A PILOT PROJECT TO INVESTIGATE THE NUTRITIONAL ATTITUDE OF ATHLETES

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Declaration

This dissertation does not contain any material which has been previously submitted for a degree or diploma in any university. To the best of my knowledge and belief, the material herein is entirely original and has not been previously reported by any other person, except where indicated to the contrary.

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May 2004
This work is dedicated to my family,
without whose support
this work would never
have materialised.
Abstract

Nutrition plays a critical role in athletic performance but many athletes do not follow a diet that helps them reach their full potential (Kleiner, 1997). Elite athletes utilise dietary knowledge as a critical and integral component of their training. In many studies dietary intervention has been shown to have a positive effect on athletic performance (Grandjean, 1997).

It is not suggested that athletes need a diet which is substantially different from that recommended to the general population (American Dietetic Association et al, 2000). However, at the same time, different demands on speed or endurance do require a specific dietary regime pre, post and during an athletic event.

Eating adequately from a variety of foods will satisfy the need for macronutrients and micronutrients (Kleiner, 1997). Generally speaking, athletes do not necessarily need vitamin and mineral supplements if intake of a wide variety of foods provides adequate energy to maintain body weight (ADA et al, 2000).

Dietary choices are therefore a key to getting the best out of an athlete's performance for a given training regime, history and genetic makeup. It has been shown that knowledge of the right dietary practice is one of the main determinants of the diet adopted. For example in a study by Variyam
et al (1998), higher education was found to promote more healthful food choices as a result of better access and use of health information.

The eating choices people make are based on a wide variety of factors: economic, ethnic, religious, convenience, family, time, taste, health implications and many others. From these and other factors Thomas (1991), singles out knowledge of nutrition and beliefs about foods and health as the most amenable to modification and hence the quickest way to change dietary decisions.

This study reports on a pilot project whose aim is to get an insight on the dietary practices of athletes and to see how their nutritional knowledge affects these dietary practices.

The primary source of field data has been via questionnaires distributed to active athletes in four disciplines: volleyball, basketball, track and field athletics and football refereeing. Questions were designed to capture demographic and biometrical data, indication of commitment to sport, diet and eating habits. A food frequency questionnaire was also distributed to gain further insight on their dietary practices. The combination of this data allowed the author to extract their level of dietary knowledge and compare that to the nutritional practice followed.

200 questionnaires were distributed with an overall response rate of 29% with a distribution across sports disciplines as follows: 44% from football
referees, 34% from track and field athletes, 28% from volleyball players and 12% from basketball players.

The study found that dietary practice and nutritional knowledge do not vary significantly between genders or across sports discipline or by age. It has also been concluded that there is a significant positive correlation between nutritional knowledge and the diet adopted by local athletes.
Acknowledgments

The work presented in this project would not have been possible without the help of many people, whose help and support I would like to acknowledge here.

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Chapter 1

Introduction
CHAPTER 1

INTRODUCTION

Section 1.1: Nutrition and Sports Performance

Physical activity, athletic performance and recovery from exercise are enhanced by optimal nutrition. This is the position statement of The American Dietetic Association, Dietitians of Canada and the American College of Sports Medicine who have jointly issued a position paper which reviews scientific data related to Nutrition and athletic performance. What an athlete eats and drinks can affect health, body weight and composition, substrate availability during exercise, recovery time after exercise and ultimately, exercise performance (ADA, 2000).

Recommendations for athletes' intakes of energy, macronutrients, vitamins and minerals are often presented in terms of milligram or gram amounts of nutrients per kg body weight and must be translated into food choices consistent with food preferences and training schedules of athletes (Rosenbloom, 2000). The proportion of energy from protein, fat and carbohydrate for the training diets of athletes, do not differ substantively from current recommendations for the general population (ADA, 2000). The fundamental differences between an athlete's diet and that of the general population are that athletes require additional fluid to cover sweat losses and additional energy to fuel physical activity (ADA, 2000).
Section 1.2: Influence on eating habits

A number of factors that influence food consumption have been identified. Variyam et al (1998) have put these factors under four broad categories: consumer incomes; prices of food and other goods; consumers' knowledge of health and nutrition; and tastes and preferences. The study goes on to state that in order to change the pattern of food consumption, one (or more) of these influences must change. Nutrition education efforts attempt to change consumers' knowledge of nutrition and behaviour.

Perron et al (1985) showed that factors such as weight management, nutrition knowledge, attitude, food availability, food preferences and income, all have an impact on an individual’s food selection and thereby on his or her energy and nutrient intake.

Nutrition is but one of many attributes people consider in their food choices. Qualities such as taste, variety and convenience may take precedence over nutrition in people’s food consumption decisions (Bishow et al, 1998). Other factors include family eating practices, ethnic, religious and social pressures that all act in some way or other to mould an individual’s eating habits.

Section 1.2.1: Nutrition knowledge

Nutrition knowledge has an important influence on nutritional intake. Higher education promotes more healthful food choices through better gaining and utilisation of health information (Varyiam et al, 1998). Authors in this study classified subjects according to their formal level of education: less than high school, high school and
more than high school. It was concluded that more-educated individuals may acquire, process and retain information more easily and thus have a higher stock of nutrition knowledge, which is then reflected in the choice of certain foods (Variyam et al, 1998).

A number of studies have examined the correlation between knowledge and diet behaviour. Some have found a positive correlation between nutrition knowledge and diet behaviour in female athletes (Werblow et al, 1978; Parr et al, 1984); others have found knowledge, attitudes and behaviour to be significantly interrelated (Johnson et al, 1985; Axelson et al, 1992), whereas others have found no significant correlations (Clark et al, 1988; Welch et al, 1987).

Section 1.2.2: Other factors that influence nutritional intake

As described earlier, other factors apart from knowledge have been used to explain in part variations in eating patterns across individuals. For example, Variyam et al, (1998) quotes income, education levels, race, ethnicity and age as key variables. Of course, some of these variables are not independent and there is a certain level of interrelation among the explaining variables e.g. education and income levels are usually shown to be positively correlated.

Economic factors, such as food prices and consumers’ incomes, are also important influences on the decision of food consumption (Huang, 1997).

Variyam et al (1998) studied dietary practice amongst various socio-demographic groups. These revealed that an individual's healthy eating index (IEI) improved with
higher income and more education. Women also tended to score higher than men in HEI in this study by Variyam. The role that women have often played in food preparation and shopping, especially in Southern European / Mediterranean cultures like Malta, may lead us to expect that they have a higher stock of nutrition information than men. Therefore, does this gender variable point to increased nutrition information amongst women?

Age also seems to be a factor - in fact some have found that older people practice better nutrition. For example in the study of Variyam et al (1998), people over 69 years of age scored higher in healthy eating index than individuals under 30 years old.

Section 1.3: Ergogenic Aids

A large number of amateur and professional athletes use numerous ergogenic aids that claim to enhance sports performance (Ahrendt, 2001; Sobal et al, 1994).

While some supplements may be of some benefit to some individuals in some situations, there is little doubt that most products fail to meet purported claims of efficacy. This can be seen from a useful table that Ahrendt (2001) provides where he summarizes the ergogenic claims of current supplements and the evidence for or against their effectiveness (Appendix D).

