male adolescent learners in the Western Cape (52). The data showed that amongst the learners 61.5%, 45.2% and 49.6%, consumed fruit, uncooked and cooked vegetables, respectively, on four or more days of the week preceding the study (52). This could result in a compromised micronutrient status as fruit and vegetables are a major source of vitamins and minerals and the current recommendation is 5 fruit and vegetables a day (117).

#### 1.6.6.1 VITAMINS

Current literature on the dietary intake of young athletes has showed that most ingest an intake that meets or comes close to meeting daily requirements. Athletes have been found to meet vitamin requirements when compared to non-active adolescents (14, 126). Typically, studies have showed that athletes have an increased energy intake and thus the intake of most of the vitamins is also increased (67). There is therefore no evidence to support the theory that there are increased vitamin requirements to meet the exercise demands of young athletes (67). There are however specific vitamins which are of a concern in the South African adolescent population as discovered in the 2003 SADHS. This included folate, thiamine, Vitamin E and niacin (153). It is therefore important to assess the vitamin intake of adolescents to identify those who may be deficient in order to allow for intervention and thus improve intake.

#### 1.6.6.2 MINERALS:

Literature on adults have shown that an elevated metabolism due to exercise does not increase mineral requirements (127, 128, 129). The exception to this are the minerals lost in high amounts of sweat such as sodium, potassium, calcium and magnesium (127, 128, 129). Petrie *et al.,* (2004) reported the same to be true in children (67). They too may need to replace those electrolytes lost during sweating to ensure that a deficiency does not develop (67). Children and adolescents have been identified as having diets deficient in iron and calcium which can adversely affect health and physical performance (129). In addition to the minerals mentioned above, the 2003 SADHS found that magnesium may also be a concern for South African adolescents (153). Calcium intake was found to be inadequate as more than 60% of the study participants had an intake less than 33% of the RDA for Calcium (153). It must be remembered that this study occurred before the mandatory fortification of maize and wheat flour. It is expected that the mean intakes of folate, niacin, thiamine, vitamin B6, riboflavin, iron, vitamin A and zinc will have improved at the next SADHS.

Adult athletes are often found to have an inadequate iron intake as well as an iron deficiency (130). Adolescent females are at a particularly high risk as this is when their menstrual cycle starts (69). An inadequate intake of iron in youth can decrease physical and mental performance without resulting in anaemia (131). A chronically inadequate intake leads to low stores which have been shown to impair muscle metabolism (132) and cognitive ability (133). The RDA for adolescent males (14-18 years) of iron is 11 mg/day and the EAR is 7.7 mg/day (76). The recommendation for iron is therefore to ensure an intake which meets requirements and to include forms of iron that are readily absorbable (67). Iron deficiency cannot be diagnosed on serum ferritin levels alone as this can be affected by an increased plasma volume which is associated with a growth spurt and possibly also as an acute response to exercise (69). Deakin (2006), has provided adequate approaches to detect and clinical manage iron deficiency (130).

The recommended calcium intake is that amount which maintains calcium balance and promotes optimum bone accretion rates (69). To obtain an optimal peak bone mass, it is essential to meet calcium requirements during childhood and adolescence (67). There is no EAR or RDA for calcium intake for youth. However, an adequate intake (AI) has been recommended at 1300 mg/day for adolescent males (14-18 years) (76). An intake of calcium of less than 400 mg/day is considered very low and negatively impacts on bone development and health (134). During puberty, 26% of bone mineral is accrued (135). Many studies have demonstrated the positive impact of activity, especially high impact activity, on bone accrual (136). Goulding *et al*., (1998) found that in girls, bone fractures resulted from poor bone quality and an increased rate of bone fracture was associated with lower bone mineral density. Bone fractures have been shown to be associated with a low calcium intake (137, 138) and lower levels of activity (138). The frequency of milk intake amongst male adolescent learners in the Western Cape was investigated in the 2008 YRBS. This study found that 55.1% consumed milk on four or more days of the week (52). The SA FBDG recommended that milk and milk products be consumed daily (117). Although the intake of additional milk products was not assessed, one might expect the calcium intake to be compromised, as milk is a major source of calcium (117).

## 1.7 Dietary supplement intake in adolescent athletes

A dietary supplement is defined by Alves and Lima (2009), as "orally administered substances used with the purpose of resolving a specific nutritional deficiency" (139). Dietary supplements are often sold as ergogenic aids which can enhance athletic performance (139). In 2009, the dietary supplement industry had an estimated worth of US$ 61 billion to the US economy (140). The media has also played a huge role in stimulating the use of dietary supplements as in 2001, US$ 46 billion was spent worldwide in advertisements to promote its use (140, 141). Current evidence indicates that dietary supplementation may be beneficial in only a small group of adults, including athletes, who have an unbalanced dietary intake (140). Despite this, there seems to be an increased use amongst adolescent athletes, regardless of whether an adequate diet was ingested (141). It has been found that the prevalence of dietary supplementation usage varies to type of sports, cultural aspects, age groups (higher prevalence in adolescents), and gender (more common in males) (142, 143).

In a survey in the UK among adolescent track and field athletes, 62% were found to be using supplements, mainly vitamins and minerals, with the expectation of improved health, immune system and exercise performance (144). In a Korean study of 1355 adolescent athletes, it was found that 36% of males and females used vitamin and mineral supplements (145). In the United States of America, supplement usage among adolescent athletes is estimated to be 46% (146). A most recent study in 2012, in Germany, investigated dietary supplement use among elite adolescent athletes and found that 91% reported dietary supplement use in the previous month (189).

Although vitamin and mineral supplementation may be beneficial for adolescents consuming inadequate diets, there is no evidence to support the view that general supplementation may improve performance (69). Petrie *et al*., (2004) recommended that young athletes generally increase their energy intake (through eating a varied diet) to meet their increased requirements and thus should have an adequate intake of vitamins and minerals. Routine supplement use is therefore not needed, unless a specific deficiency is diagnosed (67).

Factors which need to be considered when deciding to use a supplement include its efficacy, safety and legality (147). Studies which have investigated the safety and performance-enhancing effects of the majority of supplements on the market are limited. This is more so in subpopulations, like young athletes (147). Safety issues regarding supplement use include the possibility of taking toxic doses and medical conditions which may conflict with sports nutrition goals and advice (147). Another safety issue is the purity of the products and the risk of ingesting contaminants which can be harmful or banned by the anti-doping codes under which the sport is organised (147). In 2000 to 2001, the International Olympic Committee (IOC) funded a project in Cologne to analyse 634 supplements randomly obtained over-the-counter and via the internet in 13 countries. This study found that 94 of the supplements (15%) contained steroids which were undeclared on the product label and banned by the World Anti-Doping Agency (WADA) (148). HFL Sports Science, a WADA experienced laboratory, in the United Kingdom (UK) analysed 58 supplements purchased over-the-counter in the USA in 2007. It found that 11% contained prohibited stimulants and 25% contained prohibited steroids (149). This was then followed up the following year, 2008, on 152 products purchased in the UK, where it was found that 10% of the selected supplements were contaminated with steroids/or stimulants (150).

Very often the information obtained when deciding to use a supplement is inaccurate. This information usually originates from classmates, coaches, magazines, internet websites or fellow gym partners (151). Furthermore, supplements are commonly sold at gyms or pharmacies as over-the-counter products without any credible nutritional assessment or advice being provided (141, 151, 152). Young athletes are thus widely exposed to supplements which are easily accessible, potentially dangerous and which may be contaminated by banned substances.

### 1.8 Statement of the Research Question

With the ever-increasing professionalism of football, the pressure placed on aspiring young football players to perform has never been greater. However, many of the players in the South African setting (and other developing countries) come from communities where a high incidence of childhood and adolescent malnutrition exists (51, 52, 153). As previously mentioned, South Africa is faced with a problem of the “double burden of malnutrition” where both over- and under-nutrition are common (47). This is supported by the findings from the 2003 SADHS as well as the YRBS studies in 2002 and 2008 (51, 52, 153). Rosenbloom *et al.,* (2006) recommend that adolescents should be educated about nutrition at an early age with the goal of improving their nutritional intake and thus their nutritional status as they get older (25). Thus adopting this approach would address both issues of under- and over-nutrition.

Limited data currently exist on nutritional intake and status of youth athletes, and youth soccer players in particular. Information regarding nutritional status as well as training and competition nutrition practices will assist clinicians and dietitians in implementing intervention strategies aimed at optimising nutritional status of these players. This will ultimately support them in realising their athletic potential as well as ensuring optimal development during this critical growth phase, which already has increased nutritional demands. The researcher decided to use a group of high-performance youth soccer players to investigate aspects of anthropometry and nutritional intake to profile their nutritional status. It is important to understand the nutritional needs of these athletes to enable the development of effective programs that will improve the athlete’s dietary intakes and thus improve their performance.

# CHAPTER 2: METHODOLGY

## 2.1. Aim

The aim of this study was to investigate the dietary intake and anthropometric profile of high-performance adolescent soccer players (14-18 years of age) during the competitive season.

## 2.2. Objectives

- To obtain anthropometric data on junior players (14-18 years of age) at a local professional soccer club in the Western Cape (South Africa).
- To obtain information regarding the dietary intake of junior players at the club (i.e. total energy, macro- and micronutrient intake).
- To determine nutrition practices of these junior players before, during and after matches.
- To determine fluid intake practices of these junior players before, during and after matches.
- To determine the use, if any, of dietary supplements amongst these junior players.
- To explore possible associations between macronutrient intake and the anthropometric data obtained.

## 2.3. Study Design

The study design was a descriptive, observational study with an analytical component.

## 2.4. Study Population

The study population included junior players with an age range of 14-18 years, who played for the Ajax Cape Town soccer club at the time of the study. All players who met the entry criteria had the opportunity to participate in the study. A convenient sampling technique was used. All athletes who attended the soccer training sessions upon the scheduled days of data collection were approached to participate in this study.

## 2.5. Inclusion Criteria

All players who fulfilled the following criteria were included in the study:

- Junior players who were playing for the Ajax Cape Town football club at the time of data collection.
- Players with an age range from 14-18 years old at the time of being interviewed.
- Junior players who were willing to answer interviewer-administered questions.
- Junior players who were willing to undergo anthropometric measurements including weight, height, skinfold and circumference measurements.
- Informed consent had to be provided by the guardian/parent of the participant.

### 2.6. Exclusion Criteria

There were no exclusion criteria.

### 2.7. Methods of Data Collection

The study was approved by the Health Research Ethics Committee (HREC), Faculty of Health Sciences, Stellenbosch University on 10 October 2009 (reference number: N09/03/089).

The Ajax Cape Town Football Club has a reputation for being progressive and always striving to maximise their players' development and potential. The head of the medical team of the club was approached with the study proposal which was then presented to the rest of the management team in order to obtain approval. Once approval was obtained from the HREC and Ajax Cape Town Football Club, the researcher presented information sessions to prospective study participants as well as provided written information regarding the study to the parents of the players. All players, as well as their parents/guardians, signed a consent form once they agreed to participate in the study. The researcher collected data at the Ajax Cape Town Football Club premises. The parents/guardians were contacted if certain facts needed to be clarified.

Data was collected as follows:

Each participant received verbal and written information about the purpose and procedures of the study (Appendix 1). Prospective participants were provided with written information for their parents/guardians (Appendix 2). The researcher, along with two other trained dietitians, collected the data. Two soccer practice sessions of each team (U15, U17 and U19) were utilised to collect data. Socio-demographic and anthropometrical data was collected in a single session while the remaining questionnaires were self-administered by the participants in the final session (Appendices 3, 4, 5). This session had at least three facilitators and the participants were split into groups of no more than six per facilitator. The facilitator of each group guided the participants through the questionnaire and assisted with answering any queries. Each group had a set of food models, measuring equipment and utensils in front of them to assist with quantifying food items in the food frequency questionnaire. The questionnaire of each participant was checked by the facilitator at the end of the session to ensure that there were no discrepancies. The anthropometrical data collected included weight (kg), height (m), mid-arm circumference (cm) and the triceps and subscapular skinfold (mm) measurements of each participant. A single measurer, who has been accredited by Stellenbosch University, collected all the skinfold measurements.

### 2.7.1. Socio-demographic information

The socio-demographic (Appendix 3) information obtained from the participants included date of birth, gender, ethnicity, age group in which they played, level of education and their address.

### 2.7.2. Anthropometric measurements

All equipment used to obtain anthropometric data was supplied by Stellenbosch University, Division Human Nutrition. Anthropometric measurements were obtained according to the International Society for the Advancement of Kinanthropometry (ISAK) (154). A single, ISAK accredited dietitian, collected all the skinfold measurements. To ensure privacy, all anthropometric measurements were conducted and recorded in a private area (Appendix 4).

Body weight was measured with a digital scale (AND Precision Health Scale UC-300, USA) to the nearest 0.1 kg. It was calibrated for accuracy by an accredited company (Lasec SA (PTY) Ltd. Ndabeni, Cape Town). The scale was placed on an even, uncarpeted area and the researcher zero calibrated the scale. The participants were weighed barefoot, wearing training shorts and t-shirts and in an orthostatic position, before training. This procedure was repeated and the average of the two readings was recorded. If the two readings varied by more than 0.1 kg, a third reading was taken and the median was recorded.

Height measurements were done barefoot and read to the nearest 0.5cm from a fixed standard stadiometer (Seca Leicester Height Measure, Deutschland) placed on an even, uncarpeted area.

Participants were positioned facing the researcher. The shoulder blades, buttocks and heels had to touch the measuring board. Their arms had to be relaxed at their sides with their legs straight and knees together. Their heels were also together with their feet flat on the ground. The participant had to look straight ahead and the head was maintained in the Frankfurt plane position. The head piece was lowered to the crown of the head and the measurement taken. An average of two measurements was used. If they differed by more than 0.5 cm, a third reading was taken and the median was used.

Once the weight and height were established, the body mass index (BMI), using Quetelets's index (kg/m$^2$), was calculated (155). The BMI-for-age was plotted on the World Health organization (WHO) reference charts (156) and the z-score and percentile readings recorded (Appendix 5). Height-for-age was plotted on the WHO reference charts (156) and the corresponding z-score and percentile readings were recorded (Appendix 6).

### 2.7.3. Skinfold thickness measurements

Skinfold thickness measurements were taken with a Dial Gauge Harpenden Calliper to the nearest 0.1mm. The skinfold thickness at the triceps and subscapular skinfold site was measured as it is the most common approach used to assess body composition for young people (157). These specific sites are advantageous because it is highly comparable to other measures assessing body fatness, measurements taken are more reliable and objective than other sites and there are international norms to interpret the measurements (158). Standardised techniques were used to measure these skinfold measurements as described by ISAK (154). Once the anatomical landmark and subsequent skinfold site was identified it was marked with a pen. Two measurements at each site were taken in a rotational order. The skin had to be dry and lotion-free as this may influence the measurements. The measurements were taken before exercise as fluid shifts post-exercise may alter the measurements (159). The average of two measurements was used but if the measurements differed by more than 0.1mm, a third reading was taken and the median was used. Assumptions made when using skinfold thickness include the fact that skinfolds predict non-subcutaneous fat and more than 50% of the body's fat is subcutaneous, the thickness of skin is considered negligible, the compressibility of fat between subjects is similar and the selected sites represent the average thickness of all subcutaneous fat (43).

Indices of fat mass and fat free mass were calculated. Mid-upper Arm circumference (MUAC) is an indicator of muscle and subcutaneous adipose tissue (160). It is used to determine arm muscle area (AMA) which is an index of muscle protein reserves and arm fat area (AFA) which is an index of fat stores. Both measurements are therefore considered a measure of nutritional status (160). The AMA and AFA, as described by Heymsfield *et al.,* (1982), were calculated (161) and the percentiles determined and interpreted as recommended by Frisancho AR, (160a, 160b, 162). MUAC is measured at the same site as the tricep skinfold with the arm relaxed at the side of the participant and the palm facing up. A non-stretchable tape measure was used and the measurement was taken to the nearest 0.1cm (43).

#### 2.7.4. Dietary intake

The eating pattern of the soccer players was assessed with a question regarding the frequency of intake of breakfast, lunch, supper as well as snacks in between. The options ranged from 0-7 times per week.

Total energy, macronutrient and micronutrient intake was assessed using a quantified food frequency questionnaire (QFFQ) (163) (Appendix 7). The Dietary Assessment and Education Kit (DAEK) food list was used to create a food list of all foods which may be part of an athlete's diet (163). The food list was adapted to suit the South African population, including ethnic diversity, and was reviewed by a panel of experts in the field of sport and nutrition, (Eksteen *et al.,* (2007), (163). Although this list was initially developed for marathon runners, it was felt that it would still be applicable to the population of this study.

Respondents reported their usual intake over the past month. The frequency of intake was categorised as 1-3 per month, 1-3 per week, 4-6 per week, 1 per day, 2 per day or 3/more per day. The QFFQ estimates food portion size using household measures, food models as well as line drawings of actual food models. A standard portion was described and the players had to indicate if 1 x standard (std), ½ std, 1 ½ std, 2 x std or 3 x std was consumed.

The limitations of this method are that it may over- or under-estimate dietary intake and may not be as accurate as the recall method. It does not allow one to identify day-to-day variations in the diet. The actual food list can actually influence the results. If a food frequency questionnaire was developed for a particular population it may not be applicable to another (43). However, after careful consideration of a few factors, the QFFQ was considered the method of choice for this study. It could be self-administered with minimum respondent burden. It could be performed in a group with an experienced interviewer to assist and further explain any concepts if required. A food diary would require a few days to complete and considering the age of the respondents it may not have been well suited. A 24-hour recall needs administration by an experienced interviewer and resources were limited in staff and time with players.

The QFFQ was validated by comparing the data obtained from the QFFQ to food items which are known to be provided by the football club. These included the milkshake, energy bar and piece of fruit provided at the end of each training session.

#### 2.7.5. Training nutrition, fluid intake and nutritional supplement intake

A questionnaire (Appendix 8), which contained an extensive list of nutritional supplements was used to investigate supplement intake amongst the soccer players. This questionnaire was developed by the University of Cape Town for a study investigating the supplement intake in marathon runners in South Africa (165). The supplement list was developed and analysed by an expert panel which included 3 registered dietitians and 3 exercise scientists. The questionnaire was pilot tested before it was finalised. It was deemed extensive and inclusive of supplements used amongst South African athletes and adolescents. Another questionnaire investigated the fluid intake and nutrition practices of the soccer players before, during and after training and matches (166) (Appendix 8). This questionnaire was developed for a study investigating nutrition practices of South African marathon runners. This questionnaire was also developed and analysed by an expert panel and pilot tested before it was finalised.

### 2.8. Data Analysis

#### 2.8.1. Socio-demographic Information

This data included date of birth, age, ethnicity, team played in and level of education. The mean age and age-range was determined. For the remaining data, percentages for each category were calculated.

#### 2.8.2. Anthropometric and Skinfold Thickness Measurements

Weight, height and age were captured in WHO Anthro (version 3.0.3), where the weight-for-age, height-for-age and BMI-for-age percentiles and z-scores were calculated. The cut-off values for the various anthropometric indices were as follows.

**Table 2.8.1: The cut-off values for various anthropometric indices**

| Anthropometric index | Percentile cut-off value | Nutritional status indicator |
|---|---|---|
| BMI-for-age | ≥95$^{th}$ percentile | Overweight |
| BMI-for-age | ≥85$^{th}$ and <95$^{th}$ percentile | At risk for overweight |
| BMI-for-age | <5$^{th}$ percentile | Underweight |
| Length-for-age | <5$^{th}$ percentile | Short stature |

Skinfold measurements included triceps and subscapular skinfolds. The percentiles for both were determined using the NHANES, 2003-2006, data (Appendices 9 and 10). The sum of the triceps and subscapular skinfolds was also calculated and its percentile was determined using the tables from Frisancho, AR, 1990 (Appendix 11).
The percentage body fat (%BF) was determined by the following equations which have been validated for pubescent white males:

%BF= 1.21(TC+SS) - .008(TC+SS)2 - 3.4

and pubescent black males:

%BF= 1.21(TC+SS) - .008(TC+SS)2 - 5.2   (where SS = subscapular skinfold) (45)
(where TC = tricep skinfold)

As there were only 3 Caucasian players and there are no equations specific to the mixed ancestry population, it was decided to use 1 equation for all the players (pubescent black males).

### 2.8.3. Determining AMA, AMC, AFA from Skinfold Prediction Equations

The following equations were used to determine arm muscle circumference (AMC), arm muscle area (AMA) and arm fat area (AFA).

$AMC\ (mm) = MUAC - [\pi \times TSF/10]$

$AMA\ (mm^2) = (AMC)^2 / (\pi \times 4)$

$AFA\ (mm^2) = MUAC^2/(\pi \times 4) - AMA$

The percentiles for arm muscle area and arm fat area were determined using the tables from Frisancho, AR, 1981 (Appendices 12 and 13).

### 2.8.4. Dietary Intake

Each item of food on the QFFQ was converted to consumed item in g/day. This information was then captured and analysed in Medical Research Council (MRC) Foodfinder III for Windows® (www.wamsys.co.za) to determine macronutrients and micronutrients consumed. The usual intake of the players was thus determined from the QFFQ. The nutritional requirements of each participant had to be calculated in order to compare their usual intake to their recommended daily requirements. The Schofield equation (167) was used to calculate the resting energy expenditure (REE) of each player. As suggested by Carlsohn *et al*. (2011), a physical activity level (PAL) of 1.75 to 2.05 was used to calculate total energy requirements (TER) (167). This equation considers that players with varying levels of activity will have a difference in their total energy expenditure (TEE) and therefore their (TER). The adequacy of the players' micronutrient intake was assessed by comparing it to the Dietary Reference

Intake (DRI). Players were regarded as having an inadequate micronutrient intake if their intake was 67% below the DRI.
Energy requirement equation: TEE = REE x 1.75 – 2.05

### 2.8.5. Dietary Supplement Intake

Players were provided with an extensive list consisting of 27 dietary supplements. The frequency of the use of supplements was assessed as players indicated whether or not a particular supplement was used and how many days per week or month it was used.

### 2.8.6. Training nutrition and fluid intake

The frequency of meals was assessed as well as the number of players who consumed a specific meal at particular times. The mean fluid intake for matches as well as training sessions was calculated. Assessment further involved the main reasons players chose particular liquids at specific times as well as their subjective rating of their concern regarding their fluid intake at specific times.

### 2.8.7. Statistical Analysis

The data obtained from the questionnaires were captured in MS Excel (version 2007) and then analysed with STATISTICA version 9 [StatSoft Inc. (2009) STATISTICA (data analysis software system), www.statsoft.com].

Summary statistics were used to describe the variables. Data was presented as means ± standard deviation (SD), unless otherwise indicated. The distributions of variables are presented with histograms and or frequency tables. Medians or means were used as the measures of central location for ordinal and continuous responses. The relationships between continuous response variables and nominal input variables were analysed using ANOVA. Correlations among continuous and/or ordinal variables were expressed using Spearman's or Pearson's correlation coefficients. Relations between nominal variables were investigated with contingency tables and likelihood ratio chi-square tests. A p-value of $p<0.05$ represents statistical significance in hypothesis testing and 95% confidence intervals were used to describe the estimation of unknown parameters.

# CHAPTER 3: RESULTS

## 3.1. Socio-Demographic data

The total sample included *N*=39 high-performance adolescent soccer players currently playing for the Ajax Cape Town Football Club. Their socio-demographic profile is summarised in Table 3.1.1. The mean age is 16.26±1.27 years. The majority of the players are of mixed ancestry ethnicity (66.6%, *N*=26) and currently in high school (89.7%, *N*=35). Only one player admitted to smoking and has 4 cigarettes per day.

**Table 3.1.1: Socio-demographic status**

| Demographic category | *N (of 39 total)* | Percentage (%) |
|---|---|---|
| **Age** | | |
| 14 | 4 | 10.3 % |
| 15 | 8 | 20.5 % |
| 16 | 8 | 20.5 % |
| 17 | 12 | 30.8 % |
| 18 | 7 | 18.0 % |
| **Ethnicity** | | |
| Black (African) | 10 | 25.6 % |
| Caucasian | 3 | 7.7 % |
| Mixed ancestry | 26 | 66.6 % |
| **Education** | | |
| Secondary[1] | 35 | 89.7 % |
| Tertiary[2] | 4 | 10.3 % |
| **Smoking** | | |
| Yes | 1 (4cigarettes/day) | 2.6 % |
| No | 38 | 97.4 % |

[1] High-school, Grade 8-12

[2] College/Technicon

The soccer-playing history and record of additional physical activity sessions of the study population is depicted in Table 3.1.2. Each player in all the teams has 4 training days per week and each training session lasts 2 hours. Some players participate in as many as three additional physical activity sessions every week. There are 56.4% of players who participate in one additional activity, 23.1% participated in two additional activities and 12.8% participated in three additional activities per week.