Athletes are particularly vulnerable to the pressures of victory and are often blind to the consequences when competing to win. Ahrendt (2001) points out that the danger in athletes using commercial supplementation lies in the fact that once they start
using these supplements, they will continue to use more, eventually trying something that may be unsafe.

**Section 1.4: Macro & Micronutrient Requirements for Athletes**

It is not suggested that athletes need a diet which is substantially different from that recommended to the general population (ADA *et al*, 2000). Eating adequate calories from a variety of foods will satisfy the need for macronutrients and micronutrients (Kleiner, 1997).

Supplying adequate energy and nutrient intake in the diet, and timing these to be efficiently used by the body, provides the most effective and safe results (Chandler *et al*, 1994; Coggan *et al*, 1992).

**Section 1.4.1: Energy Requirements for Athletes**

Meeting energy needs is the first nutrition priority for athletes (ADA *et al*, 2000). Achieving energy balance is essential for the maintenance of lean tissue mass (Thomas, 2001), immune function (Venkatraman *et al*, 2002) and reproductive function (Loucks, 2004) and optimum athletic performance (ADA *et al*, 2000). Inadequate energy intake relative to energy expenditure compromises the athlete’s performance and the benefits associated with his training. With limited energy intake body fat stores are depleted and muscle wasting takes place (Thomas, 2001). This results in the loss of both strength and endurance. In addition, low energy intake often results in poor nutrient intake, particularly micronutrients (Clarkson, 1995). Energy requirement is primarily determined by energy expenditure which comprises of the basal metabolic rate, physical activity and dietary-induced thermogenesis.
Caloric requirements are based on one's basal energy expenditure together with the stress factor (starvation, burns, injury, infection etc) and activity factors. A number of prediction equations for the basal energy expenditure have been derived using populations that differ in age, gender, body mass and level of activity. Thompson and Manore (1996) undertook a study in order to determine which of the various energy requirement prediction equations is closest to the actual basal energy expenditure in active individuals. Actual resting (basal) metabolic rate (RMR) values measured in the laboratory were compared with RMR values predicted by the various developed predictive equations. It was found that the Cunningham equation best predicted the RMR for both active men and women followed by the Harris-Benedict equation. These equations are as follows:

Harris-Benedict (1919):
Males: \( RMR \) (kcal/d) = \( 66.47 + 13.75 \) (weight in kg) + \( 5 \) (height in cm) − \( 6.76 \) (age in years)
Females: \( RMR \) (kcal/d) = \( 655.1 + 9.56 \) (weight in kg) + \( 1.85 \) (height in cm) − \( 4.68 \) (age in years)

Cunningham (1980):
\( RMR \) (kcal/d) = \( 500 + 22 \) (lean body mass in kg)

Once the RMR has been determined, total energy expenditure is derived at by means of appropriate activity factors. Activity factors vary according to the intensity of the activity which the athlete undertakes. Activity factors normally range from 1.2 to 2 representing inactive to highly active individuals.
Section 1.4.2: Protein Requirements for Athletes

A number of mechanisms that increase athletes' protein requirement have been suggested. These include the need to repair exercise-induced microdamage to muscle fibres, use of small amounts of protein as an energy source and the need for additional protein to support gains in lean tissue mass (Butterfield, 1987; Lemon, 1998). Inadequate protein intake causes a negative nitrogen balance which slows muscle growth and causes fatigue (Ahrendt, 2001).

However, adequate protein consumption can be ensured through natural food items, which will also deliver other micronutrients. It may be healthy to avoid acquiring all the protein needs from animal sources since this would also mean increased intake of fat and cholesterol. Increasing protein beyond the general recommendation is unlikely to result in additional increases in lean tissue because there is a limit to the rate at which protein tissue can be accrued (Butterfield, 1987). Customary diets of most athletes provide sufficient protein to cover even the increased amounts that may be needed (Grandjean, 1997).

Protein supplementation practice is popular among athletes particularly those involved in strength and bodybuilding activities. The practice involves taking protein mixtures and/or individual amino acids (Manore et al, 2000). The use of individual amino acids to enhance performance has also been studied, however results have been inconsistent (Blomstrand et al, 1991; Mittleman et al, 1998; van Hall et al, 1995; Madsen et al, 1996). According to the American Dietetic Association, Dietitians of Canada and the American College of Sports Medicine, the safety and efficacy of
branched chain amino acids has not been established and their use is therefore not advocated (ADA et al, 2000).

Convincing evidence to support proposed ergogenic value of amino acid supplementation is lacking according to Manore (Manore et al, 2000).

The conclusion here is that more evidence is needed before a definitive judgement can be made about the effectiveness of protein and amino acid supplementation (Kredier et al, 1993).

Section 1.4.3: Carbohydrate rich drinks

Sports drinks typically contain 4 to 8% carbohydrates (ADA et al, 2000). It has been controversial whether sports drinks improve performance in events lasting 1 hour or less (ADA et al, 2000). However, a number of studies support the benefit of having carbohydrate sports drinks (Below et al, 1995; Suguira et al, 1998; Ball et al, 1995; Jeukendrup et al, 2000; Jeukendrup et al, 1997; Davis et al, 1997; Nicholas et al, 1995). Performance advantages are particularly evident when athletes exercise in the morning after an overnight fast when liver glycogen levels are low.

Utter et al (1997) have demonstrated that carbohydrate-containing fluids may help delay fatigue during prolonged running.

Any drink that contains both electrolytes and carbohydrate concentrations at no more than 8% can enhance fluid balance (Manore et al, 2000). The main reasons for using a beverage containing both electrolytes and carbohydrates are to maximize
fluid intake, replace electrolyte losses and provide carbohydrate for energy and for rapid replacement of muscle and liver glycogen both during and after exercise (Marriott, 1994).

Section 1.4.4: Vitamin and Mineral Requirements for Athletes

Micronutrients play an important role in energy production, haemoglobin synthesis, maintenance of bone health, adequate immune function and the protection of body tissues from oxidative damage. They are also required to help build and repair muscle tissue following exercise (ADA et al, 2000).

The B-complex vitamins have 2 major functions which are both directly related to exercise. Thiamin, riboflavin, vitamin B-6, niacin, pantothenic acid and biotin are required in energy metabolism. They are especially important in the production of energy (Clarkson, 1998; Sampson, 1997; Manore et al, 2000). Vitamin B-12 and folate play an important role in blood formation and in tissue repair and maintenance through the production of new cells (Manore et al, 2000). Because most B-complex vitamins are cofactors for metabolic reactions that produce energy, it may be natural to hypothesize that exercise increases the need for these nutrients. However, as people become more physically active, they will also consume more energy and protein and, in the process, consume more of these vitamins. The problem lies if people make poor dietary choices or restrict their energy intake (Manore et al, 2000).

Theoretically exercise could increase the need for these nutrients, however, research of vitamin status for these nutrients in active people has been limited and equivocal (Manore et al, 2000). Inconsistencies in such research may be attributed to
difference in experimental designs. However, it is concluded by Manore et al (2000) that dietary intakes of these vitamins by athletes should be adequate unless the individuals make poor dietary choices or restrict their energy intake (Manore et al, 2000).

The antioxidant micro nutrients such as vitamins A, C and E, beta-carotene and selenium play an important role in protecting cell membranes from oxidative damage (ADA et al, 2000). It has been hypothesized that chronic exercise produces a constant oxidative stress on the muscles and other cells since exercise can increase oxygen consumption by 10- to 15-fold (Clarkson, 1995; Ji, 1995). However, habitual exercise has been shown to result in an augmented antioxidant system (Clarkson, 1995; Kanter, 1998). Research examining whether exercise increases the need for antioxidant nutrients is ambiguous and controversial and there is no consensus on whether supplementation of antioxidant nutrients is necessary (Clarkson, 1995; Kanter, 1994; Kanter, 1998).

Vitamin A supplementation in individuals without its deficiency is highly toxic (Manore et al, 2000). Beta-carotene carries only very low risks of toxicity in supplemental doses. Large doses of Beta-carotene can lead to hypercarotenaemia or carotenosis which refers to yellowing of the skin. Such a condition is harmless and reversible (Manore et al, 2000). However, the authors continue to state that there are presently no definitive data to suggest that beta-carotene supplementation is beneficial. They add that, a combination of five servings of fruits and / or vegetables per day will maintain healthy levels of beta carotene in the blood.
People taking more than 2 –3 g/day of Vitamin C supplements may suffer from a variety of side effects which include nausea, diarrhoea, abdominal cramps and erythrocyte haemolysis (Manore et al, 2000). An additional risk with megadoses of Vitamin C is iron overload toxicity. Since Vitamin C promotes the absorption of iron from the digestive tract and can mobilise iron from body stores, iron-induced cardiac failure can result. The death of 3 athletes from iron-induced cardiac failure is thought to be the result of megadoses of Vitamin C (Herbert, 1993b).

Active people who regularly consume fruits and vegetables are most likely getting adequate vitamin C from dietary sources (Manore et al, 2000). Athletes following a low-fat diet, those restricting their energy intake or those with limited dietary intakes of fruits and vegetables are at greatest risk for poor antioxidant intakes (ADA et al, 2000).

Vitamin E deficiencies are rare. Its requirement rises with higher intakes of polyunsaturated fatty acids (PUFA) due to its protective function against lipid peroxidation of PUFA's (Manore et al, 2000). It is recognized by this same author that athletes may consume a diet which is considerably higher in fat and that they also utilize more oxygen than sedentary people. Therefore, Vitamin E requirement may be higher for active people. However, it is possible to consume adequate vitamin E from dietary sources (Murphy et al, 1990). Few side effects have been reported for high dose supplementation of Vitamin E, unlike for other fat-soluble vitamins (Meydani et al, 1997).
Regarding selenium, which is often included in multivitamin and multimineral supplements, Olson (1986) reports that the margin between its toxicity and deficiency is much narrower than for other trace minerals. Toxicity can result from its supplementation.

Supplementation can be associated with a variety of health risks. Herbert (1994) lists the following risks to be associated with antioxidant supplementation:

Vitamin E supplementation can cause exacerbation of autoimmune and immune diseases. Vitamin C supplementation in combination with high iron intake can promote kidney stones and increased risk of iron-induced cardiac failure or of haemochromatosis. Beta-carotene supplementation can increase the rate of lung cancer and mortality due to cardiovascular disease. Herbert (1994) emphasizes that these risks are associated with supplemental intakes of the antioxidants and not with their increased intake from food.

In view of the fact that evidence exists to suggest that supplementation with antioxidant nutrients may be harmful, caution should be exercised when considering supplementation.

A number of minerals are cofactors for many metabolic reactions that produce energy. They are also necessary for other biological functions important for exercise. Examples of such are synthesis and repair of muscle tissue, a healthy immune function and cell reproduction. It has therefore been hypothesized that active people have an increased need for them (Manore et al, 2000). Exercise also causes an increase in mineral loss through urine and sweat thus increased intakes may be
required. According to Manore et al (2000) current research reveals that few athletes exhibit poor mineral status while consuming free-living diets. Being physically active demands an increased intake of energy. With such increased dietary energy intake the increased need for minerals is met. This is again assuming that one makes good dietary choices including a variety of foods and is not restricting energy intake. In such a case there is no need for mineral supplements (Manore et al, 2000).

A study was conducted by Bazzarre et al (1993) on 91 vitamin-mineral supplement users and non-users representing a wide range of athletic interests. It is interesting to note that 100% of the female athletes used supplements whereas 51% of male athletes used supplements. Concluded in this study was that, although supplement users exhibit additional healthy lifestyle practices, their lipid profiles were unfavourable with regard to chronic disease risk factors.

Barron and Vanscoy (1993) found that there was no published scientific evidence to support the promotional claims for a large proportion of supplements marketed for enhanced athletic prowess.

To date there are no data to support improved exercise performance in individuals who supplement with vitamins or minerals as long as nutrient status was good before supplementation began (Manore et al, 2000).

ADA et al (2000) discourage the practice of supplementation with micronutrients unless clear medical, nutritional or public health reasons are present (eg iron deficiency anaemia or folic acid to prevent Spina Bifida).
Section 1.5 Body weight

Body Mass Index is an expression of one's weight and height. It is measured by dividing one's mass in kilograms by the square of his stature in metres. This index is used to indicate a measure of fatness and was suggested by Quetelet, 1869 and Keys et al, 1972 (Garrow, 2001).

World Health Organisation (1998) has used this index to classify the various states of underweight, normal or overweight in adults. A Body Mass Index (BMI) of <18.5 is considered underweight. The range for normal weight is taken as BMI 18.5 – 24.9. A BMI of > 25 is overweight with further classification of the state of overweight. Pre-obese state is taken as BMI 25 – 29.9. Obese class I is a BMI ranging from 30 – 34.9. Obese class II is a BMI ranging from 35 – 39.9 and a BMI > 40 is categorized as obese class III.

An elevation in BMI has been associated with unfavourable lipoprotein profiles (Mansen et al, 1987; Rabkin et al, 1997) and an increased relative risk of coronary heart disease (CHD), as well as an increased mortality due to cardiovascular disease (Mansen et al, 1987; Stevens et al, 1998; Garrison et al, 1996; Tunstall-Pedoe, 1997; Kujala et al, 1994).

Baron and Rinsky conducted a mortality study of professional football players and found an increased relative risk of cardiovascular mortality among players with BMIs higher than 32 kg/m² (of 6.04 times that of players with BMIs <28 kg/m²).
Garry *et al* (2001) found an inverse relationship between BMI and high density lipid (HDL) - Cholesterol and positive correlations between BMI and triglyceride levels and BMI and Total Cholesterol/HDL-Cholesterol ratio in professional football players.

The use of BMI as a determination of total body adiposity has its limitations in use among elite athletes (Barr *et al*, 1994). Body Mass Index measures the total weight of the person. It fails to consider the proportional composition of the body. One's body weight is affected by a number of factors other than excess body fat, such as bone and muscle mass and even the quantity of plasma volume that increases with exercise training (McArdle *et al*, 1996).