**Table: 3.1.2: Playing history and training load**

| | *N (of 39 total)* | Mean±SD |
|---|---|---|
| **Years of playing soccer** [a] | 39 | 10.4±2.5 |
| **Soccer training sessions** | | |
| Days per week | 39 | 4 |
| Hours per session | | 2 |
| Hours per week | | 8 |
| **Soccer Matches** | | |
| Minutes played per match | 39 | 63.0±20.9 |
| **1 additional activity**[b] | | |

| | | |
|---|---|---|
| Hours per week | 13 | 2.0±1.7 |
| **2 or more Additional activities[b]**<br><br>Hours per week | <br><br>9 | <br><br>6.9±3.1 |

[a]Total years of playing soccer, not only years playing for a club

[b]Additional activities were regarded as any physical activities which players participated in besides the specified soccer training and matches at the club

### 3.2. Anthropometric and skinfold thickness data

The weight and skinfold thickness classifications of the high-performance adolescent soccer players are depicted in Tables 3.2.1 and 3.2.2 respectively. The mean weight is 64.4±7.2 kg. Height-for-age z-score (stunting index), is all between -1.99 and 1.99 and therefore all within the normal range. The mean height is 172.0±5.4 cm. Based on their BMI-for-age, most of the players (87.2%, *N*=34) are classified as normal weight, and none of the players are classified as underweight. The mean BMI is 21.7±2.0 kg/$m^2$. The mean BMI-for-age falls on the $65^{th}$ percentile.

**Table 3.2.1: Weight classification according to WHO BMI percentiles**

| | **Overweight**<br><br>$>95^{th}$ percentile | **Risk for overweight**<br>$85^{th}$ – $95^{th}$ percentile | **Normal weight**<br><br>$5^{th}$ to $85^{th}$ percentile | **Underweight**<br><br>< $5^{th}$ percentile |
|---|---|---|---|---|
| **%** | 2.56 % (*N*=1) | 10.26 % (*N*=4) | 87.18 % (*N*=34) | 0 % |

Most of the players fall into the above-average classification for all of the skinfold measurements. This includes triceps (56.4%, *N*=22), subscapular (59.0%, *N*=23), sum of two skinfolds (71.8%, *N*=28), AMA (82.1%, *N*=32), AMC (56.4%, *N*=22) and AFA (56.4%, *N* =22). The mean percentage body fat is 10.9±3.5%, within the recommended range of 7.6-12.1%.

**Table 3.2.2: Skinfold classification according to percentiles (NHANES 2003-2006 and Frisancho, AR 1990)**

| **Percentile categories** | **Classification (sedentary adolescents)** | **%** |
|---|---|---|
| **Triceps** | | |
| $\leq 5^{th}$ | Lean | 0% |
| $>5^{th}$ but $\leq 15^{th}$ | Below average | 5.1 % (*N*=2) |
| $>15^{th}$ but $\leq 85^{th}$ | Average | 38.5 % (*N*=15) |
| $>85^{th}$ but $\leq 95^{th}$ | Above average | 56.4 % (*N*=22) |
| $>95^{th}$ | Excess fat | 0 % |

| | | |
|---|---|---|
| **Subscapular** | | |
| ≤$5^{th}$ | Lean | 0 % |
| >$5^{th}$ but ≤$15^{th}$ | Below average | 10.3 % (*N*=4) |
| >$15^{th}$ but ≤$85^{th}$ | Average | 30.8 % (*N*=12) |
| >$85^{th}$ but ≤$95^{th}$ | Above average | 59.0 % (*N*=23) |
| >$95^{th}$ | Excess fat | 0 % |
| **Sum of skinfolds** | | |
| ≤$5^{th}$ | Lean | 0 % |
| >$5^{th}$ but ≤$15^{th}$ | Below average | 5.1 % (*N*=2) |
| >$15^{th}$ but ≤$75^{th}$ | Average | 18.0 % (*N*=7) |
| >$75^{th}$ but ≤$85^{th}$ | Above average | 71.8 % (*N*=28) |
| >$85^{th}$ | Excess fat | 5.1 % (*N*=2) |
| **Arm muscle area** | | |
| ≤$5^{th}$ | Wasted | 0 % |
| >$5^{th}$ but ≤$15^{th}$ | Below average | 2.6 % (*N*=1) |
| >$15^{th}$ but ≤$85^{th}$ | Average | 7.7% (*N*=3) |
| >$85^{th}$ but ≤$95^{th}$ | Above average | 82.1 % (*N*=32) |
| >$95^{th}$ | High muscle | 7.7% (*N*=3) |
| **Arm muscle circumference** | | |
| ≤$5^{th}$ | Wasted | 0 % |
| >$5^{th}$ but ≤$25^{th}$ | Below average | 2.6 % (*N*=1) |
| >$25^{th}$ but ≤$75^{th}$ | Average | 28.2% (*N*=11) |
| >$75^{th}$ but ≤$95^{th}$ | Above average | 56.4 % (*N*=22) |
| >$95^{th}$ | High muscle | 12.8% (*N*=5) |
| **Arm fat area** | | |
| ≤$5^{th}$ | Lean | 0 % |
| >$5^{th}$ but ≤$25^{th}$ | Below average | 5.1 % (*N*=2) |
| >$25^{th}$ but ≤$75^{th}$ | Average | 33.3% (*N*=13) |
| >$75^{th}$ but ≤$95^{th}$ | Above average | 56.4 % (*N*=22) |
| >$95^{th}$ | Excess fat | 5.1% (*N*=2) |

### 3.3. Energy expenditure, dietary energy and macronutrient intake data

The total energy expenditure (TEE) for this group (as calculated from resting energy expenditure and a PAL range of 1.75 – 2.05) is 3146.9±213.4 to 3686.4±250.0 kcal/day.

The energy- and macronutrient intake of high-performance adolescent soccer players is depicted in Table 3.3.1. The mean energy intake is 4374.0±1462.4 kcal and exceeds the maximum TEE by 118.7%. The macronutrient intake also exceeds recommendations for athletes. The mean protein intake is 155.6±53.3 g/day (14.2% TEI, 2.4 g/kg BM/day), the mean carbohydrate intake is 556.8±172.1 g/day (50.9% TEI, 8.6 g/kg BM/day) and the mean fat intake is 148.8±67.8 g/day (30.6% of TEI, 2.3 g/kg BM/day). The percentages of SFA (9.9% of TEI) and PUFA (7.2% of TEI) are in line with recommendations, whilst the percentage MUFA is slightly below recommendations (9.6% of TEI). The mean intake of cholesterol is 545.5±230.1 mg/day which is above the recommended level. There are 4 players who admitted to drinking alcohol once a week with amounts ranging from 6.1-48.9

g/week. The mean intake of fibre is 44.0±14.6 g/day, therefore exceeding recommendations by 115.8%.

### 3.3.1 Consumption of meat and meat products

In table 3.3.2 the frequency of consumption of specific food items is investigated. The majority of players eat meat 1 to 3 times per week, of which 48.7% (*N*=19) eat low-fat red meat, 51.3% (*N*=20) high-fat red meat, 33.3% (*N*=13) hamburgers and 51.3% (*N*=20) sausage. Meat stew was not very common with two thirds never eating it (66.7%, *N*=26).

### 3.3.2 Consumption of milk

Almost half of the players (43.6%, *N*=17), drink full cream milk more than 4 times per week. Although most players (76.9%, *N*=30) do not report the regular consumption of low fat milk, Ajax CT does provide a low-fat flavoured milk drink to all players at each training session, which was reported separately.

### 3.3.3 Consumption of fruit and vegetables

Fruit which are not consumed by the majority of the players includes peaches/apricots (51.3%, *N*=20), Melons (61.5%, *N*-24), Guavas (51.3%, *N*=20), Mangos/paw paw (51.3%, *N*=20), grapes (51.3%, *N*=20) and strawberries (51.3%, *N*=20).

The most regularly consumed vegetable is mixed vegetables where 33.3% (*N*=13) of players consume it 1-3 times per week.

### 3.3.4 Consumption of sweets and added sugar

More than half of the players consume energy bars 4 or more times a week (51.3%, *N*=20) and added sugar 4 or more times a week (53.8%, *N*=21).

### 3.3.5 Consumption of beverages

Coke®/Pepsi® were the most regularly consumed carbonated drinks with 51.3% (*N*=20) consuming it at least 1-3 times per week. Sport drinks were also regularly consumed (1-3 times per week) by 48.7% (*N*=19) of players. Orange juice and other juice were both consumed by more than a third (35.9%, *N*=14) of players 1-3 times per week.

**Table 3.3.1: Energy and macronutrient intake of high-performance adolescent soccer players**

| | Mean intake ±SD From QFFQ | Recommendation | % intake of recommendation | % players below recommendation |
|---|---|---|---|---|
| **Energy (kcal/day)** | 4374.0±1462.4 | REE x 1.75 [a] – 2.05 [b] 3146.9±213.4 - 3686.4±250.0 | 118.7%[†] | 23.1 % (*N*=9) |

| | | | | |
|---|---|---|---|---|
| **Carbohydrate (g/day)** | 556.8±172.1<br>50.9 % TEI<br>8.6 g/kg BM/day | 393.4-460.8 g/day<br>≥ 50% TEE[c] | 120.8 %[f] | 25.6 % (*N*=10) |
| **Protein (g/day)** | 155.6±53.3<br>14.2 %TEE<br>2.4 g/kg BM/day | 109.5 g/day<br>1.7 g/kg BM/day[d] | 142.1 % | 17.9 % (*N*=7) |
| **Fat (g/day)**<br>Total | 148.8±67.8<br>30.6 %TEI<br>2.3 g/kg BM/day | 104.9-122.8<br>≤30% TEE[e] | 121.2 %[f]<br>- | 30.8 % (*N*=12) |
| Saturated fat (%) | 9.9 %TEI | <10% TEE | - | - |
| MUFA (%) | 9.6 %TEI | >10% TEE | - | - |
| PUFA (%) | 7.2 %TEI | <10% TEE | - | - |
| Cholesterol (mg) | 545.5±230.1 | <300mg | 181.9 % | - |
| **Fibre (g/day)** | 44.0±14.6 | 38g/day | 115.8 % | % (*N*=) |

[a] the minimum PAL for adolescent athletes, Carlsohn *et al.,* (2011) (167)
[b] the maximum PAL for adolescent athletes, Carlsohn *et al.,* (2011) (167)
[c, d, e] recommendations for adolescent athletes, Petrie *et al.,* (2004) (67)
[f] the maximum TEE was used as the recommended intake to determine percentage intake of recommendation

## Table 3.3.2 : The frequency of intake of specific meat, milk, fruit and vegetable food items

| Food Group | Never | 1-3 per month | 1-3 per week | ≥ 4 per week |
|---|---|---|---|---|
| **Meat** | | | | |
| Red meat : low fat | 23.1 % (*N*=9) | 20.5 % (*N*=8) | 48.7 % (*N*=19) | 7.7 % (*N*=3) |
| Red meat : high fat | 28.2 % (*N*=11) | 12.8 % (*N*=5) | 51.3 % (*N*=20) | 7.7 % (*N*=3) |
| Hamburger | 28.2 % (*N*=11) | 35.9 % (*N*=14) | 33.3 % (*N*=13) | 2.6 % (*N*=1) |
| Sausage | 7.7 % (*N*=3) | 20.5 % (*N*=8) | 51.3 % (*N*=20) | 20.5 % (*N*=8) |
| Meat stew | 66.7 % (*N*=26) | 12.8 % (*N*=5) | 17.9 % (*N*=7) | 2.6 % (*N*=1) |
| **Milk** | | | | |
| Full cream | 28.2 % (*N*=11) | 7.7 % (*N*=3) | 20.5 % (*N*=8) | 43.6 % (*N*=17) |
| Low fat | 76.9 % (*N*=30) | 2.6 % (*N*=1) | 7.7 % (*N*=3) | 12.8 % (*N*=5) |
| **Fruit** | | | | |
| Citrus | 7.7 % (*N*=3) | 10.3 % (*N*=4) | 30.8 % (*N*=12) | 51.3 % (*N*=20) |
| Apples/pears | 15.4 % (*N*=6) | 12.8 % (*N*=5) | 35.9 % (*N*=14) | 35.9 % (*N*=14) |
| Bananas | 12.8 % (*N*=5) | 5.1 % (*N*=2) | 38.5 % (*N*=15) | 43.6 % (*N*=17) |
| Peach/apricot | 51.3 % (*N*=20) | 30.8 % (*N*=12) | 17.9 % (*N*=7) | 0 % |
| Melon | 51.3 % (*N*=20) | 41.0 % (*N*=16) | 7.7 % (*N*=3) | 0 % |
| Guavas | 61.5 % (*N*-24) | 35.9 % (*N*=14) | 2.6 % (*N*=1) | 0 % |
| Mango/paw paw | 51.3 % (*N*=20) | 38.5 % (*N*=15) | 7.7 % (*N*=3) | 2.6 % (*N*=1) |
| Grapes | 51.3 % (*N*=20) | 30.8 % (*N*=12) | 10.3 % (*N*=4) | 7.7 % (*N*=3) |
| Strawberries | 51.3 % (*N*=20) | 30.8 % (*N*=12) | 15.4 % (*N*=6) | 2.6 % (*N*=1) |
| **Cooked Vegetables** | | | | |
| Cabbage | 51.3 % (*N*=20) | 33.3 % (*N*=13) | 12.8 % (*N*=5) | 2.6 % (*N*=1) |
| Broccoli | 53.8 % (*N*=21) | 33.3 % (*N*=13) | 10.3 % (*N*=4) | 2.6 % (*N*=1) |
| Spinach | 69.2 % (*N*=27) | 23.1 % (*N*=9) | 7.7 % (*N*=3) | 0 % |
| Green peas | 59.0 % (*N*=23) | 25.6 % (*N*=10) | 12.8 % (*N*=5) | 2.6 % (*N*=1) |
| Green beans | 74.4 % (*N*=29) | 20.5 % (*N*=8) | 5.1 % (*N*=2) | 0 % |
| Mixed vegetables | 23.1 % (*N*=9) | 23.1 % (*N*=9) | 33.3 % (*N*=13) | 20.5 % (*N*=8) |
| Pumpkin | 53.8 % (*N*=21) | 25.6 % (*N*=10) | 17.9 % (*N*=7) | 2.6 % (*N*=1) |
| Squash | 76.9 % (*N*=30) | 15.4 % (*N*=6) | 7.7 % (*N*=3) | 0 % |

## Table 3.3.3 : The frequency of intake of sweets, added sugar and beverages

| Food item | Never | 1-3 per month | 1-3 per week | 4-6 per week | ≥ 1 per day |
|---|---|---|---|---|---|
| **Sweets and added sugar** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Boiled Sweets | 41.0 % (*N*=16) | 15.4 % (*N*=6) | 23.1 % (*N*=9) | 2.6 % (*N*=1) | 17.9 % (*N*=7) |
| Energy sweets | 38.5 % (*N*=15) | 25.6 % (*N*=10) | 17.9 % (*N*=7) | 7.7 % (*N*=3) | 10.3 % (*N*=4) |
| Chocolate | 20.5 % (*N*=8) | 10.3 % (*N*=4) | 38.5 % (*N*=15) | 12.8 % (*N*=5) | 17.9 % (*N*=7) |
| Energy bar | 17.9 % (*N*=7) | 10.3 % (*N*=4) | 20.5 % (*N*=8) | **30.8 % (*N=12*)** | **20.5 % (*N*=8)** |
| Added sugar (tea/coffee) | 15.4 % (*N*=6) | 7.7 % (*N*=3) | 23.1 % (*N*=9) | **7.7 % (*N*=3)** | **46.2 % (N=18)** |
| **Beverages** | | | | | |
| Carbonated (Coke®/Pepsi®) | 20.5 % (*N*=8) | 7.7 % (*N*=3) | **51.3 % (*N*=20)** | 7.7 % (*N*=3) | 12.8 % (*N*=5) |
| Carbonated (other) | 64.1 % (*N*=25) | 20.5 % (*N*=8) | 10.3 % (*N*=4) | 5.1 % (*N*=2) | 0 % |
| Sports drink | 15.4 % (*N*=6) | 15.4 % (*N*=6) | **48.7 % (*N*=19)** | 7.7 % (*N*=3) | 12.8 % (*N*=5) |
| Orange juice | 28.2 % (*N*=11) | 12.8 % (*N*=5) | **35.9 % (*N*=14)** | 10.3 % (*N*=4) | 12.8 % (*N*=5) |
| Other juice | 23.1 % (*N*=9) | 25.6 % (*N*=10) | **35.9 % (*N*=14)** | 10.3 % (*N*=4) | 5.1 % (*N*=2) |
| Cordial | 43.6 % (*N*=17) | 17.9 % (*N*=7) | 30.8 % (*N*=12) | 5.1 % (*N*=2) | 2.6 % (*N*=1) |

### 3.4. Dietary micronutrient data

The vitamin and mineral intake of high-performance adolescent soccer players is presented in Table 3.4.1. The mean vitamin and mineral intake for the group as a whole meets the EAR/AI for all vitamins and minerals. There are however a few individual players who have intakes less than 67% of the EAR/AI for the following vitamins and minerals: vitamins A (307.4±70.3 µg, 10.3%, *N*=4), D (2.4±0.7 µg, 15.4%, *N*=6), E (2.8±1.7 mg, 5.1%, *N*=2) and K (25.3±15.3 µg, 20.5%, N=*8)*, calcium (719.7±135.8 mg, 7.7%, *N*=3), chromium (16.6 µg, 2.6%, *N*=1), and iodine (46.4±14.3 µg, 30.8%, *N*=12). The calcium:protein ratio is 4.6:1 which is significantly below the recommended ratio (20:1). The mean intake of sodium is 4041.5±1226.7 mg/day which is nearly double the recommended 2300mg. The dietary intake data did not consider dietary supplement intake, except for energy bars and CHO energy drinks, as it was part of the QFFQ. The usage of other sporting supplements was very low in this cohort and thus not included in the dietary intake analysis.

**Table : 3.4.1: The vitamin and mineral intake of high-performance adolescent soccer players**

| Micronutrient | Mean ± SD | DRI[a] | % of DRI | % players < 67% EAR/AI |
|---|---|---|---|---|
| **Water soluble vitamins** | | | | |
| Thiamine (mg) | 2.7±0.7 | 1.0mg | 270.0 % | 0 % |
| Riboflavin (mg) | 4.5 ±2.2 | 1.1mg | 409.1 % | 0 % |
| Niacin (mg) | 41.6±13.8 | 12.0mg | 346.7 % | 0 % |
| Vitamin B6 (mg) | 3.2±1.1 | 1.1mg | 291.0 % | 0 % |
| Folic acid (µg) | 577.2±185.6 | 330.0µg | 174.9 % | 0 % |

| | | | | |
|---|---|---|---|---|
| Vitamin B12 (µg) | 11.3±7.8 | 2.0µg | 565.0 % | 0 % |
| Pantothenic acid (mg) | 12.8±4.8 | 5.0mg | 256.0 % | 0 % |
| Vitamin C (mg) | 278.4±181.7 | 63.0mg | 441.9 % | 0 % |
| **Fat soluble vitamins** | | | | |
| Vitamin A (µg) | 1947.4±1344.5 | 630.0µg | 309.1 % | 10.3 % (*N*=4) |
| Vitamin D (µg) | 8.6±4.5 | 5.0µg | 172.0 % | 15.4 % (*N*=6) |
| Vitamin E (mg) | 24.5±12.6 | 12.0mg | 204.2 % | 5.1 % (*N*=2) |
| Vitamin K (µg) | 95.2±71.1 | 75.0µg | 126.9 % | 20.5 % (*N*=8) |
| **Minerals** | | | | |
| Calcium (mg) | 1604.5±604.3 | 1300.0mg | 123.4 % | 7.7 % (*N*=3) |
| Phosphorous (mg) | 2480.8±795.2 | 1055.0mg | 235.1 % | 0 % |
| Magnesium (mg) | 571.4±189.0 | 340.0mg | 168.1 % | 0 % |
| Iron (mg) | 22.1±6.5 | 7.7mg | 287.0 % | 0 % |
| Zinc (mg) | 19.7±6.5 | 8.5mg | 231.8 % | 0 % |
| Iodine (µg) | 81.7±30.8 | 95.0µg | 86.0 % | 30.8 % (*N*=12) |
| Chromium (µg) | 128.7±59.3 | 35.0µg | 367.7 | 2.6 % (*N*=1) |

[a]DRI, 2006 (76)

### 3.5. Training nutrition data

The frequency of consumption of specified meals or snacks by high-performance adolescent soccer players is depicted in Figure 3.5.1. The majority (61.5%, *N*=24) eat breakfast everyday while 5.1% (*N*=2) never eat breakfast. Similarly, 66.7% (*N*=26) of the players always have lunch while 10.3% (*N*=4) never have a midday meal. Supper is definitely the most regularly eaten meal by players with 97.4% (*N*=38) eating supper daily. Daily snacking is not common with only 15.4% (*N*=6) having a mid-morning snack, 35.9% (*N*=14) having a mid-afternoon snack and 18.0% (*N*=7) having an after-dinner snack. Mid-afternoon snacking on at least 4 or more days of the week is reported by 69.2% (*N*=27) of players. The number of players having a morning as well as a mid-afternoon snack is 15.4% (*N=6),* a mid-morning and an evening snack is 12.8% (*N=5)* and a morning and an evening snack is 10.3% (*N=4).* The club provides a snack after training (4 days of the week) which includes a flavoured milk drink, citrus fruit and an energy bar. The intake of these snacks are reflected in the QFFQ as follows, 100% (*N*=39) consume the milk drink, 85.0% (*N*=33) the energy bar and 97.4% (N=38) the citrus fruit.

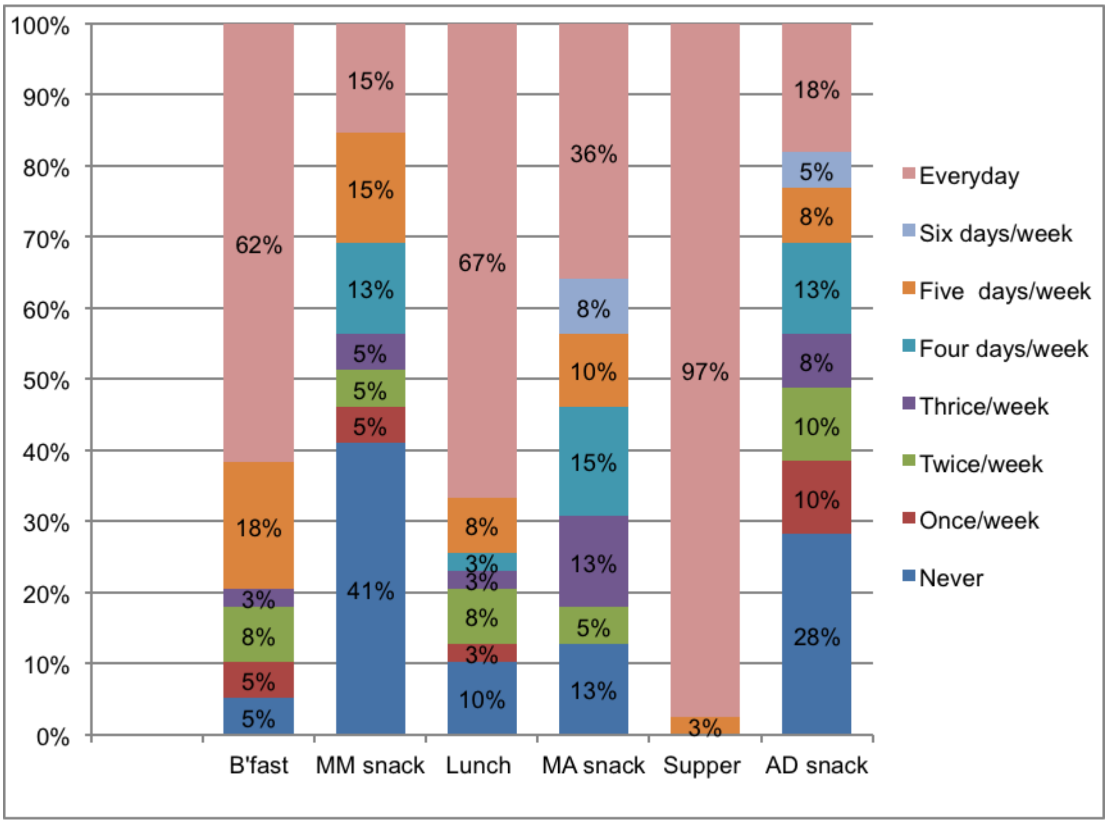


**Figure 3.5.1: Meal pattern of high-performance adolescent soccer players**

Figure 3.5.2 presents the data regarding how players subjectively rate their concern regarding their food intake pre-, during and post-exercise. There seems to be an equal number of players who always have concerns (25.6%, *N*=10) *vs.* those who never have concerns (30.8%, *N*=12) 24 hours prior to a match.