**Section 1.6. Pre-event food consumption**

In the 1960’s a number of studies conducted in Sweden demonstrated that high carbohydrate diets improved endurance performance and carbohydrate feedings during exercise delayed fatigue (Ahlborg *et al*, 1967; Bergström *et al*, 1972; Bergström *et al*, 1967). The early 1970’s saw a craze of ‘carbohydrate loading’ (Applegate *et al*, 1997). In the classical ‘carbohydrate loading’ manipulation, the athlete exercises to exhaustion to deplete glycogen stores, then ingests a carbohydrate-free diet for 2 to 5 days. This depletion phase is followed by an intake pattern of 70 – 85 % carbohydrate for 1 – 2 days (Bergström *et al*, 1972). This technique presented a number of difficulties to athletes. By the end of the 7 days of this manipulation, athletes typically gained 2 – 3 kg water, felt poorly and were apprehensive (Sherman *et al*, 1984). A modified carbohydrate manipulation was then developed in which athletes merely depleted glycogen stores through intense, exhaustive exercise and then consumed a high carbohydrate diet for several days.
before competition (Sherman et al, 1984). The number of studies on carbohydrate led to the development of the first sports nutrition product, Gatorade, in the 1960’s (Applegate et al, 1997). Other beverages were developed later (Applegate et al, 1997).

Eating before exercise, as opposed to exercising in the fasting state, has been shown to improve performance (Neufer et al, 1987; Sherman et al, 1989; Wright et al, 1991; Schabort et al, 1999). The amounts of carbohydrate used in these studies range from approximately 200 to 300g and were consumed 3 to 4 hours before exercise. The meal or snack consumed before an event should prepare the athlete for the upcoming session of physical activity. It should leave him neither hungry nor with undigested food in the stomach (ADA et al, 2000). The American Dietetic Association recommends the following guidelines for the pre-event meal: it should be sufficient in fluid to maintain hydration, low in fat and fibre to facilitate gastric emptying and minimize gastrointestinal distress, high in carbohydrate to maintain blood glucose and maximize glycogen stores, moderate in protein and composed of foods familiar to the athlete.

The timing of meals and snacks needs to be determined on an individual basis and depends partly on the athlete’s gastrointestinal characteristics as well as the intensity of the workout (Benardot et al, 1999).

The size and timing of the pre-exercise meal are interrelated. Smaller meals should be consumed in closer proximity to the event to allow for gastric emptying, whereas
larger meals can be consumed if more time is available before exercise or competition (Bernardot et al, 1999).

Consuming carbohydrates within 1 hour of physical activity has yielded various results in a number of studies. Foster et al (1979) concluded that this practice leads to hypoglycaemia and premature fatigue whereas other studies have concluded that the practice has no effect whilst others concluded some beneficial effect on performance (Coyle, 1995; Neufer et al, 1987; Alberici et al, 1993; Devlin et al, 1986, Horowitz et al, 1993).

Section 1.7 Fluid Balance

Exercise performance is optimal when athletes maintain fluid balance during exercise. Progressive dehydration has adverse effects and impairs exercise performance. This has been shown by a number of studies (Barr et al, 1991; Below et al, 1995; Buono et al, 2000; McConnell et al, 1997; Montain et al, 1992; Walsh et al, 1994).

Disturbances of fluid and electrolyte balance that can occur in athletes include dehydration, hypohydration and hyponatraemia (Barr, 1999). Athletes dissipate the metabolic heat produced during physical activity by radiation, conduction, convection and by vaporization of water (ADA et al, 2000). Exercise can induce dehydration when fluid losses exceed fluid intake whereas hypohydration occurs when athletes dehydrate themselves before physical activity (ADA et al, 2000). Hyponatraemia can result from excessive fluid intake (Noakes, 2003).
Fluid ingestion during exercise is regarded as a primary way of offsetting the detrimental effects of dehydration, which, at levels of less than 2% change in body mass, reduce exercise endurance (Walsh, 1994). Whilst some studies have used water ingestion during exercise (Armstrong et al., 1997; McConnell et al., 1997; Robinson et al., 1995) others have used hyperhydration (elevation of body water content prior to exercise) to offset the negative effects of dehydration, using either water or glycerol solutions (Greenleaf et al., 1971; Lyons et al. 1990; Montner et al., 1999; Moroff et al., 1965).

Athletes should attempt to remain well hydrated before and during exercise (ADA et al., 2000). The American College of Sports Medicine in a Position Stand on Exercise and Fluid Replacement (American College of Sports Medicine, 1996) as well as the National Athletic Trainers’ Association in their Position Statement on Fluid Replacement for Athletes (Case et al., 2000) recommend drinking 400 – 600 ml of fluid 2 – 3 hours before exercise. During exercise athletes should attempt to drink enough fluid to maintain fluid balance. Optimal hydration can be facilitated by drinking 150 to 350 ml of fluid at 15 – 20 minute intervals beginning at the start of exercise. However, according to Shireffs et al. (1996), most athletes do not consume enough fluids during exercise to balance fluid losses and thus complete their exercise sessions dehydrated to some extent. One should consume up to 150% of the weight lost during an exercise session so as to compensate for losses in sweat together with obligatory urine production (Shireffs et al., 1996).

The risks of dehydration and heat injury increase dramatically in hot, humid environments. Precaution should be taken to assure that athletes are well hydrated,
have ample access to fluids and are monitored for heat related illness (Case et al, 2000).

Inadequate fluid intake before, during and after exercise is one of the most common nutritional problems facing athletes (Manore et al, 2000).

Section 1.8 General Dietary Recommendations

Data is not presently available to suggest that athletes need a diet substantially different from that recommended to the general population (ADA et al, 2000). The World Health Organisation Regional Office for Europe, in its commitment to promote health and prevent disease, issued a set of dietary guidelines (WHO, 2000). These guidelines demonstrate that a healthy diet is one which:

- is based mainly on foods of plant origin rather than animal origin
- includes bread, grains, pasta, rice or potatoes several time daily
- includes a variety of fruits and vegetables
- helps maintain body weight at a BMI of 20 to 25 kg/m²
- controls fat intake and replace most saturated fats with unsaturated vegetable oils
- replaces fatty meat and meat products with beans, legumes, lentils, fish, poultry and lean meat.
- uses dairy products that are low in fat and salt
- includes food and drinks that are low in sugar
- includes food that are low in salt
- limits the consumption of alcohol to no more than 2 drinks daily
• includes food that are prepared in a safe and hygienic way – steaming, baking, boiling or micro-waving are suggested so as to limit the amount of fat

Sufficient food that is both safe and healthy is needed to prevent deficiency. Too much of certain foods combined with too little of others increase the risk of non-communicable diseases (WHO, 2000). Fruit and vegetables help prevent the likelihood of non-communicable diseases (WHO, 2000). Dietary requirements and precautions as set out in CINDI dietary guidelines are to be integrated in patterns for healthy living (WHO, 2000).

The increasing trend of dining out may lower the nutritional quality of consumers' diets since food away from home is generally higher in fat and saturated fat and lower in fibre and calcium than food prepared at home (Lin et al, 1998).

Athletes in heavy training or doing multiple daily workouts may need to eat more than 3 meals and 3 snacks per day and should consider every possible eating occasion (Bernardot et al, 1999).

**Section 1.9 Nutrition Education Programmes**

Nutrition advice is often given in terms of eating less or more of a particular dietary component. However, this assumes that people know what nutrients are in the food they eat and in what proportion they are present. All the dietary guidance in the world will fall on deaf ears if people believe their diets are already meeting dietary recommendations. Nutrition educators need to link people's accuracy in their self-
assessment of nutritional intake to their stock of nutritional knowledge, socio-demographic factors and of course, actual intake (Bishow et al, 1998).

In a study by Collison et al (1996), which dealt with the impact of nutrition education on female athletes, it is concluded that although changes in knowledge were documented, eating practices did not seem to change. The authors suggest that perhaps dietary habits could have been modified through one-on-one nutrition counselling or by a more extensive education programme. Personally tailored nutritional counselling sessions which were related to individual needs, interests, experiences and goals, were effective in changing dietary intake of female athletes (Welch et al, 1987). Another study dealing with nutrition education on female athlete runners found that a poorly nourished athlete is more inclined to improve her intake of lacking nutrients if dietary deficiencies are listed on a computer printout and used to initiate diet changes (Clark et al, 1988).

Other suggestions put forward by Collison et al (1996) in order to improve nutrition education are:

- Including coaches and trainers in education programmes – this may help reinforce the nutrition information to the athletes because they have regular contact time with them.
- Including a tour to a cafeteria and / or local supermarket might enhance learning and more adequately guide the athletes to select nutrient-dense foods.
Chapter 2

Methodology
CHAPTER 2

METHODOLOGY

Section 2.1: Aims and Objectives

The aim of the study is to gain an insight on some athletes' dietary practices and to establish whether their knowledge on nutrition or other factors affect these practices. This is attempted by distributing a questionnaire to 4 groups of sportspersons actively involved in various disciplines. The disciplines reviewed in this study are volleyball, basketball, track and field events and football refereeing. The objective of the study is to compare the degree of recommendable dietary practices as reflected in a number of questions to the apparent nutrition knowledge of the athletes as also reflected in a number of questions.

By means of the athletes’ answers to various questions in the questionnaire, conclusions may be drawn, in order to evaluate the athletes' nutritional attitude. Athletes' dietary practices may be compared to their nutritional knowledge. It may also result that only a particular group of sportspersons may have certain dietary practices which are recommendable. This is the reason why data such as age, sex, sport practised, demographic data, marital and social status, indication of commitment to sport, etc. were collected. Data is analysed by the Chi-Squared test of independence.

Table 2.1 depicts the data collection, coding, preparation, processing and analytic techniques adopted during this study. In the following sections the different stages are described in more detail.
Table 2.1 Overview of Methodology Applied to this Study

Survey Questionnaires by Subject are checked for completeness

Question/Answers divided into two Groups that reflect two distinct aspects/dimensions of Nutrition: Knowledge & Attitude

Knowledge Questions

Nutritional Knowledge Scoring Rules applied to each answer

A set of Nominal Knowledge Scores (Ratings): Good (-1), Neutral (0), Bad (-1) is developed for each subject for each Knowledge Question answer

Each Subject's Good, Neutral & Bad Knowledge ratings are counted

Scores are Normalised to correct for different number of applicable answers by each subject

A Set of Normalised Scores by Subject of Good Knowledge & Attitude, Neutral Knowledge & Attitude and Bad Knowledge & Attitude ready for Hypothesis Testing

The Wilcoxon matched-pairs signed rank testis used to test for The Null Hypothesis (H0): The difference in the median of the sample scores is zero i.e there is no difference in the median between Knowledge scores and Attitude scores.
Section 2.2: The Research Site

Sportspersons actively involved in volleyball, basketball, track and field events and football refereeing answered the questionnaires in December 2002. These were distributed at various training sites and at a social gathering in the case of football referees. The questionnaires were distributed to track and field athletes training at the Marsa track, volleyball athletes training at the volleyball court in the Corradino Sports Complex and basketball players training at the University Sports Hall and Ta’ Qali Basketball complex. 50 questionnaires were distributed to participants of each sport. A total of 59 questionnaires were returned. This equates to a 29.5% response rate.

Section 2.3: Target Population and Sampling Techniques

The sampling method involved identifying subjects who were currently practicing their sport. That is, the target population, was made up of athletes in the 4 different sports disciplines. The experimentally accessible population was then taken by means of cluster sampling. Each subject was asked whether he/she wanted to participate in a survey on nutritional attitudes of athletes which the author was conducting as a partial requirement for a post qualification diploma in nutrition and dietetics. If in the affirmative, a questionnaire together with a covering letter explaining the aim of the study, an optional form, regarding whether or not the participant wanted to receive feedback on the conclusion of the study and a stamped, self-addressed envelope were distributed. All questionnaires duly filled in and returned in the stamped, self-addressed envelope provided were considered in this pilot project.
Section 2.4: The Research Instruments

The questionnaire (reproduced in Appendix A) was the instrument of choice used to collect the raw data for this study.

2.4.1 Knowledge

For the purpose of this study, knowledge is defined as knowledge about nutrition. The variable of nutritional knowledge was assessed by means of a number of questions such as on their idea of healthy weight, on rate of healthy weight loss or gain, on the factors contributing to stable weight, what nutrition supplements are, their implied understanding of food allergy, their perception to healthy methods of food preparation and whether their desired eating modification is one which would fit in generally recommended guidelines by professional bodies such as the Countrywide Integrated Noncommunicable Disease Intervention (CINDI) dietary guidelines (WHO, 2000).

A scoring regime has been developed to score the respondents' answers to a number of questions which reflect nutrition knowledge. Each answer is categorised into three distinct knowledge categories: Good, Neutral or Wrong with the following numerical scores of 1, 0 and −1 respectively.

The complete list of questions used to assess one's knowledge is included in Appendix B-1a and scoring rules are defined in appendix B-1b.
2.4.2 Attitude

*Attitude* for the purpose of this study is defined to mean, “the dietary practice adopted by the subject”.

Nutritional attitude, the dependent variable, was assessed by means of a number of questions such as use of supplements, usual method of preparation of food, the number of meals or snacks per day and the interval hours between them, the frequency at which they eat out at restaurants, the most and least preferred foods, the consistency or otherwise of their eating habits, the time of day they are most hungry, any dietary modification they would like to undertake, any special meal plans prior to event, last meal or drink prior to event and drinking in relation to exercise (See Appendix C-1a for full list of questions). Subjects' responses to these questions are scored according to attitude scoring rules (defined in appendix C-1b) to fall into three distinct categories: Good, Neutral and Bad Dietary Practice (*Attitude*) each assigned respectively a numerical score of 1, 0 and −1.

Section 2.5: Data Analysis

In a research study, an important aim is that the author's interpretation can be extrapolated to the larger group of people from which the sample is taken. In order to make this inference from the sample (the 58 athletes) to the population (athletes) a number of factors are important. The sample needs to be relevant to the research question and it needs to be representative of the population. Response rate needs to be adequate. (These are discussed under Limitations of The Study in Chapter 4). The statistical test chosen to analyse the measures is also very important in making the inference from the sample to the population.
2.5.1 Statistical Tools

Each statistical test has an associated measurement requirement and a statistical model based on sampling. A given statistical tool needs to meet certain criteria for it to give valid results.

The statistical tools used in this study to check for any significance of the data results were the Chi-Squared Test of Independence and the Wilcoxon Signed Rank Test. 95% confidence intervals for means were used so as to infer the implications of conclusions on to the wider population.

2.5.1.1 The Chi-Squared Test of Independence

Analysis was undertaken for any relationship between the 2 main variables of Nutritional Knowledge and Nutritional Attitude with dependant variables such as gender, age and sport discipline.