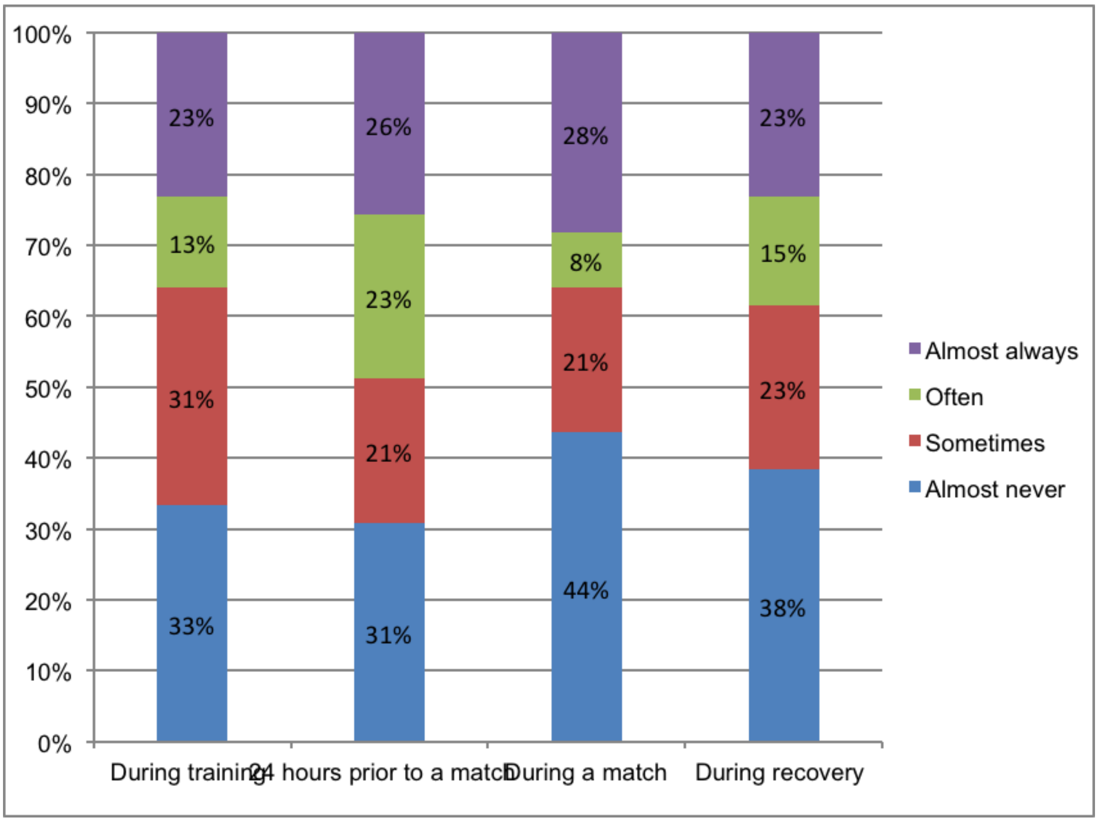


**Figure 3.5.2: Subjective rating by high-performance adolescent soccer players of their concern regarding their food intake before, during and after exercise**

Table 3.5.3 depicts the preference for taking a specific meal or drink before, during or after exercise. The data shows that the majority of players do not have or only occasionally have a specific meal or drink 24 hours prior to a match, during a match and during recovery. However, most players (51.3%, *N*=20) will have a specific meal or drink during training.

**Table 3.5.3: Dietary intake before, during and after exercise**

| | Almost never (%) | Sometimes (%) | Often (%) | Almost always (%) |
|---|---|---|---|---|
| **During training** | 10.3 % (*N*=4) | 28.2 % (*N*=11) | 10.3 % (*N*=4) | **51.3 % (*N*=20**) |
| **24 hours prior to a match** | 46.2 % (*N*=18) | 20.5 % (*N*=8) | 5.1 % (*N*=2) | 28.2 % (*N*=11) |
| **During a match** | 65.8 % (*N*=25/38 [a]) | 23.7 % (*N*=9/38 [a]) | 5.3 % (*N*=2/38 [a]) | 5.3 % (*N*=2/38 [a]) |
| **During recovery** | 33.3 % (*N*=13) | 25.6 % (*N*=10) | 5.1 % (*N*=2) | 35.9 % (*N*=14) |

[a] there was 1 non-responders in this question, therefore *N*=38

Table 3.5.4 presents the main reasons that study participants provided for selecting a specific meal or drink before, during or after exercise. It is interesting to note that at least half of the participants (56.4%, *N*=22) have a specific meal or drink during training as it is provided by the Ajax Football Club.

**Table 3.5.4: The main reasons for selecting a specific meal or food item before, during and after exercise**

| | To provide energy (%) | To carbo-load (%) | To provide protein (%) | Provided by Ajax (%) |
|---|---|---|---|---|
| **During training** | 35.9 % (*N*=14/39) | 7.7 % (*N*=3/39) | 0.0 % (*N*=0/39) | **56.4 % (*N*=22/39)** |
| **24 hours prior to a match** | 35.7 % (*N*=10/28 [a]) | 35.7 % (*N*=10/28 [a]) | 14.3 % (*N*=4/28 [a]) | 14.3 % (*N*=4/28 [a]) |
| **During a match** | 62.5 % (*N*=10/16 [b]) | 0.0 % (*N*=0/16 [b]) | 6.3 % (*N*=1/16 [b]) | 31.3 % (*N*=5/16 [b]) |
| **During recovery** | 40.6 % (*N*=13/32 [c]) | 6.3 % (*N*=2/32 [c]) | 15.6 % (*N*=5/32 [c]) | 37.5 % (*N*=12/32 [c]) |

[a] there were 11 non-responders in this question, therefore *N*=28
[b] there were 23 non-responders in this question, therefore *N*=16
[c] there were 7 non-responders in this question, therefore *N*=32

### 3.6. Fluid intake data

The mean fluid intake during a 60-80-minute match is 479.1±163.1 ml and during a 2-hour training session is 597.7±281.0 ml. The subjectively rated concern regarding fluid intake pre-, during and post-exercise is presented in Table 3.6.1. The majority of players only consider their fluid intake during a match (51.3%, *N*=20). This is interesting to note as their fluid intake (ml/minute) during a match and a training session is similar.

**Table 3.6.1: Subjective rating by high-performance adolescent soccer players regarding their concern of fluid intake before, during and after exercise**

| | Almost never (%) | Sometimes (%) | Often (%) | Always (%) |
|---|---|---|---|---|
| **During training** | 28.2 % (*N*=11) | 33.3 % (*N*=13) | 12.8 % (*N*=5) | 25.6 % (*N*=10) |
| **24 hours prior to a match** | 15.4 % (*N*=6) | 30.8 % (*N*=12) | 15.4 % (*N*=6) | 38.5 % (*N*=15) |
| **During a match** | 15.4 % (*N*=6) | 23.1 % (*N*=9) | 10.3 % (*N*=4) | **51.3 % (*N*=20)** |

| | | | | |
|---|---|---|---|---|
| **During recovery** | 28.2 % (*N*=11) | 18.0 % (*N*=7) | 20.5 % (*N*=8) | 33.3 % (*N*=13) |

The main reasons high-performance adolescent soccer players drink specific amounts of fluid at specified times is depicted in Figure 3.6.2. Most players drink to thirst during training (71.1%, *N*=27), 24-hours before a match (39.4%, *N*=13), during a match (86.8%, *N*=33) as well as during recovery (47.4%, *N*=18). Interesting to note that 36.4% (*N*=12) of players drink according to a predetermined schedule 24 hours prior to a match.

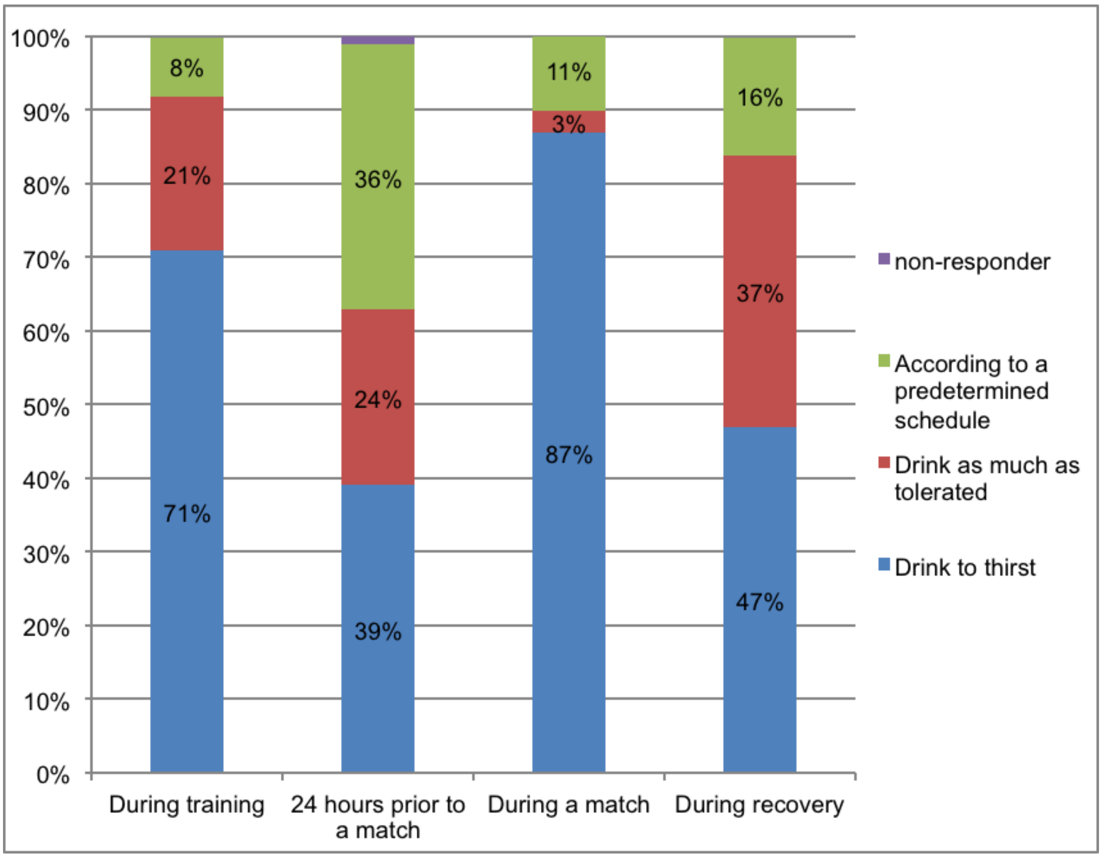


**Figure 3.6.1: The main reasons provided for fluid intake of high-performance adolescent soccer players before, during and after exercise**

Figure 3.6.3 presents the main reasons high-performance adolescent soccer players drank water, a CHO sports drinks, Coca-Cola®/Pepsi® or any other drink during a match. A sports drink was classified as a drink containing fluid, electrolytes and carbohydrates while any other drink would be any beverage which was not water, a sports drink or Coca-Cola®/Pepsi®. The percentage of players drinking water to quench thirst was 59.0% (*N*=23), and 64.1% (*N*=25) drank a CHO sports drink to provide energy.

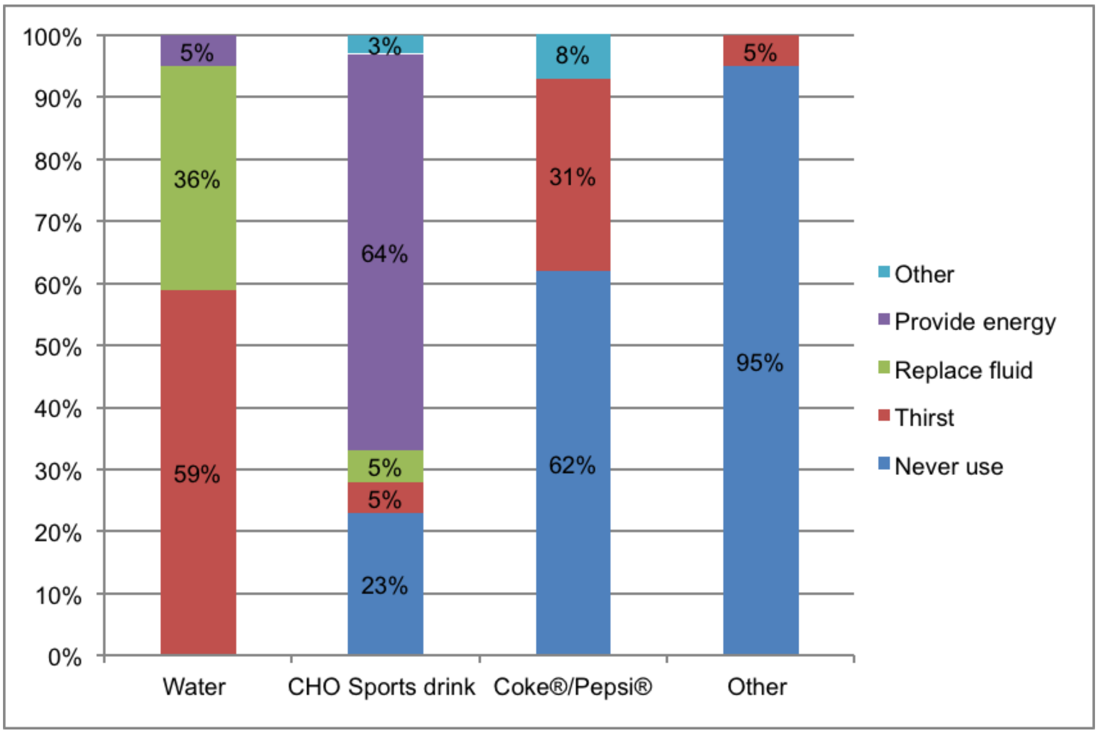


**Figure 3.6.1: The main reasons provided by high-performance adolescent soccer players for selecting a specific fluid to drink during a match**

## 3.7. Dietary supplement intake data

The data regarding the use of supplements amongst high-performance adolescent soccer players is presented in Table 3.7.1. From the table it is clear that apart from energy bars and CHO energy drinks, supplement usage amongst players is not common. Thus the two most widely used supplements by far are energy bars (100%, *N=39*) and CHO energy drinks (92.3%, *N*=36), with its respective use ranging from daily, weekly to monthly.

**Table 3.7.1: The use of supplements amongst high-performance adolescent soccer players**

| Supplement types | Pattern of usage | | | |
|---|---|---|---|---|
| | Do not use | Daily | Weekly | Monthly |
| Multivitamin and mineral | 71.8 % (*N=28*) | 12.8 % (*N=5*) | 10.3 % (*N=4*) | 5.1 % (*N=2*) |
| Vitamin C | 59.0 % (*N=23*) | 23.1 % (*N=9*) | 7.7 % (*N=3*) | 10.3 % (*N=4*) |
| Vitamin E | 84.6 % (*N=33*) | 5.1 % (*N=2*) | 7.7 % (*N=3*) | 2.6 % (*N=1*) |
| Vitamin B complex | 87.2 % (*N=34*) | 5.1 % (*N=2*) | 5.1 % (*N=2*) | 2.6 % (*N=1*) |
| Energy tonic | 61.5 % (*N=24*) | 7.7 % (*N=3*) | 20.5 % (*N=8*) | 10.3 % (*N=4*) |
| Immune Support | 89.7 % (*N=35*) | 0 % | 2.6 % (*N=1*) | 7.7 % (*N=3*) |

| | | | | |
|---|---|---|---|---|
| Zinc | 94.9 % (*N=37)* | 0 % | 2.6 % (*N=1)* | 2.6 % (*N=1)* |
| Magnesium | 87.2 % (*N=34 )* | 2.6 % (*N=1)* | 5.1 % (*N=2)* | 5.1 % (*N=2)* |
| Calcium | 82.1 % (*N=32)* | 5.1 % (*N=2)* | 7.7 % (*N=3)* | 5.1 % (*N=2)* |
| Iron | 82.1 % (*N=32)* | 7.7 % (*N=3)* | 5.1 % (*N=2)* | 5.1 % (*N=2)* |
| Antioxidant mix | 100 % (*N=39)* | 0 % | 0 % | 0 % |
| CHO Energy drinks | 7.7 % (*N=3)* | 20.5 % (*N=8)* | **69.2 % (*N=27)*** | 2.6 % (*N=1)* |
| Energy bars | 0 % | **82.1 % (*N=32)*** | 15.4 % (*N=6)* | 2.6 % (*N=1)* |
| Carboloader | 71.8 % (*N=28)* | 5.1 % (*N=2)* | 15.4 % (*N=6)* | 7.7 % (*N=3)* |
| Protein supplement | 76.9 % (*N=30)* | 2.6 % (*N=1)* | 10.3 % (*N=4)* | 10.3 % (*N=4)* |
| Amino acids | 94.9 % (*N=37)* | 0 | 2.6 % (*N=1)* | 2.6 % (*N=1)* |
| Meal replacement | 84.6 % (*N=33)* | 7.7 % (*N=3)* | 5.1 % (*N=2)* | 2.6 % (*N=1)* |
| Recovery drink | 76.9 % (*N=30)* | 10.3 % (*N=4)* | 7.7 % (*N=3)* | 5.1 % (*N=2)* |
| Creatine | 97.4 % (*N=38)* | 0 % | 0 % | 2.6 % (*N=1)* |
| HMB | 100 % (*N=39)* | 0 % | 0 % | 0 % |
| Cramp attack | 97.4 % (*N=38)* | 0 % | 2.6 % (*N=1)* | 0 % |
| Endurox | 100 % (*N=39)* | 0 % | 0 % | 0 % |
| Carnitine | 97.4 % (*N=38)* | 0 % | 0 % | 2.6 % (*N=1)* |
| Glutamine | 100 % (*N=39)* | 0 % | 0 % | 0 % |
| Testosterone enhancers | 100 % (*N=39)* | 0 % | 0 % | 0 % |
| DHEA | 97.4 % (*N=38)* | 0 % | 0 % | 2.6 % (*N=1)* |
| Caffeine | 76.9 % (*N=30)* | 10.3 % (*N=4)* | 12.8 % (*N=5)* | 0 % |

### 3.8. The exploration of possible associations between macronutrient intake and anthropometric data

Correlation studies were performed on dietary intake data against specific anthropometric measures. The Spearman Rank Order Correlation coefficient (r) was negative for all tests. For total energy intake *vs.* weight, r = -0.15 (p=0.36); total energy *vs.* BMI, r = -0.17 (p=0.30); total fat intake *vs.* AFA, r = -0.37 (p=0.02); total fat intake *vs.* percentage body fat, r = -0.31 (p=0.05); total protein intake *vs*. AMA, r = -0.14 (p=0.39) and total protein intake *vs.* AMC, r = -0.14 (p=0.40). The observed correlation therefore implies that as total energy intake increased, weight and BMI decreased. In addition, as fat intake increased, AFA and percentage body fat decreased. Also, as protein intake increased, AMA and AMC decreased. None of the correlations reached significance, except for total fat intake *vs.* AFA.

### 3.9 Sub-group analysis

There were large SD variations in the dietary intake data, especially with the regards to the macronutrient intake. In addition to this, a negative correlation was detected between dietary intake data and specific anthropometric data. The data was therefore further statistically analysed by dividing the participants according to their level of physical activity. They were divided into two groups where group 1 (43.6%, *N*=17) included players who participated in the mandatory soccer training sessions and soccer matches and group 2 (56.4%, *N*=22) included players who participated in the mandatory soccer activities as well as additional physical activities. There were no specific criteria for group 2 regarding the minimum number of hours per week spent during additional physical activities. Some players participated in one additional activity (33.3%, *N*=13) with a mean duration spent on this activity of 2.0±1.7 hours/week. Others participated in 2 or more activities (23.1%, *N*=9) with a mean duration of 6.9±3.1 hours spent per week. The mean age, weight and height of the 2 groups are displayed in table 3.9.1 and is comparable between the groups. Although the mean BMI (p=0.21) and percentage body fat (p=0.32) is lower in the group with a higher PAL, it is not significant.

The categorical anthropometrical data per sub-group is displayed in table 3.9.2. The percentage of players who fall into the above average category for the triceps (p = 0.37), subscapular (p = 0.69), sum of two skinfolds (p = 0.85) and AFA (p = 0.16) is also lower in the group with a higher level of activity but this is also not significant. In contrast, the percentage of players who fall into the above average category for the AMC (p = 0.31) and AMA (p = 0.38) is higher in the group with a higher level of activity. This is also not significant.

The dietary intake per sub-group is displayed in table 3.9.3. The TEI (p = 0.34), CHO (p = 0.47) intake, protein intake (p = 0.37) and fat intake (p = 0.63) increases with a higher level of activity. However this is not significant.

**Table 3.9.1:Mean age, weight, height and percentage body fat per sub-group**

| Mean | All groups *N*=39 | Soccer only *N*=17 | Soccer + additional activities *N*=22 | p-value* |
|---|---|---|---|---|
| **Age** | 16.3±1.3 | 16.4±1.3 | 16.2±1.3 | 0.68 |
| **Weight** | 64.4±7.2 | 65.5±6.7 | 63.6±7.7 | 0.42 |
| **Height** | 172.0±5.4 | 171.7±5.8 | 172.3±5.2 | 0.75 |
| **BMI** | 21.7±2.0 | 22.2±1.9 | 21.4±2.1 | 0.21 |

| | | | | |
|---|---|---|---|---|
| **Percentage body fat** | 10.9±3.5 | 11.5±3.6 | 10.4±3.4 | 0.32 |

* t-test

The main finding in table 3.9.1 is that although weight, BMI and percentage body fat is slightly lower in the group which participates in additional physical activities – this difference did not reach significance.