The following is a brief description on why this test was chosen. Gender and Nutrition Knowledge are used to describe the choice of test used. However, the same argument applies to the analysis of the other variables.

Gender and nutritional knowledge are 2 categorical variables that are mutually exclusive. The dependent variable here (gender) is nominal. (There is not a qualitative relationship between categories of gender.) In order to test for any relationship between these 2 variables, the Chi-Squared Test of Independence is used. The Chi-square permits the analysis of any number of categories or samples of nominal scale data to determine statistical significance. An equal distribution of
knowledge would result in 50% of the sample being males and 50% being females. If there is no special relationship between gender and nutritional knowledge, then there would result unequal proportions of males to females for an equal distribution of knowledge. The Chi-Squared Test checks for any discrepancy between the expected frequency (proportion) and the observed frequency.

2.5.1.2 The Wilcoxon Signed Rank Test – Hypothesis testing for nutritional knowledge and nutritional attitude

This section details the reasoning behind the choice of the Wilcoxon Signed Rank Test for the purpose of assessing the main hypotheses of this work.

The variables to be compared here are paired; i.e. they are variables belonging to the same subjects. Every subject is measured twice; once for knowledge on nutrition and once for nutritional attitude. The variables can also be ranked. Thus, it is referred to as an ordinal scale of measurement. Ordinal data have the property of identity and order. The scale identifies real differences between the subjects' answers and the data can be put in a semi-quantitative sequence. In the population sample of 58, the first ranked has obtained the highest score in the particular variable (nutritional knowledge or attitude) and the last ranked has obtained the lowest score. There is a "better-than" or "poorer-than" relationship between any two categories. There is no equality of difference between the scores. However, there is implied an underlying, continuous gradation between minimum and maximum on the ordinal scale.
The Wilcoxon Signed Rank Test is a statistical tool used in data when the levels of measurement are ordinal. It is a non-parametric statistical tool used in a "two-related, own-control" study design. The variables in the main hypothesis (knowledge on nutrition and attitude) meet these criteria since they are repeated measures on the same individuals. T-tests could not be used since these make some assumptions which could not be met. Examples of such assumptions are that the variances in the populations are equal and that the variables measured are normally distributed. Non-parametric tests make fewer assumptions and are therefore more widely applicable.

Section 2.6: Ethical Considerations

All subjects were free to choose whether to participate or not. Each subject was explained the aim of the study, guaranteed confidentiality and offered the option to receive generalised feedback on conclusion of the study should he so wished (Appendix A-4).

A covering letter was given to each participant (Appendix A-3). This carried the author's name and contact details in case of any difficulties when answering the questionnaire. As it happened two participants did call for further clarification. Participants were thanked for their contribution and time.
Chapter 3

Results
CHAPTER 3

RESULTS

Section 3.1: Introduction

The subjects in this pilot study are sports persons actively involved in athletics, volleyball, basketball and football refereeing. There were no exclusion criteria except for those subjects who submitted a practically unfilled questionnaire. The 2 main variables in this study are nutritional knowledge and nutritional attitude i.e. their dietary practice. These were measured by means of a numerical score allocated to a number of questions presented in the questionnaire (See Appendix B & C).

Besides these variables, thought to adequately describe dietary practice and nutritional knowledge, other data was collected which described subject characteristics. These included age, gender, weight and height, level of sport commitment and social status.

Section 3.2: Descriptive Analysis

3.2.1: Gender

Fig 3.1 depicts the gender distribution of sample. 60% of the subject population were male and 40% were female. In numerical values, 35 were male and 23 were female.
3.2.2: Age

The subjects' ages ranged from 14 to 52. There was only one subject (a female) at the lowest range of 14 and one subject (a male) at the highest range of 52. The overall average age was 28. Male subjects outnumbered female ones at practically all age groups except for the age range 20 – 25. The average age for male subjects was 28 whereas that for females was 24. Fig 3.2 shows the distribution of the sample by age and gender.
3.2.3: Height

Height varied markedly between the two genders in the sample as can be seen in Fig 3.3. Height ranged from 1.5m for both genders to 1.89m for males and 1.83m for females. Average female height was 1.63m while the average height for males was 1.73m. The various height ranges over 1.65 were predominantly males whereas height ranges below 1.65 were predominantly females.
3.2.4: Weight

The subjects' weights ranged from 42.6kg to 105kg. Average weight for all subjects was 66kg. The average weight for females was 59kg whereas that for males was 71kg. As has also been noticed in height characteristics, the higher weight ranges (over 54 kg) were predominantly occupied by males whereas the lower weight ranges i.e. 54 kg and below were predominantly occupied by females. Fig 3.4 clearly shows this distribution.

![Fig 3.4 Distribution of Sample by Weight](image)

3.2.5: Distribution of Subjects by Social Category

7 social categories were put forward in the questionnaire. The subjects were asked to tick the one which fit them best. The categories were the following:

a) Upper Middle Class i.e. Higher Managerial, administrative or professional
b) Middle Class i.e. Intermediate managerial, administrative or professional
c) Lower Middle Class i.e. Supervisor or clerical and junior managerial, administrative or professional
d) Skilled Working Class i.e. Skilled manual worker
e) Working Class i.e. Semi and unskilled manual worker

f) Unemployed (out of job, housewife, pensioner, etc)

g) Student

Fig 3.5 is a pie chart that depicts the subjects as categorized into the above-mentioned social categories together with the relevant percentages.

![Fig 3.5: Social Category]

3.2.6: Distribution of Sample by Sports Discipline

The 4 sports disciplines investigated in this pilot project were Volleyball, Basketball, Football Refereeing and Athletics. The latter was further divided into Middle distance and Long distance where specified by the athletes. Fig 3.6 shows the distribution of the sample by sports discipline.
Table 3.1 is a numerical summary of the same distribution (i.e. subjects by sports discipline).

**Table 3.1: Numerical Summary of the Sample as Distributed by Sports Discipline**

<table>
<thead>
<tr>
<th>Sport Discipline</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletics</td>
<td>2</td>
</tr>
<tr>
<td>Athletics - Middle</td>
<td>3</td>
</tr>
<tr>
<td>Athletics - Long</td>
<td>11</td>
</tr>
<tr>
<td>Basketball</td>
<td>6</td>
</tr>
<tr>
<td>Football Refereeing</td>
<td>22</td>
</tr>
<tr>
<td>Volleyball</td>
<td>14</td>
</tr>
<tr>
<td>TOTAL</td>
<td>58</td>
</tr>
</tbody>
</table>
3.2.7: Subjects' Commitment to Sport

The subjects' commitment to sport was gauged by the daily amount of hours spent on their sport. Most subjects (44 out of 57 who answered this question) spent more than 1 hour daily at their sport. Fig 3.7 is a bar graph depicting the sample as distributed according to the number of hours spent daily at physical activity.