**Table 3.9.2: The anthropometrical distribution per sub-group**

| Classification | All groups *N*=39 | Soccer only *N*=17 | Soccer + additional activities *N*=22 | *p-value** |
|---|---|---|---|---|
| **Weight-for age** | | | | **0.01** |
| Underweight | *N=0* | *N=0* | *N=0* | |
| Normal weight | *N=34* | *N=13* | *N=21* | |
| Risk of overweight | *N=4* | *N=4* | *N=0* | |
| Overweight | *N=1* | *N=0* | *N=1* | |
| **Triceps** | | | | 0.37 |
| Lean | *N=0* | *N=0* | *N=0* | |
| Below average | *N=2* | *N=0* | *N=2* | |
| Average | *N=15* | *N=6* | *N=9* | |
| Above average | *N=22* | *N=11* | *N=11* | |
| Excess fat | *N=0* | *N=0* | *N=0* | |
| **Subscapular** | | | | 0.69 |
| Lean | *N=0* | *N=0* | *N=0* | |
| Below average | *N=4* | *N=2* | *N=2* | |
| Average | *N=12* | *N=4* | *N=8* | |
| Above average | *N=23* | *N=11* | *N=12* | |
| Excess fat | *N=0* | *N=0* | *N=0* | |
| **Sum of Skinfolds** | | | | 0.85 |
| Lean | *N=0* | *N=0* | *N=0* | |
| Below average | *N=2* | *N=1* | *N=1* | |
| Average | *N=7* | *N=2* | *N=5* | |
| Above average | *N=28* | *N=13* | *N=15* | |
| Excess fat | *N=2* | *N=1* | *N=1* | |
| **AMA** | | | | 0.38 |
| Wasted | *N=0* | *N=0* | *N=0* | |
| Below average | *N=1* | *N=1* | *N=0* | |
| Average | *N=3* | *N=2* | *N=1* | |
| Above average | *N=32* | *N=12* | *N=20* | |
| High muscle | *N=3* | *N=2* | *N=1* | |
| **AMC** | | | | 0.31 |
| Wasted | *N=0* | *N=0* | *N=0* | |
| Below average | *N=1* | *N=1* | *N=0* | |
| Average | *N=11* | *N=6* | *N=5* | |
| Above average | *N=22* | *N=7* | *N=15* | |
| High muscle | *N=5* | *N=3* | *N=2* | |
| **AFA** | | | | 0.16 |
| Lean | *N=0* | *N=0* | *N=0* | |
| Below average | *N=2* | *N=1* | *N=1* | |
| Average | *N=13* | *N=3* | *N=10* | |
| Above average | *N=22* | *N=11* | *N=11* | |
| Excess fat | *N=2* | *N=2* | *N=0* | |

*Pearson's Chi square

The main finding in table 3.9.2 is that the majority of players (*N*=21) who participate in additional physical activities are categorised as normal weight. There is a statistical significance between the two groups for the weight-for-age classification (p=0.01). Although not statistically significant, the body fat indices decrease with a greater PAL while the body muscle indices increase with a greater PAL.

**Table 3.9.3: Energy and macronutrient intake per sub-group**

| | **All groups** <br> ***N*=39** | **Soccer only** <br> ***N*=17** | **Soccer + additional activities** <br> ***N*=22** | ***p-value*** |
|---|---|---|---|---|
| **TEI(kcal/day)** <br> **TEE (kcal/day)** | 4374.0±1462.4 <br> 3146.9±213.4 - 3686.4±250.0 | 4164.0±1326.5 | 4536.3±1570.4 | 0.44 |
| **CHO intake(**g/day) <br> **CHO requirement (g/day)** | 556.8±172.1 <br> 441.2-535.8 | 528.4±143.7 | 578.6±191.5 | 0.37 |
| **Protein intake(g/day)** <br> **Protein requirement (g/day)** | 155.6±53.3 <br> 109.5 | 146.7±50.3 | 162.5±55.7 | 0.37 |
| **Total fat intake(g/day)** <br> **Fat Requirement (g/day)** | 148.8±67.8 <br> 104.9-122.8 | 142.8±73.5 | 153.5±64.5 | 0.63 |
| **Fibre intake (g/day)** | 44.0±14.6 | 42.4±14.4 | 45.2±15.0 | 0.55 |

The mean total energy, CHO, protein and fat intake is higher in the group that participates in additional activities, although not significant.

# CHAPTER 4: DISCUSSION

The aim of this study was to investigate the dietary intake and anthropometric profile of high-performance adolescent soccer players (14-18 years of age) during the competitive season. The group of male adolescent soccer players included in this study are from the Ajax Cape Town Football Club with the majority of players being of coloured ethnicity and currently attending high school.

## 4.1. Anthropometry and skinfold thickness

Most of the players fall within the normal range for the BMI-for-age ($5^{th}$ to $85^{th}$ percentile) (87.2%, *N*=34), with a small percentage being categorised as 'at risk' of being overweight ($85^{th}$ to $95^{th}$ percentile) (10.3%, *N=4)* or overweight (≥$95^{th}$ percentile) (2.6%, *N*=1). The mean height-for-age and BMI-for-age of this study population falls on the 91.8 and 63.1 percentiles of the WHO growth charts, respectively. None of the players are classified as underweight (BMI-for-age ≤ $5^{th}$ percentile) or stunted (height-for-age ≤ -2SD). This is in contrast to results from the South African YRBS that found that in adolescent males in the Western Cape Province, 9.8% were stunted, 8.0% were underweight and 13.7% were overweight and obese (52). A more recent study by Naude *et al*., (2011) found that 8.8% of the adolescent males in Cape Town (SA) were stunted, 11.8% were underweight and 17.7% were overweight and obese (53). The trend from these studies showed that stunting and underweight is declining whereas overweight and obesity are increasing amongst adolescents in South Africa and more specifically, Cape Town. This local trend is in keeping with the findings from international studies which indicate an increasing prevalence of overweight amongst adolescents (186). The results of the weight, height and BMI of the present study also appear to be in agreement with the national as well as the international trend, where a higher proportion of the population exhibit signs of overnutrition rather than undernutrition.

The study population of the present study are heavier (64.4±7.2 kg BM *vs* 57.9±2.32 kg BM), taller (172.0±5.4 cm *vs* 1.57±0.01 cm) and therefore have a greater BMI (21.7±2.0 *vs* 20.4±0.43) than the adolescent male participants in the Western Cape from the SADHS. (153). The difference in weight in high-performance adolescent athletes *vs.* their sedentary counterparts may be explained by the additional muscle mass (and hence BMI), which one would expect in athletes (56). The higher muscle mass, and hence weight and BMI could result in a misclassification as overweight or obese. It is therefore recommended that BMI be combined with other means of anthropometric assessment. It is unfortunate that data regarding player positioning was not collected as part of the present study. A study in 2009 found a relationship between anthropometric characteristics and the positions in which players were selected, by their coaches (183). This same study found that players who are heavier have a greater ball shooting speed and 30 m sprinting ability. Taller players have a greater vertical jumping height, 10 and 30 m sprinting ability, maximal oxygen uptake during running and distance covered during intermittent running (183). Whilst physiological parameters were not collected in the present study, an association between anthropometric data and player positioning may have been significant.

Rico-Sanz *et. al.,* (1998), recommended a mean body weight and percentage body fat for junior soccer players (14-18 years) to be 67.2 kg (62.5-72.3 kg) and 10.1% (7.6-12.1%), respectively (61). The results of the present study (64.4±7.2 kg BM and 10.9±3.5% body fat) fall within this recommended range. It is interesting to note that a study performed on French adolescent soccer players in 2002 by Leblanc *et al.*, demonstrated a lower mean body weight than the present study as well as the recommendation by Rico-Sanz *et al.* (1998) (57.2±10 kg). However, the French players had a higher percentage body fat than both the present study and the recommended range by Rico-Sanz *et al.,* (1998) (13.0±2.5%) (87). It should be remembered that different studies employ different methods to determine percentage body fat and this could be a possible explanation for the disparities in the results from these studies. Rico-Sanz *et al.,* (1998) determined percentage body fat by using a regression equation which incorporated the sum of 6 skinfold measurements and the participants' age (61). Leblanc *et al.,* (2002) used an equation which was specifically designed for soccer players and required the measurements of 4 skinfold sites (87). The present study used an equation which only requires the sum of 2 skinfold measurements. This equation has been shown to be the most accurate in adolescents, when it was evaluated in a study against 13 other equations, where DXA was used as a reference method (190). This study was however performed on sedentary adolescents which has to be considered when interpreting data. In addition, when comparing the results of different studies, a more accurate interpretation is obtained if the studies employ the same methods for data collection and analysis. Ideally, all studies investigating the body fat indices of soccer players should be using the equation which was specifically designed for this population, as used by Leblanc *et al.,* (2002) (87), when DXA is unavailable.

Additional indices of body fat have also been investigated in the present study. The triceps, subscapular, sum of two skinfolds and AFA percentiles classify the majority of the participants of this study into the 'above average' category. This implies they have a higher body fat compared to the NHANES 2003-2006, Frisancho 1981 and Frisancho 1990 reference norms. The reference population are however based on a non-athletic population. One would expect physically active individuals such as this study population to have a lower body fat when compared to their non-active counterparts. There are no studies which have investigated the triceps, subscapular, sum of 2 skinfolds or AFA of adolescent soccer players. Thus, there is no data which provides a recommended range of these indices for this specific population.

Interestingly, the present study yielded different body classification when using percentage body fat results (calculated from 2 skinfold equation) compared to the indices of fat mass (triceps, subscapular and AFA). The mean percentage body fat was classified as falling within the normal range whilst the skinfold indices resulted in above average classifications. Limiting factors in determining percentage body fat included using only 2 SKF sites and it is also more difficult to calculate percentage body fat in adolescents than adults. Also, the equation which was used to calculate percentage body fat is specific for adolescent males, but not for high-performance athletes. An additional limitation is that at present, there are no equations available for the mixed ancestry population, which comprised more than half the study population. Hence, one must be absolutely careful when interpreting these results. Methods such as underwater weighing or neutron activation analysis are considered the 'gold standard' and would therefore provide more accurate data. An athlete with a body fat which is too high, has an increased physiological load imposed when training and playing (60). A negative correlation has also been observed between percentage body fat and performance in activities where the body mass has to move against gravity (60). This ultimately emphasises the importance of ensuring an adequate body composition in order for athletes to maximise their performance. It is important to ensure those categorised as having 'below average' fat stores seek dietary intervention to increase their energy intake and those categorised as 'above average' fat stores seek intervention to decrease energy and/or fat intake as well as increase their level of activity.

Indices of muscle mass investigated in the present study include AMA and AMC. Most of the players fall into the 'above average' muscle mass category. Again, the tables used to interpret this data came from a sedentary reference population. Considering that the present study population has a higher PAL than the reference population (Frisancho, 1981), this is an expected finding.

Again, it must be mentioned that adolescent athletes are a special population and there is no national data for this population to compare the present study data to. An interesting finding from the anthropometrical data is that it supports the recommendation that when classifying athletes according to their anthropometrical distribution, weight and BMI cannot be used exclusively. One should ideally also include skinfolds and circumferences in order to accurately classify athletes.

### 4.2. Dietary energy and macronutrient intake

The mean TEI (4374.0±1462.4 kcal/day) of the soccer players in the present study exceeds the DRI (3152 kcal/day) for adolescent males (14-18 years), with an active PAL, as well as the recommended energy intake (3146.9±213.4 to 3686.4±250.0 kcal/day) for adolescent athletes as suggested by Carlsohn *et al.,* (2011) (76, 166). The TEI of the present study was compared to another equation suggested by the Institute of Medicine, 2005, and is above this recommendation (3525.2 kcal/day) as well (177). This may therefore explain why the players are heavier and have increased indices of fat mass. During adolescence it is important to maintain an adequate energy intake to ensure optimal growth, development and performance. Literature has also shown that exercise results in increased energy and nutrient requirements (67, 69). In this special population of high-performance adolescent athletes it is thus desirable to have an energy intake above the DRI (3152 kcal/day) but not above the TEE (3146.9±213.4 to 3686.4±250.0 kcal/day). It is therefore imperative to accurately determine energy requirements based on the level of activity of athletes. However, athletes who exceed this energy requirement could have an excess weight and therefore excess body fat which negatively affects performance. In this study we find that the mean TEI (4374.0±1462.4 kcal) exceeds the TEE (3686.4±250.0 kcal) by 118.7%, as calculated from the equation provided by Carlsohn *et al.* (2011) (166). The anthropometrical data is in agreement with an excess energy intake as there are a number of players who fall into the above average category for body fat indices which include triceps, subscapular, sum of two skinfolds and AFA measurements.

The TEI data from this study (4374.0±1462.4 kcal/day) is not in keeping with the data from a recent study by Naude *et al*. (2011), which found the mean energy intake of adolescent males in Cape Town to be 2252.6 kcal (53), which is nearly 1000kcal below the DRI (3152 kcal/day). The mean intake of the athletes of the present study exceeds this amount by 194.2%. One should keep in mind that the participants from the Naude *et al.,* (2011) study were not athletes. Due to the higher TEE of the participants in the present study, it is not surprising to see a higher TEI. However, the mean intake of this study also exceeds the TEI reported in other studies on adolescent soccer players. These studies include Iglesias-

Gutierrez *et al*., (2005) (3003 kcal), Ruiz *et al*., (2005) (3030 to 3478 kcal), Leblanc *et al*., (2002) (2352 - 3395 kcal) and Rico-Sanz *et al*., (1998) (3952 kcal) (80, 81, 87, 61).

The CHO intake of this study (556.8±172.1 g/day) exceeds the DRI (130 g/day), as set for healthy American adolescents who are not high-performance athletes by the Institute of Medicine (2006) (76). There is no national data regarding the CHO intake of adolescents to compare our data to. Physically active adolescents, as in the present study population, will require additional carbohydrates (178). Petrie *et al.,* (2007) recommended that the CHO intake for adolescent athletes should be 50% of TEI (67). The mean CHO intake of the present study is 120.8% above the recommended range. An energy intake which exceeds energy expenditure may once again result in additional body fat stores, which are evident in the anthropometrical data of this study, regardless of which macronutrient is in excess. The 2009 position statement from the American Dietetic Association state that athletes require additional energy and macronutrient intake in proportion to their BM, which should be expressed in kg, in comparison to sedentary individuals (99). They further suggest that energy and macronutrient requirements be expressed in terms of g/kg BM (99). In following this practical method of expressing CHO requirements, the present study has a CHO intake of 8.6 g/kg BM/day. Zehnder *et al*., (2001) postulate that high-performance adult soccer players required 4.8 g/kg BM CHO/day. The intake of the adolescents of the present study significantly exceeds this recommendation. Thus the excess intake may contribute to excess body weight and body fat indices, as observed in the anthropometrical data of the present study.

The results of the CHO intake of the present study (50.9% TEI) are in contrast to previous studies investigating the intake of adolescent soccer players, where the players had an inadequate CHO intake. The study by Ruiz *et al*., (2004) had a CHO intake of 44% of TEI (81). The same was true for studies by Leblanc *et al*., (2002) and Iglesias-Gutierrez *et al*., (2005) where CHO intakes were 49 - 57% and 45% of TEI, respectively (87, 80). In 1998, Rico-Sanz *et al*., investigated young soccer players and found that they had a mean CHO intake of 53% of TEI, which met requirements (61). The degree of how high the present study CHO intake is further emphasised when it is compared to the same studies mentioned above but in g/kg BM/day. The present study CHO intake (8.6 g/kg BM/day) is much higher than in the studies by Leblanc *et al*., (2002) (5.1-6.9 g/kg BM/day), Iglesias-Gutierrez *et al*., (2005) (5.6 g/kg BM/day) and Ruiz *et al*., (2004) (5.6 g/kg BM/day) who found a more moderate CHO intake and was closer to the recommended 4.8 g/kg BM/day (87, 81, 80). The only study which was similar to the present study was by Rico-Sanz *et al*., (1998) (8.3 g/kg BM/day) (61).

The importance of CHO as a substrate in high intensity exercise is well recognised even though its benefits specifically in this population remain unclear (67). Players may have had previous input from the club providing advice regarding their CHO intake and thus encouraging players to increase their CHO intake. This is also in line with the South African FBDG which advises that starch should be the basis of all meals (117). This is the advice which is taught at school level as well. Another contributing factor to the CHO intake may be the high frequency of intake of energy bars (51.03%, *N*=20, ≥ 4 times per week), added sugar (46.2%, *N*=18, ≥ 4 times per week), Coke®/Pepsi® (71.8%, *N*=28, ≥ 1-3 times per week) and sports drinks (69.2%, *N*=27, ≥ 1-3 times per week).

The protein intake of the adolescent soccer players of this study (2.4 g/kg BM/day) exceed the DRI (0.85 g/kg BM/day), which has been set for healthy adolescents. Considering this study population is a group of high-performance athletes, this is expected as a study by Boisseau *et al.,* (2007) demonstrated that 14 year old soccer males had a higher protein requirement than their non-active counter-parts to maintain their nitrogen balance (107). Both Petrie *et al.,* (2004) and Meyer *et al.,* (2007)*,* agree on a protein requirement in active adolescents of 12-15% TEI amounting to 1.7 g/kg BM/day (67, 69). These articles all agree that although this needs to be better defined, as current literature regarding protein requirements in adolescent athletes is limited, this recommendation should be adequate. When comparing the data from the present study to this recommendation, the players have an intake 142.1% greater than the estimated requirement. Meyer *et al.,* (2007) also found that protein intake was rarely inadequate if the energy intake was adequate (69). So although this intake is inappropriate, it is not unexpected in view of the TEI. The level of protein intake is also in agreement with that found in other studies done in adolescent athletes such as Leblanc *et al.,* (2002) (1.3 to 2.3 g/kg BM/day), Ruiz *et al.,* (2004) (1.8 to 2.14 g/kg BM/day), Rico-Sanz *et al*., (1998) (2.3 g/kg BM/day) (87, 81, 61).The only study which had an intake which was lower than the present study was by Iglesias-Gutierrez *et al.,* (2005) (1.9 g/kg/day) (80).

The percentage fat intake (30.6%) of the adolescent players in the present study falls within the AMDR for healthy adolescents (25-35% relative percentage fat intake) (76). Meyer *et al.,* (2007) recommended the fat intake for adolescent athletes be in accordance with public health guidelines (69). Based on the prudent dietary guidelines this level is ≤30% of TEI, of which saturated fatty acids (SFA) and polyunsaturated fatty acids (PUFA) should not exceed 10% of TEI and saturated fatty acids (SFA) should be more than 10% TEI (187). Although our results are in accordance with the guidelines in terms of relative percentage fat intake

(30.6%), the TEI (i.e. number of dietary calories) exceeds the requirements and therefore the absolute level of fat intake (148.8±67.8 g/day) is above recommendations (122.9 g/day). The above recommended fat intake of the present study population may therefore contribute to an excess of body fat stores, as is evident in the anthropometrical data.

The fat intake in the present study was also higher compared to that found in the SADHS (2003), where the quality of fat intake of non-athletic adolescents was investigated based on the frequency of eating selected foods (153). The fat intake was scored from 1 to 6 with a low score indicating a low fat intake (153). In the Western Cape, the fat intake was found to be low (2.2) based on the subjects' reported frequency of eating selected foods. Unfortunately this study did not specify the amount of fat consumed. In a study investigating the dietary fat intake of adolescent athletes, Leblanc *et al.,* (2002) found an intake exceeding recommendations (29.1±2.8 to 34.1±3.1% TEI (87). Similar results were found by Rico-Sanz *et al.* (1998), where adolescent soccer players had a fat intake of 32.4±4.0% of TEI as well as by Iglesias-Gutierrez *et al.* (2005), where players had a fat intake of 29-47% of TEI (61, 80).

The qualitative distribution of fats, namely SFA:MUFA:PUFA in a <1:>1:<1 ratio has been shown to be of particular importance as this constitutes a healthy diet (80). The fat distribution in this study meets the recommended ratio for SFA, MUFA and PUFA. Two studies reported on the dietary fat quality in adolescent soccer players. Boisseau *et al*., (2002) reported a remarkably high intake of SFA (25.6%) and Iglesias-Guteirraz *et al.,* (2005) reported a 9% SFA, 13% MUFA and 5% PUFA intake (179, 80). The cholesterol intake of the present study is more than 1.5 times above the recommended value (<300 mg/day). In summary, the total fat intake does not comply with the prudent guidelines and furthermore, cholesterol levels are also too high, thus classifying the intake of the adolescent players as an unhealthy diet.

Although there are no data regarding the protein intake of adolescents in SA, the 2008 YRBS investigated the frequency of meat intake amongst male adolescents and found that 66.6% of the study population ate meat 4 or more times a week (52). The QFFQ used in the present study investigated the intake of 5 different types of meat products which included high-fat red meat, low-fat red meat, sausage, hamburgers and meat stew. The majority of players ate each option 1-3 times a week. The frequency of consumption of processed meats was particularly high, especially sausage which was consumed by 51.3% (*N*=20) of players at least 1-3 times per week. Meat stew was not consumed regularly at all (17.9%, *N=7,* 1-3 times per week. This leads one to assume that the consumption of high-fat fast foods is quite high in comparison to healthier meals. Thus, contributing to the high energy and fat intake. In the 2008 YRBS it was found that 66.6% of male adolescents consumed milk on 4 or more days of the week (52). In the present study, 56.4% consume milk on 4 or more days of the week. The majority of players therefore do not consume milk regularly. Most of the players do however use full fat milk which contributes to the high total energy intake as well as the fat intake. In addition to the milk consumption, 94.9% (*N*=37) consume the low-fat flavoured milk drink ≥ 1-3 times per week, which is provided by the club at the end of each training session (4 days per week). The high protein intake in the present study may therefore be explained by the high meat intake as well as the high low-fat flavoured milk drink intake.

The percentage amongst male adolescents in the 2008 YRBS who consume fruit 4 or more times a week was 61.5% (52). Citrus fruits (30.8%, *N*=12), apples/pears (35.9%, *N*=14) and bananas (38.5%, *N*=15) are the most regularly consumed fruit, 1-3 times per week, in the present study. Citrus fruits are provided to players at the end of each training session which may be reasons why it is so popular. The fruits which are not regularly consumed include melons, strawberries, grapes, mangoes and guavas. These are the most expensive fruits and since this group mainly comes from lower socio-economic status, financial constraints may explain why it is eaten less frequently. Another explanation might be the seasonality of fruit availability – the collection date of the QFFQ occurred during December and some fruit (e.g. guavas) are readily available only in winter. The intake of cooked vegetables seems more sporadic as the majority still do not include it regularly. More than half of the study population do not include any of the vegetables in the list except for mixed vegetables (33.3%, *N*=13) which is the most regularly eaten vegetable, 1-3 times per week. The recommendation of 5 fruit and vegetables portions per day (117) would be more difficult to achieve if fruit was not supplied by the soccer club.

The DRI for fibre is 38 g/day (76). The fibre intake in the current study (44.0±14.6 g/day) exceeds this recommendation by nearly 1.5 times, which is inconsistent with previous international studies that showed an inadequate fibre intake (80, 179). Data reported by Boisseau *et al*., (2002) showed a mere 17.1 g/day in active adolescents while Iglesias-Guteirraz *et al.,* (2005) showed 24 g/day (179, 80). There is no national data regarding the fibre intake of adolescents. A possible reason for the high fibre intake may be the portion sizes which were selected for the fruit intake. Although the frequency of consumption was moderate, players indicated large portion sizes. This can further be explained by the fact that the club did not limit players with the fruit provided at training sessions.

The percentage of players who smoke and use alcohol in the present study is much lower than the results from the SADHS (153). In the Western Cape, 32.5% of adolescents admitted to smoking daily while 52.5% reported that they abstained from alcohol (153). The SADHS is not specific to athletes and it may also be that players are more aware of the health risks associated with smoking and alcohol use and the effects it may have on performance, therefore making a conscious decision not to smoke or use alcohol.

There are large differences in the nutritional intake of the present study when comparing it to other studies investigating the nutritional intake of adolescents in SA as well as internationally. The profile of the study population in the SADHS included sedentary individuals. As already explained, high-performance athletes require additional energy and macronutrients to ensure adequate growth and development as well as optimal playing performance. This suggests that although it is good to compare the data of this study to current literature in SA, it may not be applicable. It is however recommended that adolescent athletes should aim to at least meet these requirements. SADHS had a very large sample size which was representative of the population it was investigating. The sample size of the present study was not representative of all adolescent soccer players in SA, making it difficult to extrapolate the data.

Comparing the data to international studies which investigated the nutritional intake of adolescents presents a different set of challenges. These studies differ from each other as well as the present study, in their age ranges, their place of origin (developing *vs*. developed countries) including socio-economic status, the number of subjects as well as the method used to obtain dietary intake information. The study by Rico-Sanz *et al.* (1998), consisted of 80 players with a mean age of 17±2 years in South America, a developing country. The nutritional intake data was obtained with a 12-day food diary where players quantified the amount eaten with a combination of weighing, spoon size, size (small, medium, large) and number of pieces consumed (61). The study by Iglesias-Gutierrez *et al.,* (2005) consisted of 33 players with an age range of 14-16 years in Spain, a developed European country. The nutritional intake data was obtained with a 6-day weighed food diary (80). The study by Ruiz *et al.,* (2004) consisted of 81 Spanish players with ages 14.0-20.9 years. The nutritional intake data was obtained from a 3-day weighed food diary (81). The study by Leblanc *et al*., (2002) consisted of 180 players with an age range of 13-16 years from a very prestigious training centre in east France. The nutritional intake was obtained with a 5-day dietary record quantifying amounts with household measures (87). In addition to this, they all differed in the type of programs used to analyse the nutritional intake. It is therefore important to consider all these varying factors when comparing data of different studies.

In summary, the mean total energy intake, CHO intake, fat intake and protein intake are above the recommended levels and can therefore explain why the majority of players fall into the above average category for the body fat indices. Based on these findings, the players will require counselling regarding practical advice to meet, but not exceed, energy as well as macronutrient requirements. A decrease in processed meat alone would decrease TEI, protein intake, fat intake as well as sodium and cholesterol intake. The benefits of selecting low fat food items, such as low fat milk, should also be encouraged. Convenience foods must be limited while a greater emphasis should be placed on healthier meals.

### 4.3. Dietary micronutrient intake

The mean intake of vitamins and minerals in this study meet the EAR/AI for all the micronutrients. There are however a few individual players who have intakes less than 67% of the EAR/AI for the following vitamins and minerals: vitamins A (307.4±70.3 µg, 10.3%, *N*=4), D (2.4±0.7 µg, 15.4%, *N*=6), E (2.8±1.7 mg, 5.1%, *N*=2) and K (25.3±15.3 µg, 20.5%, N=*8)*, calcium (719.7±135.8 mg, 7.7%, *N*=3), chromium (16.6 µg, 2.6%, *N*=1), and iodine (46.4±14.3 µg, 30.8%, *N*=12). The mean intake of sodium is 4041.5±1226.7 mg/day which is above the recommended 2300 mg.

The Vitamin and mineral intake of adolescent athletes can be compared to the EAR/AI as there is consensus that unless a specific deficiency has been diagnosed, athletes do not have increased requirements (67, 69).

The 2003 SADHS demonstrated that the nutrient intake of adolescents in South Africa is of a poor nutrient quality (153). However, the micronutrient intake for male adolescents in the Western Province was better than the national findings where an average intake was observed with the following data: more than 50% of adolescents had less than 67% of the recommended dietary intake (RDA) for vitamin E, thiamine, folic acid, niacin, iron, calcium and magnesium. Calcium intake was a huge concern as more than 60% of the population had an intake of less than 33% of its RDA. Caucasian adolescents had a lower rate of deficiency than their African counterparts for all nutrients except for calcium and magnesium which was a concern in all groups (153). As most of the players from the current study are of coloured and African ethnicity, one would therefore expect the vitamin and mineral intake of the current study to be less adequate. However, the findings of the present study are in contrast to this. Players are provided with fruit at each training session and this may contribute to their vitamin and mineral intake. Athletes drink energy drinks which contains vitamins and minerals and may also therefore contribute to their micronutrient intake. The SADHS also occurred before the national fortification policy of maize and wheat flour. As this study occurred 9 years ago, it is expected that the national micronutrient status would have improved, as seen in the present study.

As previously mentioned, calcium intake was a big concern in the 2003 SADHS. In the present study group only 3 players had an intake less than 67% of the RDA. The Ajax soccer club provides a flavoured low-fat milk drink to each player after their training session which provides 439.7 mg of calcium per 350ml serving which is 33.8% of the RDA. A third of the recommended intake is therefore provided by the club and may explain why the calcium intake of the players is mostly adequate. However, the calcium:protein ration is 4.6:1 which is far below the recommended 20:1. This is a particular concern for adolescents as they are in a prime bone mineral density accrual phase (135). This is especially important for athletes as a high fracture rate is associated with a low bone mineral density (137, 138). The present study population may therefore be at risk for developing fractures.

Very little data about micronutrient intake in adolescent soccer players is available. Iglesias-Gutierrez *et al*., (2005) found inadequate intakes in folic acid, vitamin E, calcium, magnesium and zinc. Rico-Sanz *et al.,* (1998) demonstrated inadequate intakes of calcium and iron (80, 61). Again the only vitamin which is inadequate in this study as well as the 2003 SADHS which investigated the intake of adolescent soccer players, is vitamin E. The Foodfinder® program which analyses the dietary intake does not take sunlight exposure into account and in countries with a high percentage of sunlight such as South Africa, vitamin D deficiency is rarely seen (188).

### 4.4. Training nutrition

Although the majority of players eat breakfast, lunch and supper daily, there are still a number of players who do not eat meals regularly. A total of 5.1% of players reported never eating breakfast whilst 20.5% ate breakfast 3 days per week. For lunch, this number increased to 10.3% and 23.2% respectively of players either missing the meal completely or eating lunch 3 days a week. If one considers the huge physiological demands of adolescent growth and development as well as being a high-performance athlete, this irregular eating pattern may negatively impact on their physiological and sporting abilities (22). These negative outcomes may be more prominent in lower socio-economic environments which have a higher prevalence of underweight children (153, 53).

The data of this study is consistent with a study, by Temple *et al.,* (2006), which investigated food items consumed by adolescents (12-16 years) in Cape Town (41). It was found that 22% of adolescents did not eat breakfast before school (41). This is consistent with data from previous South African studies where 15-20% of children did not eat anything before school (180). This data is particularly important in Cape Town where a recent study by Naude *et al.,* (2011) found that adolescents (12-16 years) had a prevalence of 8.9% for stunting and 7.6% for underweight (53), although this is not the case with the current study. A concern for this group may be more an impaired scholastic potential and suboptimal performance of the players, due to fluctuating blood glucose levels caused by irregular eating patterns.

Daily snacking between meals is not common amongst the players, where only 15.4% have a mid-morning snack, 35.9% have a mid-afternoon snack and 18.9% have a late evening snack. The most common snack was the mid-afternoon snack where 69.2% (*N*=27) of players had it at least 4 times per week. This coincides with the snack provided by the club at the end of each training session (4 days per week). Snacking by the high-performance athlete should be encouraged to ensure an adequate intake of their high nutritional demands. However, it should be an appropriate item such as fruit or dairy or even CHO if taken before a training session or match and it should form part of a healthy diet. In the study by Temple *et al.,* (2006), it was found that adolescents were twice as likely to bring 'unhealthy' items from home and 70% of those who did purchase items at school bought 'unhealthy' items (41). An interesting point to note from the same study was that the knowledge that adolescents had about healthy *vs*. unhealthy foods did not influence the choices they made (41). This is a fact to consider if nutritional education is recommended to the players. Incentives may be useful as well as educating the players about the consequences of not following a healthy diet, especially those impacting on playing performance.

### 4.5. Fluid intake

The majority of players subjectively reported being more concerned about their fluid intake during a match than they were during training sessions. This data is in agreement with the actions of the players as they consume more fluid per minute in a 60-80 minute match (479.1±163.1 ml) *vs.* a training session (597.7±281.0 ml). The US soccer federation guideline states that players should consume between 150ml to 260ml for every 20 minutes during an activity (183). The majority of the players indicated they only drink during a training session or a match when they are thirsty. This goes against what the US Soccer Federation guidelines recommended, which states players should drink according to a pre-determined schedule and not rely on thirst alone. Noakes TD in 2007 found that there was no evidence that full fluid replacement was superior to drinking to thirst (184). Young athletes may benefit from incorporating a combination of the two findings into their practice as they may not immediately respond to thirst. This might imply that the optimal guideline, especially for young athletes who may not recognise thirst or necessarily realise a prompt action is needed in response to it, may be to employ a combination of the two recommendations. Thus ensuring adequate hydration by using a pre-determined drinking schedule, in conjunction with thirst recognition. The US Soccer Federation specifically issued guidelines to avoid dehydration in response to athletes who died from it. Although soccer is a winter sport, the professional league in SA runs alongside the European league. It is therefore played in summer when the risk of becoming dehydrated is greater. As a result, athletes in SA have to be more diligent in rehydrating to avoid the consequences of dehydration. Regarding the type of fluid replacement of the players during a match, the majority of players (59%) selected water to combat thirst with a smaller percentage (31%) selecting Coca-Cola®/Pepsi®. However, most players (64%) select a CHO sports drink as their preferred beverage to provide energy during a match. The intake of coke®/Pepsi® in the present study was quite high with 71.8% (*N*=28) of players consuming it ≥ 1-3 times per week in addition to a CHO sports drinks where 69.2% (*N*=27) of players consumed it ≥ 1-3 times per week. The US Soccer Federation suggested that sports drinks are a better choice than water and carbonated and caffeine beverages should be avoided. However, since the participants of this study have above average body fat indices, water may be the better option for this specific group to rehydrate. CHO sports drinks provide lots of additional energy which may be converted to fat if not utilised and will contribute to the already high fat stores (185). The same is true for the Coca-Cola®/Pepsi® beverages which are high in simple CHO.

A study by Nichols *et al*., (2005) found that despite being aware of the recommendations, players did not always adhere to the advice or were unsure of the specific fluid amounts they were meant to consume (70). The soccer club should therefore not only ensure that players are well educated regarding the importance of hydration status, they should also provide specific, practical advice to ensure it is followed through. Clubs could even further assist by providing a specific drinking schedule for each player to utilise as a guide before, during and after training sessions and matches. It is also important for the parents as well as the coaches to be educated about the importance of hydration, the quantities which should be consumed and the preferred type of fluid to consume. They can play an important role in encouraging, assisting and allowing the players to adhere to the advice.

The majority of players subjectively rated themselves as not concerned about their overall intake pre-, during as well as post-exercise. Interesting to note that the majority of players only ingested a specific meal or food item during their training sessions and the most common reason provided for this was because it was supplied by the club. At each training session, players were provided with a fruit, Parmalat Steri-Stumpie® flavoured low-fat milk drink and a Jungle Oats® energy bar. This information is supported in the data of the completed QFFQs. Fresh fruit is a good source of fibre, natural sugar and important micronutrients and is therefore an excellent snack. A mineral which is a big concern in national adolescent population, as found in the 2003 SADHS, is calcium (67, 69). Thus the low fat flavoured milk drink is appropriate as it provides 125.6 mg of calcium per 100 ml. The portion size may have to monitored, especially in players who are at risk of or already overweight. The Jungle Oats® bar is high in calories and more specifically CHO. These items are usually provided at the end of a training session. Although it will contribute to the TEI, it is needed for the recovery phase post exercise. According to Leblanc *et al.,* (2002) snacks should provide 10% of TEI (87). It is thus very important that clubs are providing the correct food items which send out the correct health messages. Snacks should form part of a healthy, well balanced diet and good options should be low calorie and low fat. From the above data, it seems that the energy intake of the players is appropriate around the training sessions as well as the recovery phase. However, the overall energy intake is excessive. This implies that the TEI and macronutrient intake may not be appropriate outside of training sessions. Players may therefore benefit from education regarding healthy food choices during the rest of the day as well as smaller, more regular meals throughout the day.

### 4.6. Dietary supplement intake

In this study, CHO energy drinks (69.2%, *N*=27, ≥ 1-3 times per week) and energy bars (84.6%, *N*=33, ≥ 1-3 times per week) are the only two supplements which are used by a significant number of players. It is interesting to note that these two items are provided to the players by the club. As most of the players come from lower socioeconomic status, the energy levels of players may have been a previous concern. Petrie *et al.,* (2005) stated that dietary supplements have become attractive to adolescents as they are being touted as performance enhancing (67). The use of vitamin and mineral supplementation may be useful in improving the nutritional status of players who have an inadequate intake from their diet (67, 69). The participants of the present study do not demonstrate an inadequate intake and the use of vitamins and mineral supplementation would therefore not be indicated. There is also no scientific evidence to support its general use to improve performance (67, 69). More importantly, most of the participants of this study are in the above average category for fat stores and their TEI, macronutrient and micronutrient intake is above recommended values. Unless players exhibit specific nutrient deficiencies, this group would not benefit from the use of nutritional supplements.

### 4.7. The exploration of possible associations between macronutrient intake and anthropometric data

The mean energy intake of the players was negatively correlated to weight (r= -0.15, p=0.36) as well as BMI (r= -0.17, p=0.30). Total fat intake was negatively correlated to AFA (r= -0.37, p=0.02) and percentage body fat (r= -0.31, p=0.05). Also, total protein intake was negatively correlated to AMA (r= -0.14, p=0.39) and AMC (r= -0.14, p=0.40). However, none of these were significant except for AFA, which may lead one to question its use in high-performance adolescent athletes. This correlation is an unexpected finding as it goes against current literature, which clearly states that these parameters should be positively correlated with each other (67). Although diet is a significant determinant of anthropometric status, it is not the only determinant. Factors which may assist in explaining this data may include the varying stages of maturation of the players. Those undergoing a growth spurt may require more energy than those not experiencing a growth spurt in order to support this growth and development. Players undergoing a growth spurt may therefore exhibit more favourable anthropometric indices compared to players who are not undergoing a growth spurt, even if they are ingesting the same amount of calories. Another factor may include the genetic predisposition to obesity which may be relevant in certain players. Studies have found that the body’s response to overfeeding or a negative energy balance may be influenced by genetics. This implies that some individuals may be prone to excessive fat accumulation while others are protected against it, based on genetic make-up (191). Finally, physical activities, including activities of daily living, may vary between players which may affect energy expenditure. Since the physical level of activity of the players was the only factor which was investigated, this was used to perform additional sub-group analysis.

### 4.8. Sub-group analysis

There is a large spread in the data regarding the energy and macronutrient intake of the players. This is evident by the large SD expressed in the statistical analysis. The data was then further analysed by separating the players into 2 groups namely: those who only attend soccer training sessions and matches, and those who participate in soccer trainings session, matches as well as additional physical activities. This data was then tested against each other to explore any significant differences between the groups.

The weight, BMI and percentage body fat was lower in the more active group than the group who only participated in soccer, although not statistically significant. This is an expected finding as literature tells us that individuals who are more physically active have a lower body weight, and therefore BMI, and percentage body fat than their more sedentary counterparts (9). In addition to this finding, all of the players in the more active group are classified as normal for weight-for-age, except for one player who is classified as overweight. Interesting to note that this difference in weight-for-age classification between the groups was statistically significant ($p = 0.01$). This displays that a greater physical activity is not only associated with a lower body weight but more importantly, a normal body weight range. It may have been interesting to collect data regarding player positioning as a study in 2011 found that goalkeepers were often heavier than players in other positions (9).

Further investigations were also done on the fat and muscle indices. With regards to the triceps, subscapular, sum of two skinfolds and AFA, the percentage of players who fell into the above average category was lower in the physically more active group, although this was not statistically significant. Again, literature shows that fat indices are lower in individuals who are more physically active (9). This finding is therefore in agreement with current evidence. With regards to the muscle indices, the more physically active group had a higher percentage of players in the above average category, again this was not statistically significant. This finding is also in agreement with current literature which states that physical activity increases muscle mass (9).

The TEI, CHO intake, protein intake and fat intake was higher in the more physically active group. It is expected that TEE and therefore requirements, are higher in individuals who have a higher PAL (167).

The sub-group analysis data puts the association analysis into perspective. It seems that the more physically active players had a lower body weight, BMI and body fat, despite having a higher energy intake. Thus explaining why there was a negative correlation between energy intake and weight and BMI.

Although this analysis displays interesting findings, no statistically significant data was generated between the 2 groups except for the difference in weight-for-age classification. This may however be attributed to the small sample size of the study population which makes detecting associations difficult. A larger sample size may be thus be more sensitive in detecting associations.

### 4.9. Shortcomings and limitations of the study

Various methods exist with which one can determine dietary intake. However, they all come with strengths and limitations. The researcher will usually select a method according to what is best suited to the research design, participant characteristics, resources available and the type of intake one is trying to determine. Some of the most common methods to determine intake include food diaries, food records, 24-hour recalls, diet histories and food frequency questionnaires (175). Limitations of a QFFQ include the following: respondents may choose foods or portion sizes which are not representative of their usual intake, it is dependent on the subject's ability to describe their diet and respondents may be influenced by the list of multiple foods. During the information sessions, players were sitting next to each other and their responses may have been influenced by each other. At one point, one player mocked another for having a limited food selection and others seemed to copy what their friends selected or had a discussion before making their choices. This behaviour was stopped but at times the boys were difficult to control. It is therefore probable that respondents were influenced by other players within their group. Although the QFFQ used in this study has been validated in athletes it's use has not been validated in adolescents and is therefore another limitation. Validation is important to determine reliability and precision. Respondent fatigue must also be considered as the QFFQ took ± 45 minutes to complete and the players appeared to lose concentration/interest. It is unfortunate that the nutritional content of the snacking was not investigated as well as whether it was brought from home or bought at school. This would have provided a greater insight and perhaps a better understanding regarding snacking and thus make intervention more targeted.

Another limitation included the small sample size which is not representative of all adolescent soccer players in SA. Previous studies which investigated the nutritional status of adolescent soccer players had a sample size of 33, 8, 180 and 81 (80, 61, 87). There is therefore quite a range and better quality data may be obtained with a bigger sample size. More or stronger statistically significant data may be obtained with a larger sample size.

The equation which was used to determine percentage body fat was that by Slaughter *et al*., (1988), (45) which requires the triceps and subscapular skinfold measurements. However, this equation has only been validated in non-athletic adolescents and may therefore not be suitable for use in adolescent athletes. There are equations which are better suited and validated for athletes which require additional skinfold measurements which could be used for better accuracy. In addition, this equation is specific to the Caucasian and black population but there is no equation for the mixed ancestry population, which made up the majority of the study population. The reference population against which the skinfold measurements were compared to are for the general population which considers age and sex but not physical activity. This too may not be appropriate to use for adolescent athletes.

# CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

## 5.1. Conclusions

The majority of the high-performance adolescent soccer players considered in this study fall into the normal weight category and all are of a normal height. Using a regression equation, the majority of players have an appropriate percentage of body fat. However, upon further analyses of their body composition, most of the players fall into a category placing them in an 'above average' range for their triceps, subscapular, sum of two skinfolds, AMC, AMA and AFA. The implication of this finding is that the players are considered to have an excess of body fat stores, which is not desirable for soccer players. However, the majority of players also have an 'above average' muscle mass which is beneficial for soccer players.

The diet of the adolescent soccer players is considered to be in excess of their requirements. The reported mean energy, CHO, protein and fat exceeds recommendations. The mean micronutrient intake met the EAR/AI for all of the vitamins and minerals. Players who participated in additional physical activities had a lower weight, BMI and percentage body fat, despite having a higher TEI. The group who had a higher PAL had significantly more players in the normal weight range for the weight-for-age classification. The players who have a higher PAL also tended to have higher indices of body muscle mass.

The importance of regular meal patterns should be emphasised to the players, especially breakfast which was the most poorly eaten meal. Appropriate snacks which are low calorie and low fat should be encouraged. Clubs need to advocate for adequate hydration and equip players with the necessary knowledge about why it is needed, what should be used, how much and how often it should be used for training and matches. The only dietary supplements which the players have on a regular basis are those provided by the club which is primarily an energy drink and an energy bar. These items are consumed during the recovery phase which is appropriate to restore glycogen stores. Since the use of supplements, especially in adolescents, may have negative health implications and have not shown to improve or enhance performance, its use should not be encouraged.

## 5.2. Recommendations

Future studies should consider the use of validated methods to determine dietary intake such as repeated 24-hour recall and weighed food diaries which are more accurate. The validity and accuracy of the QFFQ should be determined with the doubly labelled water technique and indirect calorimetry which are very accurate indicators of energy expenditure.

A bigger sample size for future studies is recommended. Although trends were detected in the present study, a larger sample size may detect more associations. The collection of data in group sessions is very difficult and when done, strict supervision is required with no discussion or interaction between participants. Participants should not be allowed to see each other's responses and they should therefore be spaced far apart (as per exam-writing rules). Coaching staff may be able to assist with supervision. When interpreting micronutrient adequacy, micronutrient supplementation should also be included in the data. Alternative methods to determine body composition include underwater weighing and neutron activation analysis. These methods are considered the 'gold standard' and thus much more accurate than the methods employed in this study. The findings of this study is in agreement with recommendations and evidence of previous studies which state that in addition to weight and BMI, athletes should be classified with additional anthropometrical measurements such as skinfolds and circumferences.

Dietetic professionals should use the findings of this study to implement targeted intervention for this population. By providing accurate and evidence-based data, they will help to ensure healthy adolescent soccer players with optimal nutritional status and development which will result in maximal training and playing performance. Providing education to the players as well as the coaches, biokineticists and all involved staff about the importance of meeting, but not exceeding, energy, macronutrient, micronutrient and fluid requirements is imperative. Players may benefit from personalised drinking schedules to assist them with meeting their fluid requirements during training sessions as well as during matches. Players should also be coached how to recognise thirst and take the appropriate action. A constant fluid supply should always be available during training sessions and matches and players should be allowed the opportunity to drink. Education is essential, to players, parents and staff alike, regarding what a healthy diet constitutes and what the benefits of it are. The consequences of unhealthy diets must be emphasised, especially the implications it may have on sporting performance. Players should also be educated regarding types of fat and its sources, with special attention to processed meats (hamburgers and sausage) as well as practical advice to reduce total fat intake (such as using low fat milk). Focus should also be around healthy snacking, especially outside of training sessions. Although nutritional supplement use is not common amongst these players, education regarding its use and lack of evidence to support its use is still important.

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# THE NUTRITIONAL PROFILE OF HIGH PERFORMANCE JUNIOR FOOTBALL PLAYERS IN WESTERN CAPE, SOUTH AFRICA

## PARTICIPANT INFORMATION LEAFLET

This study will be conducted by Fatima Hoosen from the University of Stellenbosch. The aim of this study is to investigate the dietary intake and anthropometric profile of club / provincial-level adolescent soccer players (13-19 yrs of age) during the competitive season. All the junior players who currently play for Ajax Cape Town football club will have the opportunity to participate in this study, provided they meet the inclusion criteria.In order to meet the objectives of the study information regarding the participants' dietary intake practices, use of dietary supplements and nutrition and fluid intake practices before, during and after matches will be required. A few anthropometrical measurements will also have to be performed. The data will be obtained in an interview with the researcher and the participant at the Ajax football club at a pre-arranged time convenient for the participant. .

Your consent means that you agree to provide the following information:

1. Basic demographic information: eg age, sex, address
2. Participants will also be asked to provide information about their use of nutritional supplements as well as any nutrition and fluid practices before, during and after matches.
3. Food frequency questionnaire: the participant is provided with a list of foods and they are asked to indicate how often and how much is eaten.

Your consent also means that the researcher is allowed to perform anthropometrical measurements on you. These measurements include the following:

1. Weight: this will be measured in light training clothing
2. Height: this will be measured without shoes
3. Mid-arm circumference: the top half of the arm is measured with a tape measure
4. Triceps skinfold measurement: the top half of the arm is measured with a calliper (metal instrument which measures fat)
5. Subscapular skinfold measurement: a calliper(metal instrument) is used to measure body fat on the back below the scapular.

Once the study is completed, it will be presented to the Ajax Cape Town football club and the players who have participated in the study. All information provided during this study remains confidential.

The information gathered from this study will enable the researcher to provide guidance to players and their families on how to improve nutritional habits and thus ensure optimal development as well as optimal athletic performance.

If you require further information regarding this study please contact the researcher, Fatima Hoosen, on 084 849 3607.

**INFORMED CONSENT** **APPENDIX 2**

**Title of project:** The nutritional profile of high performance junior football players in Western Cape, South Africa.

**Principal researcher:** Fatima Hoosen

**Declaration by participant and parent/guardian:**

By signing below, I …………………………………………….. agree to participate in the abovementioned research study entitled*The nutritional profile of high performance junior football players in Western Cape, South Africa.* I understand that this study aims to investigate the dietary intake as well as the anthropometric profile of club / provincial-level adolescent soccer players (13-19 yrs of age). I declare that I have attended an information session where the study was fully explained and I was provided with an opportunity to ask questions which have been adequately answered. I understand that taking part in this study is voluntary and that I may choose to leave the study at any time. I also understand that I am allowing the researcher to take anthropometrical measurements (weight, height, skinfold measurements) on me as well as obtain dietary information regarding usual intake, supplement intake as well as match-day fluid and nutrition practices. All information obtained during this study remains confidential. If you require further information please contact the researcher on the following number: 084 849 3607.

Signed at (place)…………………………………. On (date)……………………..2009

……………………………… ……………………………..

**Signature of participant** **Signature of parent**

...........................................