Fig 3.7: Distribution of Sample by daily hours spent on physical activity

![Bar graph showing distribution of hours of physical activity](image)

3.2.8: Subject Characteristics re BMI and Weight perception

3.2.8.1 Body Mass Index by Gender

The minimum BMI was 17.7, a female, long distance athlete while the maximum BMI was 32, a male, football referee. Fig 3.8 shows the BMI distribution among all subjects. It can be seen from this table that mainly male subjects occupy the higher BMI's in the ranges taken so as to be representative of the sample. BMI from 22 and over seem to follow this trend. The lowest BMI seems to be the exception where there are also more males than females.
3.2.8.2 BMI by Sports Discipline

The subjects' Body Mass Index according to Sports Discipline showed that football referees had the highest BMI and Long Distance Athletes had the lowest BMI. Middle distance athletes as well as Volleyball and Basketball athletes were very close in their median BMI averaging 22 kg/m². Fig 3.9 is a bar graph depicting the median BMI in each Sports Discipline.
3.2.8.3: Description of Subjects' "Weight / Body Composition" Intentions by gender

In the "wishing to lose fat" category the subjects were predominantly females whereas in the "wishing to increase muscle mass" category, the subjects were predominantly males. Only 1 male wanted to gain weight. The categories showing the percentage of subjects wishing to "lose weight" and "maintain" weight were approximately equally distributed between males and females. Fig 3.10 is a graphical representation of the subjects' intent on weight/body composition.

![Graph](image)

3.2.8.4 Subjects' Stability of Weight

The question posed in the questionnaire was whether the subject's weight had been stable since he / she has been an established athlete. The majority by far (70% of females and 63% of males) answered in the affirmative.
Section 3.3: Experimental Analysis

This section deals with tests for significance carried out on a number of hypotheses.

As described earlier, the two dependent variables in this pilot study are knowledge on nutrition and nutrition attitude. Each of these variables was tested for any difference by gender, age bracket and sports discipline.

3.3.1 Hypothesis testing for knowledge on nutrition by gender

The null hypothesis is that knowledge on nutrition is independent of gender.

The alternate hypothesis is that knowledge on nutrition is not independent of gender.

The level of significance tested is at the 95% confidence level. At a 95% confidence level the critical value of $x^2$ for acceptance of the null hypothesis is 5.99. The result of $x^2$ however is 0.003296714 which is $< 5.99$, thus, the null hypothesis is accepted. It can therefore be concluded at 95% confidence interval that knowledge on nutrition is independent of gender.

3.3.2 Hypothesis testing for nutritional attitude by gender

Nutritional attitude and gender are categorical variables. Therefore the Chi-Squared Test of Independence is used to check for any dependency between these two variables.

The null hypothesis is that attitude towards nutrition is independent of gender.
The alternate hypothesis is that attitude towards nutrition is not independent of gender.

At a 95% confidence level the critical value of $x^2$ for acceptance of the null hypothesis is 5.99. The result of $x^2$ however is 0.985549 which is < 5.99 thus the null hypothesis is accepted. It can therefore be concluded at 95% confidence interval that attitude on nutrition is independent of gender.

3.3.3 Hypothesis testing for nutritional knowledge by age

The Chi-Squared Test of Independence is used to address the question of whether nutritional knowledge is dependent on age.

The null hypothesis is that knowledge on nutrition is independent of age.

The alternate hypothesis is that knowledge on nutrition is not independent of age.

At a 95% confidence level the critical value of $x^2$ for acceptance of the null hypothesis is 18.31. The result of $x^2$ however is 0.65508339 which is < 18.31, thus the null hypothesis is accepted. It can therefore be concluded at 95% confidence interval that knowledge on nutrition is independent of age.

3.3.4 Hypothesis testing for nutritional attitude by age

The Chi-Squared Test of Independence is used to address the question of whether attitude towards nutrition is dependent on age.
The null hypothesis is that attitude towards nutrition is independent of age.

The alternate hypothesis is that attitude towards nutrition is not independent of age.

At a 95% confidence level the critical value of $x^2$ for acceptance of the null hypothesis is 18.31. The result of $x^2$ however is 0.5416612 which is < 18.31 thus the null hypothesis is accepted. It can therefore be concluded at 95% confidence interval that attitude towards nutrition is independent of age.

3.3.5 Hypothesis testing for nutritional knowledge by sports discipline

To check for any dependency between nutritional knowledge and a particular sector of the sample by sports discipline, the Chi Squared Test of Independence is used.

The null hypothesis is that knowledge on nutrition is independent of sports discipline.

The alternate hypothesis is that knowledge on nutrition is not independent of sports discipline.

At a 95% confidence level the critical value of $x^2$ for acceptance of the null hypothesis is 12.59. The result of $x^2$ however is 0.0552241 which is < 12.59 thus the null hypothesis is accepted. It can therefore be concluded at 95% confidence interval that knowledge on nutrition is independent of sports discipline.
3.3.6 Hypothesis testing for nutritional attitude by sports discipline

In order to test whether attitude towards nutrition varies by sports discipline, the Chi-Squared test of Independence is again used.

The null hypothesis is that attitude towards nutrition is independent of sports discipline.

The alternate hypothesis is that attitude towards nutrition is not independent of sports discipline.

At a 95% confidence level the critical value of $x^2$ for acceptance of the null hypothesis is 12.59. The result of $x^2$ however is 0.8715 which is $< 12.59$ thus the null hypothesis is accepted. It can therefore be concluded at 95% confidence interval that attitude towards nutrition is independent of sports discipline.

3.3.7 Hypothesis testing for knowledge on nutrition and nutritional attitude using the Wilcoxon Signed Rank Test

The subjects' nutritional attitude is compared to their knowledge on nutrition. These two variables are tested for any correlation. Scores for each variable were categorized under good, neutral and bad. Should there be no correlation between the two variables then it is expected that the median for the two variables will vary. Whereas, if there is a correlation between dietary attitude and nutritional knowledge, then there would be no difference in the median of the sample scores. The Wilcoxon Signed Rank Test is used to check for any significance.
The Null Hypothesis (H₀) is: There is no difference in the median between Knowledge Scores and Attitude Scores.

The Alternate Hypothesis (H₁) is: There is a difference in the median between Knowledge Scores and Attitude Scores.

Table 3.2 shows the normalised scores of all the subjects as categorised into good, neutral and wrong nutritional knowledge and attitude.

<table>
<thead>
<tr>
<th>Subject No</th>
<th>Knowledge Normalised Scores</th>
<th>Attitude Normalised Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
<td>Neutral</td>
</tr>
<tr>
<td>1</td>
<td>7.1</td>
<td>2.9</td>
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<tr>
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</tr>
<tr>
<td>6</td>
<td>10.0</td>
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</tr>
<tr>
<td>7</td>
<td>8.3</td>
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</tr>
<tr>
<td>19</td>
<td>6.7</td>
<td>1.7</td>
</tr>
<tr>
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<td>7.1</td>
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</tr>
<tr>
<td>21</td>
<td>7.5</td>
<td>0.0</td>
</tr>
<tr>
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<td>0.0</td>
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<tr>
<td>23</td>
<td>7.1</td>
<td>1.4</td>
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<tr>
<td>24</td>
<td>8.6</td>
<td>0.0</td>
</tr>
<tr>
<td>25</td>
<td>6.0</td>
<td>0.0</td>
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<tr>
<td>26</td>
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<td>0.0</td>
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<tr>
<td>27</td>
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<tr>
<td>28</td>
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<tr>
<td>29</td>
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<tr>
<td>30</td>
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</tr>
<tr>
<td>32</td>
<td>8.0</td>
<td>0.0</td>
</tr>
<tr>
<td>33</td>
<td>7.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>
### The Wilcoxon Signed Rank Test applied to Scores relating to Good Knowledge and Good Dietary Attitude

The Null Hypothesis ($H_0$) is: There is no difference in the median between Good Knowledge Scores and Good Attitude Scores.