**Signature of researcher**

**SOCIO-DEMOGRAPHIC QUESTIONNAIRE APPENDIX 3**

**The nutritional profile of high performance junior football players in Western Cape, South Africa.**

Subject Number: ☐☐☐ Date: ☐☐☐☐☐☐

Subject Name: ________________________________________

Parent/Guardian Name: ________________________________

Address: ____________________________________________

_______________________________________________________

_______________________________________________________

Contact Number: ______________________________________

Birth Date: ☐☐☐☐☐☐

Age: ☐☐

Gender: ☐ male

☐ female

Ethnicity: ☐ black ☐ white ☐ coloured

☐ indian ☐ other, specify __________

Education: ☐ primary school ☐ secondary school

tertiary institution ☐

Team: ☐ U13 ☐ U15 ☐ U17

☐ U19

**ANTHROPOMETRIC QUESTIONNAIRE** **APPENDIX 4**

**The nutritional profile of high performance junior football players in Western Cape, South Africa.**

Subject Number: ☐☐☐ Date: ☐☐☐☐☐☐

Weight: ☐☐☐ , ☐ Kg

Average Weight: ☐☐☐ , ☐ Kg

Weight: ☐☐☐ , ☐ Kg

Height: ☐☐☐ , ☐ cm

Average Height: ☐☐☐ , ☐ cm

Height: ☐☐☐ , ☐ cm

BMI (Kg/m²): ☐☐

BMI-for-Age (z-score): ☐☐

BMI-for-Age (percentile): ☐☐

Height-for-Age (z-score): ☐☐

Height-for-Age (percentile): ☐☐

Triceps: ☐☐ , ☐ mm

Average Triceps: ☐☐, ☐ mm

Triceps: ☐☐ , ☐ mm

Percentile of triceps-for-age: ☐☐

Sub-scapular: ☐☐ , ☐ mm

Average Sub-scapular: ☐☐ , ☐ mm

Sub-scapular: ☐☐ , ☐ mm

Percentile of subscapular-for-age: ☐☐

Sum of two skinfolds: ☐☐☐, ☐mm

Percentile of sum of skinfold thickness(mm): ☐☐

MUAC: ☐☐ . ☐ cm

cAMA for males: $= \frac{[MAC - (\pi \times TSF)]^2}{4\pi} - 10 =$ ☐☐ cm²

cAMA for females: $= \frac{[MAC - (\pi \times TSF)]^2}{4\pi} - 6.5 =$ ☐☐ cm²

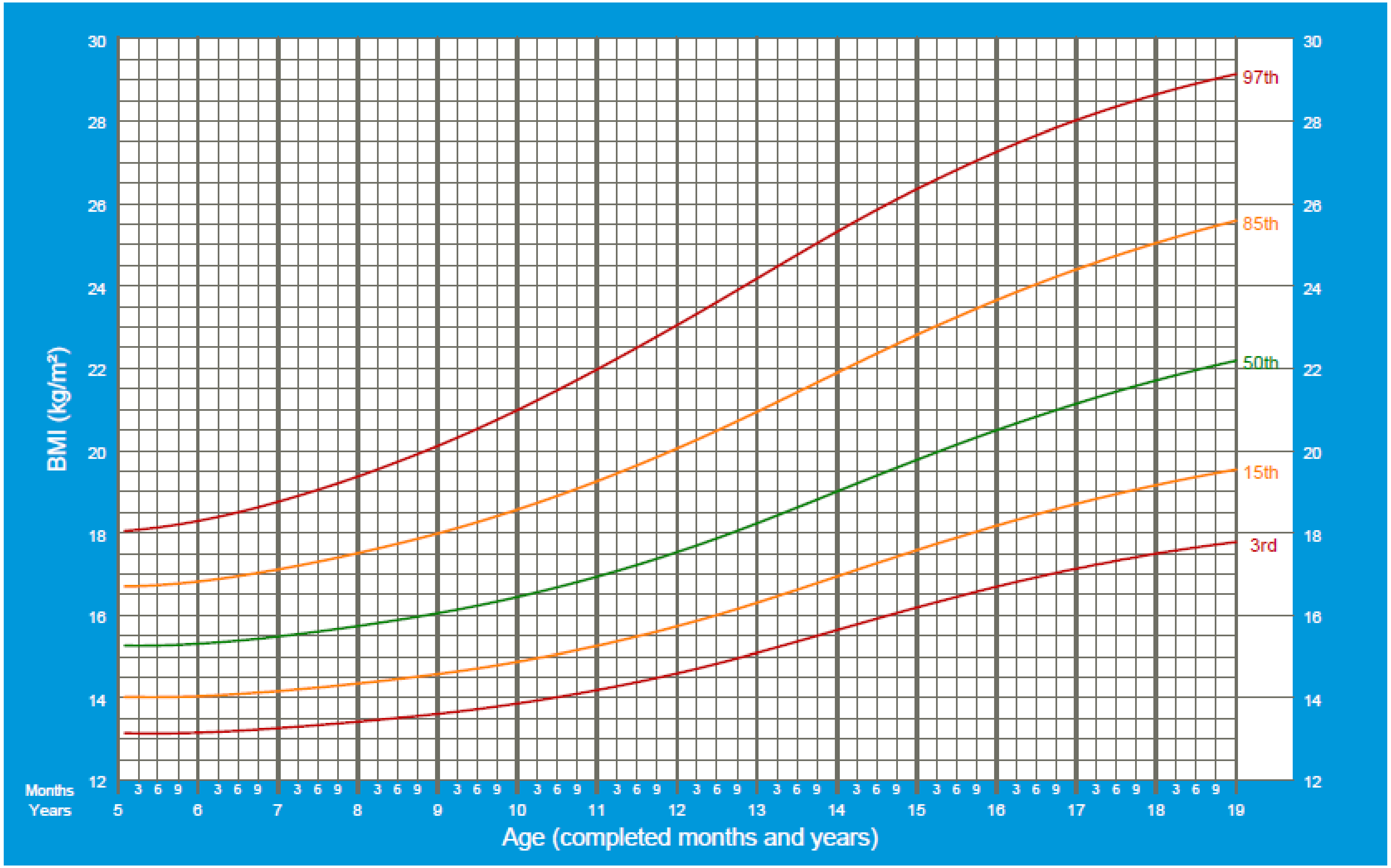
Percentile of AMA (cm²): ☐☐

---

# BMI-for-age BOYS

5 to 19 years (percentiles)

World Health Organization

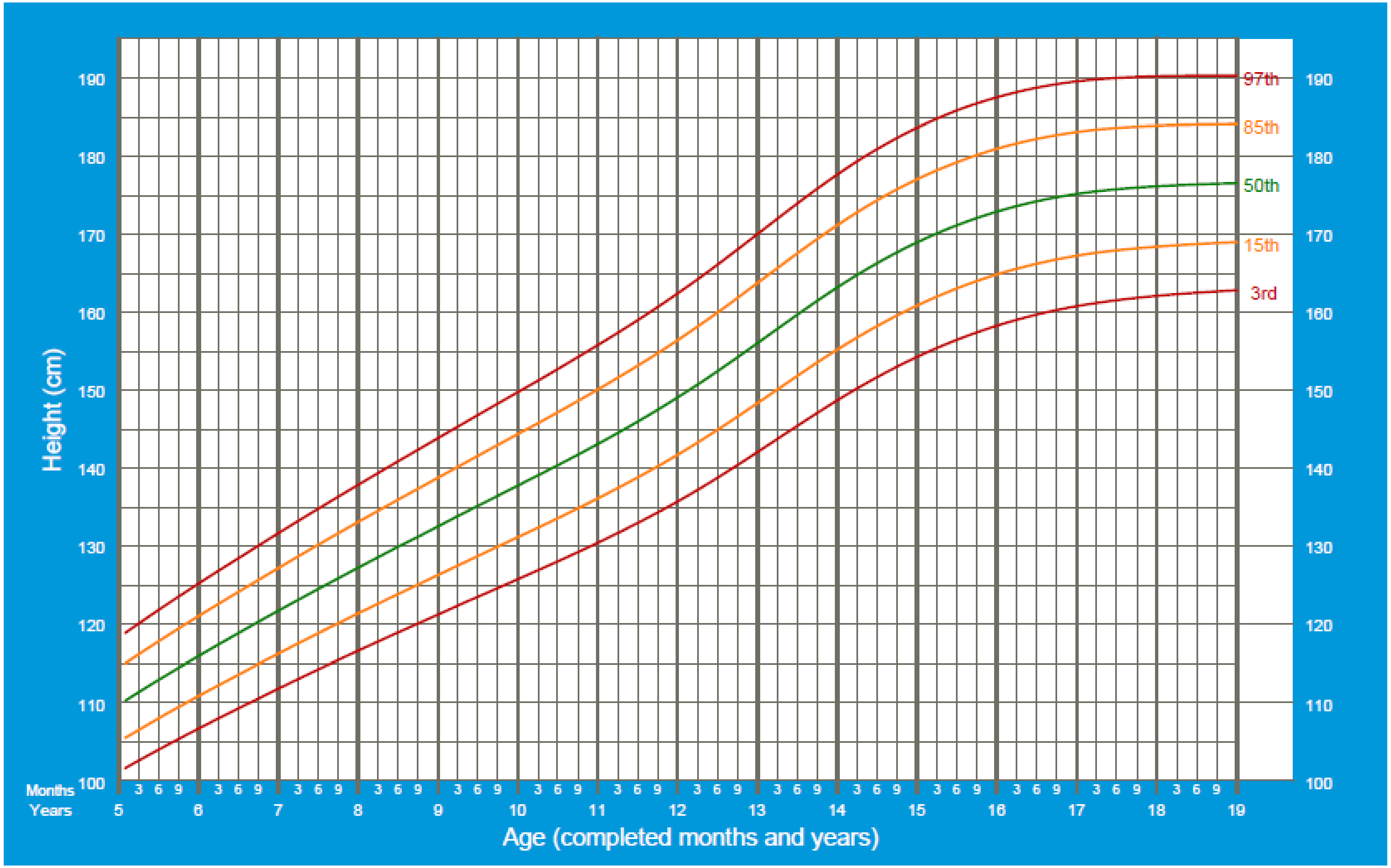



2007 WHO Reference

# Height-for-age BOYS

5 to 19 years (percentiles)

World Health Organization




2007 WHO Reference

**FOOD FREQUENCY QUESTIONNAIRE APPENDIX 7**

**The nutritional profile of high performance junior football players in Western Cape, South Africa.**

| **Subject Date:** | | | | **Number:** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

For the completion of this section of the questionnaire we would like you to think carefully what you ate (including fruit in season) and drank during ***the last week.***
In the table below you will find a list of foods and drinks (Column 1). We would like you to tick off:

- **How often** you ate or drank the specified item during the **last week**(Column 2); and
- On average, **how much** (or portion size) you ate/drank of the specified item if you did eat it (Column 3).

Guidelines are given in Column 3 to help you with portion size estimation.
The ***standard (Std) portion size*** of each food item/drink is indicated in Column 3 in household measures (e.g. cups, spoons, grams) or a unit (e.g. a hamburger). Where possible the Std portion size is also shown in terms of visual aids, including a matchbox, a tennis ball and a sketch of half a cup of dished up food. Sketches of these aids are attached to the questionnaire (next page).
Once you are sure about the size of the Std portion, tick one of the following options in Column 3:

- If the portion you ate/drank of the specified item on average is ± the same as the Std portion size, tick the ***1X Std*** column; OR
- If the portion you ate/drank of the specified item on average is less than the Std portion size, tick the ½X Std column; OR
- If the portion you ate/drank of the specified item on average is a little more than the Std portion size, tick the ***1½X Std;*** OR
- If the portion you ate/drank of the specified item on average is much more than the Std portion size, tick the ***2X or 3X Std*** column.

Explanation of abbreviations/symbols used:

| | |
|---|---|
| Teaspoon: tsp<br>Table spoon: Tbs<br>Gram: g<br>Milliliters: ml<br>Etc - whatever is necessary | Tennis ball: ●<br>½ cup of dished up food: ◎<br>Matchbox:  |

Please <u>make sure that you tick every line</u>. If you did not eat/drink a particular item in the last week , make sure that you tick the "NO" column. Remember that if you ticked the "NO" option in Column 2, you do not have to complete Column 3 (portion size).

**<u>EXAMPLE (see first highlighted portion of questionnaire):</u>** During Jimmy's training period, one of the foods he eats is brown bread. He eats brown bread every day for breakfast and for lunch. At each meal he eats about 2 slices of bread.

| **Usual intake during the LAST WEEK** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Column 1** | | **Column 2** | | | | | | | **Column 3** | | | | | |
| | | NO | 1-3 per month | 1-3 per week | 4-6 per week | 1 per day | 2 per day | 3 or more per day | Std portion | 1X std | ½ X std | 1½ X std | 2X std | 3X std |
| | **EXAMPLE** | This person eats 2 slices of brown bread twice a day. | | | | | | | | | | | | |
| | BREAD/ROLLS: brown | | | | | | √ | | 1 roll or 1 med slice | | | | √ | |
| 1 | RED MEAT: low fat cuts (no visible fat) e.g. Steak, lean minces, roast, ham (beef, veal mutton, pork, venison, ostrich) | | | | | | | | 90g/ 3X | | | | | |
| 2 | RED MEAT: high fat cuts e.g. Regular mince, ribs chops with fat (beef, pork, mutton) | | | | | | | | 90g/ 3X | | | | | |
| 3 | HAMBURGER | | | | | | | | 1 | | | | | |
| 4 | SAUSAGE: viennas, russians, frankfurt, boerewors etc. | | | | | | | | 10cm sausage | | | | | |
| 5 | MEAT STEW: e.g. chuck, neck (with or without vegetables) | | | | | | | | 1 cup or 2X | | | | | |
| 6 | CHICKEN/TURKEY: with skin | | | | | | | | 90g/ 3X | | | | | |
| 7 | CHICKEN/TURKEY: without skin | | | | | | | | 90g/ 3X | | | | | |
| 8 | FRIED CHICKEN/ SCHNITZEL: Kentucky or homemade | | | | | | | | 90g/ 3X | | | | | |
| 9 | FISH: fried in fat/oil | | | | | | | | 90g/ 3X | | | | | |
| 10 | FISH: steamed, grilled, braaied (fire) | | | | | | | | 90g/ 3X | | | | | |
| 11 | FISH: tinned sardines, pilchards, salmon, tuna | | | | | | | | 90g/ 3X or ½ small tin | | | | | |
| 12 | ORGAN MEATS: liver, kidney, heart, tripe (beef, sheep, chicken) | | | | | | | | 90g/ 3X | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | SMOKED/CURED: meat, fish, poultry | | | | | | | | 90g/ 3X ❒ | | | | | |
| 14 | BACON | | | | | | | | 1 rasher | | | | | |
| 15 | PROCESSED MEATS: e.g. Polony, salami | | | | | | | | 1 thin slice | | | | | |
| 16 | MEAT PIE/SAUSAGE ROLL | | | | | | | | 1X ◎ or 1 med | | | | | |
| | | | | | | | | | | | | | | |
| | | NO | 1-3 per month | 1-3 per week | 4-6 per week | 1 per day | 2 per day | 3 or more per day | Std portion | 1X std | ½ X std | 1½ X std | 2X std | 3X std |
| 17 | MARGERINE/OIL/FAT IN PREPARATION (added to chicken/ beef/fish) | | | | | | | | 1 tsp | | | | | |
| 18 | EGGS (WITHOUT FAT): boiled/ poached | | | | | | | | 1 egg | | | | | |
| 19 | EGGS (WITH FAT): scrambled/ baked/ omelette | | | | | | | | 1 egg | | | | | |
| 20 | BREAD/ROLLS: white | | | | | | | | 1 roll or 1 med slice | | | | | |
| 21 | BREAD/ROLLS: brown | | | | | | | | 1 roll or 1 med slice | | | | | |
| 22 | BREAD/ROLLS: whole wheat/health/low GI | | | | | | | | 1 roll or 1 med slice | | | | | |
| 23 | PROVITA/ RYVITA | | | | | | | | 2 biscuits | | | | | |
| 24 | PIZZA: commercial/ homemade | | | | | | | | 4 slices | | | | | |
| 25 | BREAKFAST CEREAL: high fibre e.g. All bran, highbulk, muesli, weet-bix, Pro-nutro | | | | | | | | ½ cup or 1 weet-bix or 1X◎ | | | | | |
| 26 | BREAKFAST CEREAL: other e.g. cornflakes, rice crispies, special K | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 27 | OATS/OAT BRAN: cooked porridge | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 28 | MAIZE PORRIDGE: stiff/crumbled | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 29 | RICE: white | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 30 | RICE: brown | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 31 | MEALIE RICE/SAMP | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 32 | CORN: e.g. mealie, sweetcorn | | | | | | | | ½ cup/1 med/ 1X ◎ | | | | | |
| 33 | POPCORN | | | | | | | | 1 cup or 2X ◎ | | | | | |
| 34 | LEGUMES (tinned or dry beans) e.g. baked beans, lentils | | | | | | | | ½ cup or 1X ◎ | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | PASTA: e.g. Macaroni, spaghetti, noodles | | | | | | | | 1 cup or 2X ◎ | | | | | |
| 36 | PASTA SAUCE: white or cheese sauce | | | | | | | | ½ cup | | | | | |
| 37 | POTATO: boiled, mashed, baked | | | | | | | | ½ cup or 1X ◎ or 1 med | | | | | |
| 38 | POTATO: roasted/fried in any fat/oil (includes french-fries/slap chips) | | | | | | | | ½ cup or 1X ◎ or 1 med | | | | | |
| | | | | | | | | | | | | | | |
| | | NO | 1-3 per month | 1-3 per week | 4-6 per week | 1 per day | 2 per day | 3 or more per day | Std portion | 1X std | ½ X std | 1½ X std | 2X std | 3X std |
| 39 | MARGERINE/OIL/FAT IN PREPARATION: (added to pasta, potato, rice) | | | | | | | | 1 tsp | | | | | |
| 40 | FULL CREAM (FRESH/ POWDERED): milk, sour milk (Maas) on porridge/cereal or to drink (excluding milk blends) | | | | | | | | ½ cup or ½ std glass | | | | | |
| 41 | LOW FAT (FRESH/ POWDERED): milk, sour milk (Maas) on porridge/cereal or to drink (excluding milk blends) | | | | | | | | ½ cup or ½ std glass | | | | | |
| 42 | SKIMMED (FRESH/ POWDERED): milk, sour milk (Maas) on porridge/cereal or to drink (excluding milk blends) | | | | | | | | ½ cup or ½ std glass | | | | | |
| 43 | MILK IN TEA/COFFEE: full cream/low fat/skimmed | | | | | | | | 3 Tbs | | | | | |
| 44 | COFFEE CREAMER IN TEA/COFFEE: e.g. Cremora | | | | | | | | 1 tsp | | | | | |
| 45 | YOGHURT: full cream | | | | | | | | ½ cup or 125ml serving | | | | | |
| 46 | YOGHURT: low fat | | | | | | | | ½ cup or 125ml serving | | | | | |
| 47 | YOGHURT: fat free | | | | | | | | ½ cup or 125ml serving | | | | | |
| 48 | DRINKING YOGHURT | | | | | | | | ½ cup or 125ml serving | | | | | |
| 49 | FLAVOURED MILK | | | | | | | | 1 cup | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DRINKS: milo, nesquick, horlicks, sterri-stumpie | | | | | | | | | | | | | |
| 50 | ICE-CREAMS (DAIRY): ice-cream, milkshakes, smoothies, frozen yoghurt | | | | | | | | 1 cup | | | | | |
| 51 | ICE-CREAM (NON-DAIRY): sorbet, milkshakes, smoothies | | | | | | | | 1 cup | | | | | |
| 52 | SMOOTHIES (WITHOUT ICE-CREAM): fruit and ice blend only | | | | | | | | 1 cup | | | | | |
| 53 | CUSTARD, MILK PUDDINGS | | | | | | | | ½ cup | | | | | |
| | | | | | | | | | | | | | | |
| | | NO | 1-3 per month | 1-3 per week | 4-6 per week | 1 per day | 2 per day | 3 or more per day | Std portion | 1X std | ½ X std | 1½ X std | 2X std | 3X std |
| 54 | CHEESE: on bread or in dishes (excluding cottage/cream cheese) | | | | | | | | 1 slice or 1X □ | | | | | |
| 55 | COTTAGE CHEESE | | | | | | | | 1 Tbs | | | | | |
| 56 | CREAM CHEESE | | | | | | | | 1 Tbs | | | | | |
| 57 | REGULAR SALAD DRESSING/ MAYONNAISE | | | | | | | | 1 Tbs | | | | | |
| 58 | LOW FAT/LIGHT SALAD DRESSING/ MAYONNAISE | | | | | | | | 1 Tbs | | | | | |
| 59 | SAUCES: tomato, chutney, mustard, sweet chilli | | | | | | | | 1 Tbs | | | | | |
| 60 | PEANUT BUTTER: | | | | | | | | 1 Tbs | | | | | |
| 61 | PEANUTS: | | | | | | | | 30g or 1X □ | | | | | |
| 62 | OTHER NUTS: | | | | | | | | 30g or 1X □ | | | | | |
| 63 | RAISINS: | | | | | | | | 30g or 1X □ | | | | | |
| 64 | OTHER DRIED FRUIT: | | | | | | | | 30g or 1X □ | | | | | |
| 65 | CITRUS FRUIT: e.g. Oranges, grapefruit, naartjies, minolas etc.* | | | | | | | | 1 med or 1X ● | | | | | |
| 66 | APPLES/PEARS: | | | | | | | | 1 med or 1X ● | | | | | |
| 67 | BANANAS: | | | | | | | | 1 med or 1X ● | | | | | |
| 68 | PEACH/APRICOT:* | | | | | | | | 1 med or 1X ● | | | | | |
| 69 | WATERMELON/ SWEET MELON:* | | | | | | | | 1 large slice | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | GUAVAS:* | | | | | | | | 1 med or 1X ● | | | | | |
| 71 | MANGO/ PAW-PAW/ PINEAPPLE:* | | | | | | | | 1 large slice | | | | | |
| 72 | GRAPES:* | | | | | | | | 8-10 grapes | | | | | |
| 73 | STRAWBERRIES:* | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 74 | AVOCADO:* | | | | | | | | ½ med | | | | | |
| 75 | FRUIT SALAD: tinned/ fresh | | | | | | | | ½ cup or 1X ◎ | | | | | |

*IF A PARTICULAR FRUIT WAS NOT IN SEASON DURING YOUR LAST MONTH OF TRAINING, YOU CAN MARK THE 'NO' COLUMN.

| | | NO | 1-3 per month | 1-3 per week | 4-6 per week | 1 per day | 2 per day | 3 or more per day | Std portion | 1X std | ½ X std | 1½ X std | 2X std | 3X std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 76 | CABBAGE: (raw/ cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 77 | BROCCOLI, CAULIFLOWER, BRUSSEL SPROUTS: (raw/cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 78 | SPINACH/MAROG/ IMIFINO: (raw/ cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 79 | CARROTS (raw/cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 80 | BEETROOT: | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 81 | TOMATO: (raw/cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 82 | ONIONS: (raw/cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 83 | TOMATO AND ONION: stewed | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 84 | GREEN PEAS: (raw/ cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 85 | GREEN BEANS: (raw/ cooked) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 86 | MIXED VEGETABLES: carrots, peas, mealies, beans (in any combination) | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 87 | PUMPKIN, HUBBARD, BUTTERNUT | | | | | | | | ½ cup or 1X ◎ | | | | | |
| 88 | GEM SQUASH, MARROWS, PATTY-PANS | | | | | | | | 1 med/ ½ cup or 1X ◎ | | | | | |
| 89 | MIXED SALAD: lettuce, cucumber, tomato, | | | | | | | | ½ cup or 1X ◎ | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | peppers, onions in any combination | | | | | | | | | | | | | |
| 90 | SWEET POTATOES: | | | | | | | | 1 med/ 1/2 cup or 1X ◎ | | | | | |
| 91 | MARGERINE/OIL/FAT IN PREPARATION: (added to vegetables) | | | | | | | | 1 tsp | | | | | |
| 92 | SUGAR: (white and/or brown added to vegetables) | | | | | | | | 1 tsp (heaped) | | | | | |
| 93 | MUFFIN/SCONE (bran, whole wheat only) | | | | | | | | 1 med or 1X ● | | | | | |
| 94 | MUFFIN/SCONE (all other) chocolate/ poppy-seed etc | | | | | | | | 1 med or 1X ● | | | | | |
| 95 | RUSKS: any | | | | | | | | 1 med or 2X ❒ | | | | | |
| | | | | | | | | | | | | | | |
| | | NO | 1-3 per month | 1-3 per week | 4-6 per week | 1 per day | 2 per day | 3 or more per day | Std portion | 1X std | ½ X std | 1½ X std | 2X std | 3X std |
| 96 | VETKOEK, DOUGHNUTS, SAMOOSAS, KOEKSISTER | | | | | | | | 1 med or 1X ◎ | | | | | |
| 97 | SALTY CRISPS: Simba chips, Lays etc. | | | | | | | | 1 small packet | | | | | |
| 98 | SALTY BISCUITS: Salty Crax etc. | | | | | | | | 2 biscuits | | | | | |
| 99 | ICED CAKES, TARTS, COOKIES with filling | | | | | | | | 1 med piece or 2 cookies or 1X ◎ | | | | | |
| 100 | CAKE: commercial, homemade cakes/ tarts | | | | | | | | 1 med piece or 2 cookies or 1X ◎ | | | | | |
| 101 | JAM/SYRUP/HONEY | | | | | | | | 1 tsp | | | | | |
| 102 | SWEETS: boiled sweets, jellies, toffee | | | | | | | | 4 sweets | | | | | |
| 103 | SWEETS: super C's, energy sweets | | | | | | | | 4 sweets | | | | | |
| 104 | CHOCOLATE | | | | | | | | 1 small bar/2-3 blocks | | | | | |
| 105 | ENERGY/HEALTH/BREA KFAST BARS | | | | | | | | 1 small bar | | | | | |
| 106 | TEA NORMAL (excluding rooibos) | | | | | | | | 1 cup | | | | | |
| 107 | TEA ROOIBOS | | | | | | | | 1 cup | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 108 | COFFEE: instant/ground (excluding decaffeinated) | | | | | | | | 1 cup | | | | | |
| 109 | COFFEE: decaffeinated | | | | | | | | 1 cup | | | | | |
| 110 | SUGAR: (white & brown in tea/coffee) | | | | | | | | 1 tsp (heaped) | | | | | |
| 111 | ORANGE/GUAVA JUICE | | | | | | | | 1 std glass | | | | | |
| 112 | OTHER FRUIT JUICE | | | | | | | | 1 std glass | | | | | |
| 113 | MIXED JUICES/ CORDIALS : e.g. Oros, powdered mixes etc | | | | | | | | 1 std glass | | | | | |
| 114 | ENERGY DRINKS: Energade, Poweradeetc | | | | | | | | 500ml | | | | | |
| 115 | CAFIENATTED ENERGY DRINKS: Red-Bull, Play etc. | | | | | | | | 250ml or 1 Tin | | | | | |
| 116 | WINE: red/white | | | | | | | | 1 wine glass or ± 200ml | | | | | |
| 117 | PORT/SHERRY/ LIQUEUR etc. | | | | | | | | 1 sherry glass | | | | | |
| | | NO | 1-3 per month | 1-3 per week | 4-6 per week | 1 per day | 2 per day | 3 or more per day | Std portion | 1X std | ½ X std | 1½ X std | 2X std | 3X std |
| 118 | REGULAR BEER/ CIDERS/COOLERS | | | | | | | | 340ml (1X can/ bottle) | | | | | |
| 119 | LIGHT BEER/ CIDERS/COOLERS | | | | | | | | 340ml (1X can/ bottle) | | | | | |
| 120 | SPIRITS: brandy, whiskey,rum,vodka,gin | | | | | | | | 1 tot/ shot | | | | | |
| 121 | NON-DIET FIZZY SOFT DRINKS: coke, fanta | | | | | | | | 1 std glass/can | | | | | |
| 122 | DIET FIZZY DRINKS: e.g. Coke zero, coke light, sprite zero etc. | | | | | | | | 1 std glass/can | | | | | |
| 123 | OTHER SOFT DRINKS OR FIZZY FRUIT SQUASH | | | | | | | | 1 std glass/can | | | | | |

**NUTRITION PRACTICE AND NUTRITIONAL SUPPLEMENT INTAKE QUESTIONNAIRE** **APPENDIX 8**

| |
|---|
| **The nutritional profile of high performance junior football players in Western Cape, South Africa.** |

**Subject Number:** | | | | **Date:** | | | | | | |

**Exercise/ sport participation/smoking**

1. For how many years have you been playing soccer at club level: ………………..years

2. On average, how many days do you train per week: ……………………………days/week

3. On average, how many hours do you train per training session: ………………hrs/day

4. On average, how long do you play for on match day: .................................min/match

5. Do you participate in any **other sport/exercise** on a **weekly** basis?

   **Examples:**Jogging, aerobic dance/step, dancing, swimming, martial art, skating, cycling, volleyball, walking, strength/resistance training, squash, hiking, badminton, rock climbing, hockey, netball, tennis, football/soccer, golf, rugby, canoeing

| Yes | No |
|---|---|

**IF NO, go to question 7**

6. **IF YES,** please complete the following table regarding participation in any other sport/exercise.

| Type of sport | Number of sessions per week | Duration of each session |
|---|---|---|

| | | |
|---|---|---|
| | | |
| | | |
| | | |

7. Are you a smoker?

| Yes | No |
|---|---|
| | |

**IF NO, go to question 9**

8. **IF YES,** on average how many do you smoke/day…………………………..cigarettes/day

**Food Intake Information**

9. How many times during the week do you eat (never = 0; or else mention how many times per week) (**complete each** of the 6 options):

| Breakfast | Mid morning snack | Lunch | Afternoon snack | Dinner | After dinner snack |
|---|---|---|---|---|---|
| | | | | | |

10. Are you concerned about your food intake (mark **1 option** in each **row**)

| | Almost never | Sometimes | Often | Almost always |
|---|---|---|---|---|
| During training? | | | | |
| 24 hours prior to a match? | | | | |
| During a match? | | | | |
| During recovery? | | | | |

11. Do you eat a specific meal/food item (mark **1 option** in each **row**)

| | Almost never | Sometimes | Often | Almost always |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| During training? | | | | |
| 24 hours prior to a match? | | | | |
| During a match? | | | | |
| During recovery? | | | | |

12. Indicate the **main** reason when eating a meal/food item during the specified times (mark **1 option** in each**row**):

| | To provide energy | To carbo-load | To provide protein | Ajax provides the meal/food item |
|---|---|---|---|---|
| During training? | | | | |
| 24hrs prior to a match? | | | | |
| During a match? | | | | |
| During recovery? | | | | |

**Fluid intake (hydration)**

13. Do you control OR are you concerned about your fluid intake/hydration (mark **1 option** in each **row**)

| | Almost never | Sometimes | Often | Almost always |
|---|---|---|---|---|
| During training? | | | | |
| 24 hours prior to a match? | | | | |
| During a match? | | | | |
| During recovery? | | | | |

14. Indicate the **1 most important** reason for fluid intake during the specified times (mark **1 option** in each**row**):

| | I drink to thirst | I drink as much as tolerable | I drink according to predetermined fluid intake schedule |
|---|---|---|---|

| | | | |
|---|---|---|---|
| During training | | | |
| 24hrs prior to a match | | | |
| During a match | | | |
| During recovery | | | |

15. What is the **main** reason for drinking a particular drink/fluid **during** a match (mark only **1 option** per drink)?

| | Never use | Thirst | Replace Fluid | Provide Energy | Other |
|---|---|---|---|---|---|
| Water | | | | | |
| Sports drink | | | | | |
| Coke/pepsi | | | | | |
| Other | | | | | |

16. What would your usual **total** fluid intake during a match be? ______ml

17. What would your usual **total** fluid intake during a training session be? _____________ml

**Supplement use**

18. Mark the supplements you used during the past 6 months

| Supplements | Do not use | Daily | Weekly, not every day | Monthly, not every week | Brand if known |
|---|---|---|---|---|---|
| Multi vitamin and mineral | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Vitamin C | | | | | |
| Vitamin E | | | | | |
| Vitamin B complex | | | | | |
| Energy tonic (egbioplus) | | | | | |
| Immune support (eg viral guard) | | | | | |
| Zinc | | | | | |
| Magnesium | | | | | |
| Calcium | | | | | |
| Iron | | | | | |
| Anti-oxidant mix | | | | | |
| Energy drinks | | | | | |
| Energy bars | | | | | |
| Carboloader | | | | | |
| Protein supplement | | | | | |
| Amino acids | | | | | |
| Meal replacement (egmyoplex) | | | | | |
| Recovery drink (eg recovery max) | | | | | |
| Creatine | | | | | |
| HMB | | | | | |
| Cramp attack/cramp stop | | | | | |
| Endurox/Enduraid | | | | | |
| Carnitine | | | | | |
| Glutamine products | | | | | |
| Testosterone enhancers | | | | | |
| DHEA | | | | | |
| Caffeine/ guarana | | | | | |

**Table 30. Triceps skinfold thickness in millimeters for children and adolescents aged 2 months–19 years by sex and age, by mean, standard error of the mean, and selected percentiles: United States 2003–2006**

| Sex and age[1] | Number examined | Mean | Standard error | Percentile | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 5th | 10th | 15th | 25th | 50th | 75th | 85th | 90th | 95th |
| **Male** | | | | Millimeters | | | | | | | | |
| 2 months | 11 | * | * | * | * | * | * | * | * | * | * | * |
| 3–5 months | 128 | 11.0 | 0.25 | * | 8.4 | 8.7 | 9.0 | 10.5 | 12.0 | 13.9 | 14.5 | * |
| 6–8 months | 128 | 10.6 | 0.26 | * | 7.3 | 8.0 | 8.9 | 10.1 | 12.3 | 13.0 | 13.4 | * |
| 9–11 months | 122 | 10.2 | 0.30 | * | * | 7.7 | 8.1 | 9.7 | 11.9 | 12.9 | * | * |
| 1 year | 336 | 9.8 | 0.19 | 6.4 | 7.2 | 7.4 | 8.0 | 9.4 | 11.0 | 12.0 | 12.5 | 14.3 |
| 2 years | 260 | 9.6 | 0.13 | 6.3 | 6.8 | 7.2 | 8.0 | 9.5 | 11.1 | 12.0 | 12.7 | 13.2 |
| 3 years | 195 | 9.3 | 0.21 | * | 6.4 | 6.9 | 7.3 | 9.0 | 10.7 | 11.4 | 12.0 | * |
| 4 years | 199 | 9.1 | 0.26 | * | 6.2 | 6.5 | 7.0 | 8.3 | 10.4 | 11.5 | 12.3 | * |
| 5 years | 197 | 10.0 | 0.32 | * | 6.1 | 6.5 | 7.2 | 8.7 | 11.0 | 12.9 | 15.8 | * |
| 6 years | 173 | 9.8 | 0.25 | * | 6.0 | 6.3 | 7.1 | 8.9 | 11.9 | 13.0 | 14.6 | * |
| 7 years | 176 | 10.5 | 0.53 | * | 6.2 | 6.6 | 7.4 | 8.9 | 12.1 | 13.7 | 15.4 | * |
| 8 years | 146 | 11.7 | 0.69 | * | 6.2 | 6.4 | 7.2 | 10.0 | 14.5 | 17.7 | 20.6 | * |
| 9 years | 173 | 12.6 | 0.51 | * | 6.4 | 6.9 | 7.6 | 11.4 | 16.2 | 19.3 | 20.3 | * |
| 10 years | 169 | 14.4 | 0.54 | * | 7.4 | 8.1 | 8.8 | 12.2 | 18.9 | 21.2 | 24.1 | * |
| 11 years | 147 | 15.3 | 0.93 | * | 7.6 | 8.0 | 9.3 | 13.1 | 19.3 | 24.2 | 26.6 | * |
| 12 years | 265 | 15.4 | 0.56 | 6.1 | 7.4 | 8.4 | 9.5 | 12.9 | 20.4 | 23.4 | 26.5 | 28.9 |
| 13 years | 277 | 14.6 | 0.58 | 6.3 | 6.8 | 7.4 | 8.2 | 12.3 | 18.7 | 23.9 | 26.2 | 28.7 |
| 14 years | 253 | 13.4 | 0.62 | * | 6.4 | 6.8 | 7.8 | 10.4 | 17.7 | 22.6 | 24.9 | * |
| 15 years | 263 | 12.6 | 0.45 | 6.4 | 6.7 | 7.3 | 8.0 | 9.9 | 15.4 | 19.2 | 22.4 | 26.4 |
| 16 years | 290 | 13.6 | 0.47 | 5.8 | 6.2 | 6.8 | 7.4 | 9.9 | 19.1 | 24.5 | 26.3 | 29.1 |
| 17 years | 259 | 12.7 | 0.56 | 5.2 | 6.0 | 6.5 | 7.3 | 10.1 | 17.2 | 19.8 | 22.4 | 26.4 |
| 18 years | 266 | 13.1 | 0.88 | 5.4 | 6.2 | 6.5 | 7.2 | 9.9 | 17.8 | 20.8 | 24.7 | 28.7 |
| 19 years | 254 | 13.6 | 0.72 | * | 5.9 | 6.9 | 7.9 | 11.0 | 16.2 | 22.9 | 26.6 | * |
| **Female** | | | | | | | | | | | | |
| 2 months | 9 | * | * | * | * | * | * | * | * | * | * | * |
| 3–5 months | 91 | 10.8 | 0.31 | * | * | 8.0 | 8.9 | 10.6 | 11.9 | 13.4 | * | * |
| 6–8 months | 120 | 11.1 | 0.30 | * | * | 7.6 | 8.8 | 11.3 | 12.8 | 13.9 | * | * |
| 9–11 months | 118 | 10.8 | 0.24 | * | * | 8.0 | 8.9 | 10.9 | 12.3 | 12.9 | * | * |
| 1 year | 316 | 10.1 | 0.19 | 6.5 | 7.2 | 7.5 | 8.3 | 9.7 | 11.4 | 12.7 | 13.2 | 14.6 |
| 2 years | 299 | 10.5 | 0.21 | 6.3 | 7.0 | 7.7 | 8.4 | 10.1 | 12.4 | 13.2 | 14.2 | 15.3 |
| 3 years | 174 | 10.2 | 0.28 | * | 6.7 | 7.0 | 7.6 | 9.4 | 11.9 | 13.2 | 14.8 | * |
| 4 years | 220 | 10.6 | 0.23 | * | 7.1 | 7.4 | 8.2 | 10.3 | 12.1 | 13.2 | 14.2 | * |
| 5 years | 194 | 10.7 | 0.32 | * | 7.2 | 7.6 | 8.4 | 9.9 | 12.1 | 13.3 | 14.9 | * |
| 6 years | 188 | 10.8 | 0.30 | * | 6.2 | 6.9 | 8.0 | 10.0 | 12.9 | 14.7 | 15.1 | * |
| 7 years | 153 | 12.7 | 0.38 | * | 7.7 | 8.0 | 8.8 | 11.0 | 15.0 | 18.4 | 19.8 | * |
| 8 years | 176 | 12.6 | 0.48 | * | 7.4 | 7.8 | 8.7 | 11.0 | 15.3 | 17.7 | 20.1 | * |
| 9 years | 182 | 15.5 | 0.59 | * | 8.4 | 9.2 | 10.7 | 14.1 | 18.4 | 22.2 | 24.6 | * |
| 10 years | 176 | 16.4 | 0.60 | * | 8.3 | 9.6 | 11.3 | 15.1 | 19.9 | 22.8 | 26.6 | * |
| 11 years | 167 | 17.6 | 0.72 | * | 8.8 | 9.3 | 11.2 | 16.0 | 22.9 | 26.0 | 28.5 | * |
| 12 years | 231 | 16.0 | 0.52 | * | 8.9 | 9.2 | 11.1 | 14.6 | 19.8 | 22.8 | 25.5 | * |
| 13 years | 274 | 18.8 | 0.49 | 9.2 | 10.2 | 10.8 | 12.9 | 18.3 | 23.2 | 26.0 | 29.2 | 32.1 |
| 14 years | 252 | 18.3 | 0.84 | * | 10.1 | 11.1 | 12.9 | 16.2 | 23.9 | 26.4 | 27.6 | * |
| 15 years | 226 | 19.7 | 0.65 | * | 11.0 | 11.9 | 13.8 | 18.5 | 23.8 | 26.4 | 30.0 | * |
| 16 years | 236 | 18.8 | 0.72 | * | 10.5 | 11.2 | 13.2 | 17.1 | 23.3 | 27.0 | 29.3 | * |
| 17 years | 227 | 20.3 | 0.56 | * | 11.3 | 13.1 | 14.6 | 18.7 | 25.1 | 28.0 | 29.7 | * |
| 18 years | 246 | 21.0 | 0.76 | * | 11.1 | 12.8 | 14.8 | 20.1 | 26.2 | 29.9 | 33.2 | * |
| 19 years | 208 | 20.5 | 0.80 | * | 11.2 | 12.3 | 14.2 | 19.9 | 25.2 | 27.1 | 29.5 | * |

* Figure does not meet standards of reliability or precision.
[1]Age shown is age at time of examination.

NOTE: Pregnant females were excluded.

**Table 27. Subscapular skinfold thickness in millimeters for children and adolescents aged 2 months–19 years by sex and age, by mean, standard error of the mean, and selected percentiles: United States 2003–2006**

| Sex and age[1] | Number examined | Mean | Standard error | Percentile 5th | 10th | 15th | 25th | 50th | 75th | 85th | 90th | 95th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | | | | Millimeters | | | | | | | | |
| 2 months | 12 | * | * | * | * | * | * | * | * | * | * | * |
| 3–5 months | 126 | 8.3 | 0.20 | * | * | 6.5 | 7.0 | 7.9 | 9.2 | 10.6 | * | * |
| 6–8 months | 126 | 7.6 | 0.18 | * | * | 5.8 | 6.2 | 7.3 | 8.4 | 9.2 | * | * |
| 9–11 months | 121 | 7.6 | 0.26 | * | * | 5.6 | 5.9 | 7.1 | 9.0 | 9.5 | * | * |
| 1 year | 333 | 6.8 | 0.11 | 4.8 | 5.0 | 5.2 | 5.7 | 6.5 | 7.5 | 8.2 | 8.5 | 9.7 |
| 2 years | 255 | 6.5 | 0.10 | * | 4.8 | 4.9 | 5.2 | 6.0 | 7.1 | 8.2 | 8.5 | * |
| 3 years | 195 | 6.7 | 0.18 | * | 4.4 | 4.7 | 5.2 | 6.2 | 7.7 | 8.4 | 9.1 | * |
| 4 years | 197 | 6.1 | 0.19 | * | 4.1 | 4.3 | 4.8 | 5.4 | 6.3 | 7.3 | 8.4 | * |
| 5 years | 196 | 7.3 | 0.46 | * | 4.3 | 4.5 | 4.9 | 5.9 | 7.3 | 9.1 | 11.9 | * |
| 6 years | 170 | 7.0 | 0.20 | * | 4.3 | 4.5 | 4.9 | 5.9 | 7.9 | 9.2 | 10.5 | * |
| 7 years | 174 | 7.1 | 0.35 | * | 4.3 | 4.5 | 4.9 | 5.9 | 7.5 | 9.0 | 10.4 | * |
| 8 years | 140 | 7.9 | 0.53 | * | 4.2 | 4.4 | 4.8 | 5.9 | 8.7 | 11.3 | 15.0 | * |
| 9 years | 164 | 8.8 | 0.50 | * | 4.4 | 4.9 | 5.4 | 6.7 | 9.7 | 14.3 | 16.5 | * |
| 10 years | 165 | 10.4 | 0.65 | * | 4.9 | 5.1 | 5.9 | 7.4 | 13.4 | 17.1 | 20.4 | * |
| 11 years | 141 | 10.7 | 0.59 | * | 5.2 | 5.4 | 5.9 | 7.8 | 14.8 | 17.3 | 20.5 | * |
| 12 years | 258 | 11.5 | 0.61 | 4.9 | 5.1 | 5.5 | 6.0 | 8.5 | 14.6 | 18.1 | 21.9 | 29.3 |
| 13 years | 272 | 12.0 | 0.64 | 5.0 | 5.6 | 6.1 | 6.6 | 9.3 | 15.2 | 19.8 | 22.4 | 25.8 |
| 14 years | 242 | 10.6 | 0.46 | * | 5.7 | 6.1 | 6.7 | 8.5 | 13.4 | 15.8 | 19.3 | * |
| 15 years | 257 | 11.2 | 0.41 | 6.0 | 6.5 | 6.9 | 7.2 | 9.0 | 12.9 | 15.2 | 20.1 | 24.5 |
| 16 years | 285 | 12.7 | 0.38 | 6.4 | 6.7 | 7.2 | 7.8 | 9.6 | 16.3 | 20.8 | 23.6 | 26.5 |
| 17 years | 256 | 12.7 | 0.60 | 6.2 | 7.1 | 7.5 | 8.2 | 10.0 | 14.4 | 20.5 | 24.2 | 27.8 |
| 18 years | 257 | 13.9 | 0.69 | 7.1 | 7.4 | 8.0 | 8.7 | 10.5 | 17.4 | 21.7 | 24.5 | 28.4 |
| 19 years | 240 | 14.5 | 0.62 | * | 7.8 | 8.2 | 9.1 | 12.4 | 18.0 | 21.4 | 26.1 | * |
| Female | | | | | | | | | | | | |
| 2 months | 10 | * | * | * | * | * | * | * | * | * | * | * |
| 3–5 months | 92 | 8.4 | 0.26 | * | * | 5.9 | 6.4 | 8.1 | 9.6 | 10.4 | * | * |
| 6–8 months | 116 | 8.4 | 0.37 | * | * | 5.9 | 6.3 | 7.8 | 9.6 | 10.8 | * | * |
| 9–11 months | 120 | 8.3 | 0.16 | * | 5.9 | 6.1 | 6.6 | 7.9 | 9.2 | 10.4 | 11.0 | * |
| 1 year | 310 | 7.3 | 0.12 | 4.9 | 5.1 | 5.3 | 5.9 | 6.9 | 8.3 | 8.9 | 9.3 | 10.5 |
| 2 years | 292 | 7.0 | 0.16 | 4.5 | 4.9 | 5.0 | 5.4 | 6.3 | 7.9 | 9.0 | 9.8 | 10.7 |
| 3 years | 173 | 7.2 | 0.23 | * | 4.6 | 4.9 | 5.3 | 6.5 | 8.0 | 9.1 | 11.0 | * |
| 4 years | 216 | 7.2 | 0.21 | * | 4.9 | 5.0 | 5.2 | 6.3 | 7.9 | 9.5 | 10.4 | * |
| 5 years | 191 | 7.8 | 0.40 | * | 4.9 | 5.2 | 5.4 | 6.3 | 8.2 | 9.9 | 12.1 | * |
| 6 years | 185 | 7.5 | 0.24 | * | 4.5 | 4.8 | 5.3 | 6.5 | 8.4 | 10.3 | 11.8 | * |
| 7 years | 148 | 8.5 | 0.40 | * | 4.6 | 5.0 | 5.4 | 7.3 | 9.8 | 11.9 | 12.9 | * |
| 8 years | 174 | 9.1 | 0.53 | * | 4.7 | 5.0 | 5.5 | 6.8 | 10.1 | 13.4 | 17.9 | * |
| 9 years | 174 | 11.1 | 0.50 | * | 5.4 | 6.1 | 6.7 | 9.4 | 13.7 | 17.6 | 19.0 | * |
| 10 years | 168 | 12.1 | 0.44 | * | 5.7 | 6.1 | 7.4 | 10.1 | 16.1 | 19.1 | 20.2 | * |
| 11 years | 158 | 13.5 | 0.61 | * | 6.3 | 6.8 | 8.0 | 11.5 | 17.9 | 21.0 | 23.2 | * |
| 12 years | 225 | 12.4 | 0.61 | * | 6.1 | 6.9 | 7.9 | 10.6 | 15.3 | 19.0 | 20.6 | * |
| 13 years | 268 | 14.6 | 0.65 | 6.0 | 7.1 | 7.7 | 8.7 | 12.7 | 18.3 | 23.9 | 26.3 | 28.9 |
| 14 years | 240 | 14.0 | 0.72 | 6.9 | 7.6 | 8.1 | 9.0 | 11.7 | 16.3 | 20.8 | 24.1 | 29.8 |
| 15 years | 220 | 15.7 | 0.49 | * | 7.9 | 8.6 | 9.9 | 13.9 | 20.2 | 22.8 | 24.4 | * |
| 16 years | 226 | 14.8 | 0.52 | * | 8.1 | 8.6 | 9.3 | 12.9 | 17.5 | 20.7 | 24.9 | * |
| 17 years | 213 | 16.2 | 0.56 | * | 8.3 | 9.0 | 10.5 | 14.2 | 19.6 | 24.6 | 27.3 | * |
| 18 years | 226 | 16.7 | 0.62 | * | 8.4 | 9.3 | 10.8 | 15.0 | 20.9 | 24.2 | 25.8 | * |
| 19 years | 192 | 18.2 | 0.78 | * | 8.5 | 9.0 | 10.7 | 16.5 | 24.4 | 25.9 | 28.1 | * |

* Figure does not meet standards of reliability or precision.
[1]Age shown is age at time of examination.
NOTE: Pregnant females were excluded.

## Means, Standard Deviations, and Percentiles of Sum of Skinfold Thickness (mm) by Age for Males and Females of 1 to 74 Years

| | | | | Percentile | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age (yrs) | *N* | Mean | SD | 5th | 10th | 15th | 25th | 50th | 75th | 85th | 90th | 95th |
| Males | | | | | | | | | | | | |
| 1.0–1.9 | 681 | 16.8 | 4.1 | 11.0 | 12.0 | 12.5 | 14.0 | 16.5 | 19.0 | 21.0 | 22.0 | 24.0 |
| 2.0–2.9 | 677 | 16.0 | 4.3 | 10.0 | 11.0 | 12.0 | 13.0 | 15.5 | 18.0 | 20.0 | 21.5 | 24.0 |
| 3.0–3.9 | 716 | 15.4 | 4.1 | 10.5 | 11.0 | 12.0 | 13.0 | 14.5 | 17.5 | 19.0 | 20.5 | 23.0 |
| 4.0–4.9 | 707 | 14.5 | 4.2 | 9.5 | 10.5 | 11.0 | 12.0 | 14.0 | 16.5 | 18.0 | 19.0 | 21.5 |
| 5.0–5.9 | 677 | 14.2 | 5.0 | 9.0 | 10.0 | 10.0 | 11.0 | 13.0 | 16.0 | 18.0 | 19.0 | 22.0 |
| 6.0–6.9 | 298 | 14.3 | 6.7 | 8.0 | 9.0 | 10.0 | 10.5 | 13.0 | 15.2 | 18.0 | 20.0 | 28.0 |
| 7.0–7.9 | 312 | 14.8 | 6.9 | 8.5 | 9.0 | 9.5 | 10.5 | 13.0 | 16.0 | 19.5 | 23.0 | 26.6 |
| 8.0–8.9 | 296 | 15.6 | 7.8 | 8.5 | 9.0 | 10.0 | 11.0 | 13.5 | 17.0 | 20.0 | 24.5 | 30.5 |
| 9.0–9.9 | 322 | 17.0 | 9.4 | 8.5 | 9.5 | 10.0 | 11.0 | 14.0 | 19.0 | 24.0 | 29.0 | 34.0 |
| 10.0–10.9 | 334 | 19.1 | 10.6 | 9.0 | 10.0 | 11.0 | 12.0 | 15.5 | 22.0 | 27.0 | 33.5 | 42.0 |
| 11.0–11.9 | 324 | 21.4 | 13.9 | 9.0 | 10.0 | 11.0 | 12.5 | 16.5 | 25.0 | 33.0 | 40.0 | 53.5 |
| 12.0–12.9 | 348 | 21.0 | 13.2 | 9.0 | 10.0 | 11.0 | 12.5 | 17.0 | 24.0 | 34.0 | 40.5 | 53.0 |
| 13.0–13.9 | 350 | 19.8 | 13.3 | 8.5 | 10.5 | 11.0 | 12.5 | 15.0 | 21.0 | 29.0 | 37.0 | 48.0 |
| 14.0–14.9 | 358 | 19.4 | 12.6 | 9.0 | 10.0 | 11.0 | 12.0 | 15.0 | 22.0 | 27.0 | 33.0 | 45.0 |
| 15.0–15.9 | 356 | 19.3 | 12.8 | 10.0 | 10.5 | 11.0 | 12.0 | 15.0 | 21.0 | 27.0 | 32.5 | 43.0 |
| 16.0–16.9 | 349 | 20.0 | 11.4 | 10.0 | 11.5 | 12.0 | 13.0 | 16.0 | 22.5 | 27.5 | 33.5 | 44.0 |
| 17.0–17.9 | 337 | 19.1 | 10.8 | 10.0 | 11.0 | 12.0 | 13.0 | 16.0 | 22.0 | 27.0 | 31.5 | 41.0 |
| 18.0–24.9 | 1748 | 24.6 | 13.1 | 11.0 | 12.0 | 13.5 | 15.0 | 21.0 | 30.0 | 37.0 | 41.5 | 50.5 |
| 25.0–29.9 | 1246 | 27.6 | 13.9 | 11.5 | 13.0 | 14.0 | 17.0 | 24.5 | 35.0 | 41.0 | 46.0 | 54.5 |
| 30.0–34.9 | 938 | 30.4 | 14.1 | 12.0 | 14.5 | 16.5 | 20.0 | 28.0 | 38.0 | 44.0 | 49.0 | 58.0 |
| 35.0–39.9 | 829 | 30.3 | 13.3 | 12.0 | 14.5 | 16.5 | 21.0 | 29.0 | 37.0 | 42.4 | 47.0 | 54.5 |
| 40.0–44.9 | 816 | 30.1 | 13.3 | 13.0 | 15.0 | 16.5 | 20.5 | 28.5 | 37.0 | 42.5 | 47.5 | 55.0 |
| 45.0–49.9 | 856 | 30.9 | 13.6 | 12.5 | 15.0 | 17.5 | 20.5 | 29.0 | 39.0 | 44.0 | 48.0 | 55.0 |
| 50.0–54.9 | 872 | 30.1 | 13.1 | 13.0 | 15.0 | 17.0 | 20.5 | 28.0 | 37.5 | 43.0 | 48.0 | 55.5 |
| 55.0–59.9 | 802 | 29.9 | 12.7 | 12.0 | 15.0 | 17.0 | 21.0 | 28.5 | 37.0 | 43.0 | 47.0 | 53.5 |
| 60.0–64.9 | 1250 | 30.5 | 13.1 | 13.0 | 15.5 | 17.5 | 21.0 | 29.0 | 37.5 | 43.0 | 47.0 | 55.5 |
| 65.0–69.9 | 1770 | 28.9 | 13.1 | 11.0 | 13.5 | 16.0 | 19.5 | 27.0 | 36.0 | 42.0 | 46.5 | 53.5 |
| 70.0–74.9 | 1247 | 28.2 | 12.4 | 11.5 | 14.0 | 16.0 | 19.0 | 26.0 | 35.0 | 41.0 | 45.0 | 51.0 |

Percentiles of upper arm circmference (mm) and estimated upper arm muscle circumference (mm) for whites of the United States Health and Nutrition Examination Survey I of 1971 to 1974

| Age group | Arm circumference (mm) | | | | | | | Arm muscle circumference (mm) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 25 | 50 | 75 | 90 | 95 | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| **Males** | | | | | | | | | | | | | | |
| 1–1.9 | 142 | 146 | 150 | 159 | 170 | 176 | 183 | 110 | 113 | 119 | 127 | 135 | 144 | 147 |
| 2–2.9 | 141 | 145 | 153 | 162 | 170 | 178 | 185 | 111 | 114 | 122 | 130 | 140 | 146 | 150 |
| 3–3.9 | 150 | 153 | 160 | 167 | 175 | 184 | 190 | 117 | 123 | 131 | 137 | 143 | 148 | 153 |
| 4–4.9 | 149 | 154 | 162 | 171 | 180 | 186 | 192 | 123 | 126 | 133 | 141 | 148 | 156 | 159 |
| 5–5.9 | 153 | 160 | 167 | 175 | 185 | 195 | 204 | 128 | 133 | 140 | 147 | 154 | 162 | 169 |
| 6–6.9 | 155 | 159 | 167 | 179 | 188 | 209 | 228 | 131 | 135 | 142 | 151 | 161 | 170 | 177 |
| 7–7.9 | 162 | 167 | 177 | 187 | 201 | 223 | 230 | 137 | 139 | 151 | 160 | 168 | 177 | 190 |
| 8–8.9 | 162 | 170 | 177 | 190 | 202 | 220 | 245 | 140 | 145 | 154 | 162 | 170 | 182 | 187 |
| 9–9.9 | 175 | 178 | 187 | 200 | 217 | 249 | 257 | 151 | 154 | 161 | 170 | 183 | 196 | 202 |
| 10–10.9 | 181 | 184 | 196 | 210 | 231 | 262 | 274 | 156 | 160 | 166 | 180 | 191 | 209 | 221 |
| 11–11.9 | 186 | 190 | 202 | 223 | 244 | 261 | 280 | 159 | 165 | 173 | 183 | 195 | 205 | 230 |
| 12–12.9 | 193 | 200 | 214 | 232 | 254 | 282 | 303 | 167 | 171 | 182 | 195 | 210 | 223 | 241 |
| 13–13.9 | 194 | 211 | 228 | 247 | 263 | 286 | 301 | 172 | 179 | 196 | 211 | 226 | 238 | 245 |
| 14–14.9 | 220 | 226 | 237 | 253 | 283 | 303 | 322 | 189 | 199 | 212 | 223 | 240 | 260 | 264 |
| 15–15.9 | 222 | 229 | 244 | 264 | 284 | 311 | 320 | 199 | 204 | 218 | 237 | 254 | 266 | 272 |
| 16–16.9 | 244 | 248 | 262 | 278 | 303 | 324 | 343 | 213 | 225 | 234 | 249 | 269 | 287 | 296 |
| 17–17.9 | 246 | 253 | 267 | 285 | 308 | 336 | 347 | 224 | 231 | 245 | 258 | 273 | 294 | 312 |
| 18–18.9 | 245 | 260 | 276 | 297 | 321 | 353 | 379 | 226 | 237 | 252 | 264 | 283 | 298 | 324 |
| 19–24.9 | 262 | 272 | 288 | 308 | 331 | 355 | 372 | 238 | 245 | 257 | 273 | 289 | 309 | 321 |
| 25–34.9 | 271 | 282 | 300 | 319 | 342 | 362 | 375 | 243 | 250 | 264 | 279 | 298 | 314 | 326 |
| 35–44.9 | 278 | 287 | 305 | 326 | 345 | 363 | 374 | 247 | 255 | 269 | 286 | 302 | 318 | 327 |
| 45–54.9 | 267 | 281 | 301 | 322 | 342 | 362 | 376 | 239 | 249 | 265 | 281 | 300 | 315 | 326 |
| 55–64.9 | 258 | 273 | 296 | 317 | 336 | 355 | 369 | 236 | 245 | 260 | 278 | 295 | 310 | 320 |
| 65–74.9 | 248 | 263 | 285 | 307 | 325 | 344 | 355 | 223 | 235 | 251 | 268 | 284 | 298 | 306 |
| **Females** | | | | | | | | | | | | | | |
| 1–1.9 | 138 | 142 | 148 | 156 | 164 | 172 | 177 | 105 | 111 | 117 | 124 | 132 | 139 | 143 |
| 2–2.9 | 142 | 145 | 152 | 160 | 167 | 176 | 184 | 111 | 114 | 119 | 126 | 133 | 142 | 147 |
| 3–3.9 | 143 | 150 | 158 | 167 | 175 | 183 | 189 | 113 | 119 | 124 | 132 | 140 | 146 | 152 |
| 4–4.9 | 149 | 154 | 160 | 169 | 177 | 184 | 191 | 115 | 121 | 128 | 136 | 144 | 152 | 157 |
| 5–5.9 | 153 | 157 | 165 | 175 | 185 | 203 | 211 | 125 | 128 | 134 | 142 | 151 | 159 | 165 |
| 6–6.9 | 156 | 162 | 170 | 176 | 187 | 204 | 211 | 130 | 133 | 138 | 145 | 154 | 166 | 171 |
| 7–7.9 | 164 | 167 | 174 | 183 | 199 | 216 | 231 | 129 | 135 | 142 | 151 | 160 | 171 | 176 |
| 8–8.9 | 168 | 172 | 183 | 195 | 214 | 247 | 261 | 138 | 140 | 151 | 160 | 171 | 183 | 194 |
| 9–9.9 | 178 | 182 | 194 | 211 | 224 | 251 | 260 | 147 | 150 | 158 | 167 | 180 | 194 | 198 |
| 10–10.9 | 174 | 182 | 193 | 210 | 228 | 251 | 265 | 148 | 150 | 159 | 170 | 180 | 190 | 197 |
| 11–11.9 | 185 | 194 | 208 | 224 | 248 | 276 | 303 | 150 | 158 | 171 | 181 | 196 | 217 | 223 |
| 12–12.9 | 194 | 203 | 216 | 237 | 256 | 282 | 294 | 162 | 166 | 180 | 191 | 201 | 214 | 220 |
| 13–13.9 | 202 | 211 | 223 | 243 | 271 | 301 | 338 | 169 | 175 | 183 | 198 | 211 | 226 | 240 |
| 14–14.9 | 214 | 223 | 237 | 252 | 272 | 304 | 322 | 174 | 179 | 190 | 201 | 216 | 232 | 247 |
| 15–15.9 | 208 | 221 | 239 | 254 | 279 | 300 | 322 | 175 | 178 | 189 | 202 | 215 | 228 | 244 |
| 16–16.9 | 218 | 224 | 241 | 258 | 283 | 318 | 334 | 170 | 180 | 190 | 202 | 216 | 234 | 249 |
| 17–17.9 | 220 | 227 | 241 | 264 | 295 | 324 | 350 | 175 | 183 | 194 | 205 | 221 | 239 | 257 |
| 18–18.9 | 222 | 227 | 241 | 258 | 281 | 312 | 325 | 174 | 179 | 191 | 202 | 215 | 237 | 245 |
| 19–24.9 | 221 | 230 | 247 | 265 | 290 | 319 | 345 | 179 | 185 | 195 | 207 | 221 | 236 | 249 |
| 25–34.9 | 233 | 240 | 256 | 277 | 304 | 342 | 368 | 183 | 188 | 199 | 212 | 228 | 246 | 264 |
| 35–44.9 | 241 | 251 | 267 | 290 | 317 | 356 | 378 | 186 | 192 | 205 | 218 | 236 | 257 | 272 |
| 45–54.9 | 242 | 256 | 274 | 299 | 328 | 362 | 384 | 187 | 193 | 206 | 220 | 238 | 260 | 274 |
| 55–64.9 | 243 | 257 | 280 | 303 | 335 | 367 | 385 | 187 | 196 | 209 | 225 | 244 | 266 | 280 |
| 65–74.9 | 240 | 252 | 274 | 299 | 326 | 356 | 373 | 185 | 195 | 208 | 225 | 244 | 264 | 279 |

TABLE 3
Percentiles for estimates of upper arm fat area (mm$^2$) and upper arm muscle area (mm$^2$) for whites of the United States Health Examination Survey I of 1971 to 1974

| Age group | Arm muscle area percentiles (mm$^2$) | | | | | | | Arm fat area percentiles (mm$^2$) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 25 | 50 | 75 | 90 | 95 | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| **Males** | | | | | | | | | | | | | | |
| 1–1.9 | 956 | 1014 | 1133 | 1278 | 1447 | 1644 | 1720 | 452 | 486 | 590 | 741 | 895 | 1036 | 1176 |
| 2–2.9 | 973 | 1040 | 1190 | 1345 | 1557 | 1690 | 1787 | 434 | 504 | 578 | 737 | 871 | 1044 | 1148 |
| 3–3.9 | 1095 | 1201 | 1357 | 1484 | 1618 | 1750 | 1853 | 464 | 519 | 590 | 736 | 868 | 1071 | 1151 |
| 4–4.9 | 1207 | 1264 | 1408 | 1579 | 1747 | 1926 | 2008 | 428 | 494 | 598 | 722 | 859 | 989 | 1085 |
| 5–5.9 | 1298 | 1411 | 1550 | 1720 | 1884 | 2089 | 2285 | 446 | 488 | 582 | 713 | 914 | 1176 | 1299 |
| 6–6.9 | 1360 | 1447 | 1605 | 1815 | 2056 | 2297 | 2493 | 371 | 446 | 539 | 678 | 896 | 1115 | 1519 |
| 7–7.9 | 1497 | 1548 | 1808 | 2027 | 2246 | 2494 | 2886 | 423 | 473 | 574 | 758 | 1011 | 1393 | 1511 |
| 8–8.9 | 1550 | 1664 | 1895 | 2089 | 2296 | 2628 | 2788 | 410 | 460 | 588 | 725 | 1003 | 1248 | 1558 |
| 9–9.9 | 1811 | 1884 | 2067 | 2288 | 2657 | 3053 | 3257 | 485 | 527 | 635 | 859 | 1252 | 1864 | 2081 |
| 10–10.9 | 1930 | 2027 | 2182 | 2575 | 2903 | 3486 | 3882 | 523 | 543 | 738 | 982 | 1376 | 1906 | 2609 |
| 11–11.9 | 2016 | 2156 | 2382 | 2670 | 3022 | 3359 | 4226 | 536 | 595 | 754 | 1148 | 1710 | 2348 | 2574 |
| 12–12.9 | 2216 | 2339 | 2649 | 3022 | 3496 | 3968 | 4640 | 554 | 650 | 874 | 1172 | 1558 | 2536 | 3580 |
| 13–13.9 | 2363 | 2546 | 3044 | 3553 | 4081 | 4502 | 4794 | 475 | 570 | 812 | 1096 | 1702 | 2744 | 3322 |
| 14–14.9 | 2830 | 3147 | 3586 | 3963 | 4575 | 5368 | 5530 | 453 | 563 | 786 | 1082 | 1608 | 2746 | 3508 |
| 15–15.9 | 3138 | 3317 | 3788 | 4481 | 5134 | 5631 | 5900 | 521 | 595 | 690 | 931 | 1423 | 2434 | 3100 |
| 16–16.9 | 3625 | 4044 | 4352 | 4951 | 5753 | 6576 | 6980 | 542 | 593 | 844 | 1078 | 1746 | 2280 | 3041 |
| 17–17.9 | 3998 | 4252 | 4777 | 5286 | 5950 | 6886 | 7726 | 598 | 698 | 827 | 1096 | 1636 | 2407 | 2888 |
| 18–18.9 | 4070 | 4481 | 5066 | 5552 | 6374 | 7067 | 8355 | 560 | 665 | 860 | 1264 | 1947 | 3302 | 3928 |
| 19–24.9 | 4508 | 4777 | 5274 | 5913 | 6660 | 7606 | 8200 | 594 | 743 | 963 | 1406 | 2231 | 3098 | 3652 |
| 25–34.9 | 4694 | 4963 | 5541 | 6214 | 7067 | 7847 | 8436 | 675 | 831 | 1174 | 1752 | 2459 | 3246 | 3786 |
| 35–44.9 | 4844 | 5181 | 5740 | 6490 | 7265 | 8034 | 8488 | 703 | 851 | 1310 | 1792 | 2463 | 3098 | 3624 |
| 45–54.9 | 4546 | 4946 | 5589 | 6297 | 7142 | 7918 | 8458 | 749 | 922 | 1254 | 1741 | 2359 | 3245 | 3928 |
| 55–64.9 | 4422 | 4783 | 5381 | 6144 | 6919 | 7670 | 8149 | 658 | 839 | 1166 | 1645 | 2236 | 2976 | 3466 |
| 65–74.9 | 3973 | 4411 | 5031 | 5716 | 6432 | 7074 | 7453 | 573 | 753 | 1122 | 1621 | 2199 | 2876 | 3327 |
| **Females** | | | | | | | | | | | | | | |
| 1–1.9 | 885 | 973 | 1084 | 1221 | 1378 | 1535 | 1621 | 401 | 466 | 578 | 706 | 847 | 1022 | 1140 |
| 2–2.9 | 973 | 1029 | 1119 | 1269 | 1405 | 1595 | 1727 | 469 | 526 | 642 | 747 | 894 | 1061 | 1173 |
| 3–3.9 | 1014 | 1133 | 1227 | 1396 | 1563 | 1690 | 1846 | 473 | 529 | 656 | 822 | 967 | 1106 | 1158 |
| 4–4.9 | 1058 | 1171 | 1313 | 1475 | 1644 | 1832 | 1958 | 490 | 541 | 654 | 766 | 907 | 1109 | 1236 |
| 5–5.9 | 1238 | 1301 | 1423 | 1598 | 1825 | 2012 | 2159 | 470 | 529 | 647 | 812 | 991 | 1330 | 1536 |
| 6–6.9 | 1354 | 1414 | 1513 | 1683 | 1877 | 2182 | 2323 | 464 | 508 | 638 | 827 | 1009 | 1263 | 1436 |
| 7–7.9 | 1330 | 1441 | 1602 | 1815 | 2045 | 2332 | 2469 | 491 | 560 | 706 | 920 | 1135 | 1407 | 1644 |
| 8–8.9 | 1513 | 1566 | 1808 | 2034 | 2327 | 2657 | 2996 | 527 | 634 | 769 | 1042 | 1383 | 1872 | 2482 |
| 9–9.9 | 1723 | 1788 | 1976 | 2227 | 2571 | 2987 | 3112 | 642 | 690 | 933 | 1219 | 1584 | 2171 | 2524 |
| 10–10.9 | 1740 | 1784 | 2019 | 2296 | 2583 | 2873 | 3093 | 616 | 702 | 842 | 1141 | 1608 | 2500 | 3005 |
| 11–11.9 | 1784 | 1987 | 2316 | 2612 | 3071 | 3739 | 3953 | 707 | 802 | 1015 | 1301 | 1942 | 2730 | 3690 |
| 12–12.9 | 2092 | 2182 | 2579 | 2904 | 3225 | 3655 | 3847 | 782 | 854 | 1090 | 1511 | 2056 | 2666 | 3369 |
| 13–13.9 | 2269 | 2426 | 2657 | 3130 | 3529 | 4081 | 4568 | 726 | 838 | 1219 | 1625 | 2374 | 3272 | 4150 |
| 14–14.9 | 2418 | 2562 | 2874 | 3220 | 3704 | 4294 | 4850 | 981 | 1043 | 1423 | 1818 | 2403 | 3250 | 3765 |
| 15–15.9 | 2426 | 2518 | 2847 | 3248 | 3689 | 4123 | 4756 | 839 | 1126 | 1396 | 1886 | 2544 | 3093 | 4195 |
| 16–16.9 | 2308 | 2567 | 2865 | 3248 | 3718 | 4353 | 4946 | 1126 | 1351 | 1663 | 2006 | 2598 | 3374 | 4236 |
| 17–17.9 | 2442 | 2674 | 2996 | 3336 | 3883 | 4552 | 5251 | 1042 | 1267 | 1463 | 2104 | 2977 | 3864 | 5159 |
| 18–18.9 | 2398 | 2538 | 2917 | 3243 | 3694 | 4461 | 4767 | 1003 | 1230 | 1616 | 2104 | 2617 | 3508 | 3733 |
| 19–24.9 | 2538 | 2728 | 3026 | 3406 | 3877 | 4439 | 4940 | 1046 | 1198 | 1596 | 2166 | 2959 | 4050 | 4896 |
| 25–34.9 | 2661 | 2826 | 3148 | 3573 | 4138 | 4806 | 5541 | 1173 | 1399 | 1841 | 2548 | 3512 | 4690 | 5560 |
| 35–44.9 | 2750 | 2948 | 3359 | 3783 | 4428 | 5240 | 5877 | 1336 | 1619 | 2158 | 2898 | 3932 | 5093 | 5847 |
| 45–54.9 | 2784 | 2956 | 3378 | 3858 | 4520 | 5375 | 5964 | 1459 | 1803 | 2447 | 3244 | 4229 | 5416 | 6140 |
| 55–64.9 | 2784 | 3063 | 3477 | 4045 | 4750 | 5632 | 6247 | 1345 | 1879 | 2520 | 3369 | 4360 | 5276 | 6152 |
| 65–74.9 | 2737 | 3018 | 3444 | 4019 | 4739 | 5566 | 6214 | 1363 | 1681 | 2266 | 3063 | 3943 | 4914 | 5530 |