The Alternate Hypothesis ($H_1$) is: There is a difference in the median between Good Knowledge Scores and Good Attitude Scores.
The difference between the medians for these 2 scores was of 2.04. At 95 %
confidence interval the medians could lie between 1.42 and 2.62. Thus, with 95%
confidence, the null hypothesis is accepted. It is therefore concluded that based on
this data, having good knowledge on nutrition implies good dietary attitude.

3.3.7.2 The Wilcoxon Signed Rank Test applied to Scores relating to Wrong
Knowledge and Wrong Dietary Attitude

The Null Hypothesis (H₀) is: There is no difference in the median between Wrong
Knowledge Scores and Wrong Attitude Scores.

The Alternate Hypothesis (H₁) is: There is a difference in the median between Wrong
Knowledge Scores and Wrong Attitude Scores.

The difference between the medians for these 2 scores was of -0.86. At 95 %
confidence interval the medians could lie between -1.33 and -0.40. Thus, with 95%
confidence, the null hypothesis is accepted and it is therefore concluded that based
on this data, having wrong knowledge on nutrition implies wrong dietary attitude.

3.3.7.3 The Wilcoxon Signed Rank Test applied to Scores relating to Neutral
Knowledge and Neutral Dietary Attitude

The Null Hypothesis (H₀) is: There is no difference in the median between Neutral
Knowledge Scores and Neutral Attitude Scores.

The Alternate Hypothesis (H₁) is: There is a difference in the median between Neutral Knowledge Scores and Neutral Attitude Scores.
The difference between the medians for these 2 scores was of $-1.28$. At 95% confidence interval the medians could lie between $-1.17$ and $-0.99$. Thus, with 95% confidence, the null hypothesis is accepted and it is therefore concluded that based on this data, having neutral knowledge on nutrition implies neutral dietary attitude.
Chapter 4

Discussion
CHAPTER 4
DISCUSSION

In Chapter 3 the experimental data collected was presented and analysed. In this chapter the analysed data will be interpreted and discussed. Comparisons will be made to studies by other authors and the limitations of this study exposed. Finally, the major conclusions will be summarised and some recommendations made for future studies in this area.

Section 4.1: Subject Characteristics

This section refers to the data presented and described in Section 3.2.1 through to Section 3.2.7. In those sections data was gathered from subjects in response to a series of questions aimed at collecting socio-demographic data, biometric data as well as data relating to their sport.

4.1.1 Gender and Age

The majority of the sample was composed of males. This was partly due to the fact that males dominate one discipline, namely football refereeing. However, even when considering the whole sample, male subjects outnumbered female ones. This outnumbering of males can be seen at practically all age groups except for the age range 20 – 25 (refer to Fig 3.2 in the previous chapter). Beyond 25 years of age (especially beyond 29 years), it seems that female participation in sport decreased rather markedly. This may be due to motherhood and also to the role of housewife which is still rather prominent in Maltese society. However, a number of studies have
shown that women and girls find a less competitive and more socially oriented atmosphere more appealing than do men and boys (Dubois, 1990; Flood et al, 1991; Gibbons et al, 1997; Knoppers et al, 1986; Koivula, 1999). Therefore this could explain the gender difference in sports participation amongst subjects in this pilot study.

The average ages by the various disciplines are as follows: Volleyball, 20; Football refereeing, 31; athletics, 33 and basketball, 27.

4.1.2 Height and Weight
As is to be expected, females' heights were generally lower than males'. 1.7 metres seemed to be the dividing point for predominance of gender for height. As for the subjects' weight, there was a clear predominance of males beyond the 62 kg mark. It is also a well-accepted fact that males generally weigh more than females. However, since the participation of females in the study population diminished markedly beyond the age of 29, this could be contributing further to the predominance of males in the higher weight ranges. Beyond a certain age, one's body weight tends to increase. A gain in body weight (attributed primarily to gains in adipose tissue) has been commonly observed after the age of 20 and until the age of 50 after which there is a modest decline in fat free mass (Bemben et al, 1998). Another possible contributing factor lies due to the fact that a high percentage of football referees answered the questionnaire. As can be seen in Section 3.2.8.2, football referees predominantly occupied the highest BMI category.
4.1.3 Social Category

The subjects' self-categorisation into social classes yielded an interesting picture. In spite of there being 7 categories, the vast majority (82%) categorized themselves in 1 of 3 social classes. These were Lower middle Class (28%), Student (28%) and Middle Class (26%). A fair amount (12%) categorized themselves into Upper middle Class (which was the highest social category) whereas 3% of the study population each categorized themselves into Skilled Working Class and Unemployed. Nobody categorized himself as Working Class (unskilled manual worker). 94% of the population in the study fall under categories a, b, c and g. These referred to higher, intermediate and junior managerial, administrative or professional posts and students. The remaining ‘unpopular’ categories related to working class and unemployed. This seems to suggest that people participating in sports activities seem to be of a higher social class. Alternatively, there may be a tendency to over-report one’s social class. Macintosh (1982) has found that a high percentage of interschool athletes in Canada, when compared to other students, came more often from the professional and less often from the labour class. If this is the case, it could augur well when it comes to nutrition education intervention programmes for athletes of higher social class.

4.1.4 Distribution of Subjects by Sport and their commitment to Sport

An equal amount (50) of questionnaires was distributed to participants of each sport discipline. However, the response rate was unequal; the highest response rate was of 44% and this came from football referees. A possible reason for this is that the author’s husband is a referee. The questionnaires were distributed at a social gathering whereas in the case of the other subjects, they were distributed at their
place of training. 34% of subjects participating in Athletics sent in their questionnaire. However, one of these was disregarded since most of it was left unanswered. Here again, there is a close relative of the author (sister) who practices the sport discipline of athletics. This might partially explain the better response when compared to volleyball and basketball participants. 28% of subjects practising volleyball sent in the questionnaire whereas the poorest response of 12% came from basketball players.

An interesting fact is the number of subjects who opted to receive feedback on completion of the study. 59% of football referees, 63% of subjects participating in athletics, 71% of volleyball participants and 50% of basketball participants asked to receive feedback. This shows the eagerness that the majority of athletes have on the topic of sports nutrition.

The number of daily hours spent at their sport reflects the subjects' commitment to the sport. 77% of the subjects spent more than 1 hour daily practising their sport.

Section 4.2: Subjects' Weight Perception and BMI

This section refers to the data presented and described in Section 3.2.8. In that section data was gathered from subjects in response to a series of questions aimed at collecting data relating to their height, weight and perception to their body mass and body composition.
4.2.1 Intention to change weight / body composition

Weight management has been found to be of concern to female athletes by many researchers (Perron et al., 1985; Loosi et al., 1986; Clark et al., 1988; Wolch et al., 1987; Werblow et al., 1978; Tilgner et al., 1989; Potter et al., 1991). Female athletes often engage in harmful dietary and weight control practices (Turner et al., 2001). In this pilot study subjects were approximately equally distributed by gender in their intent on losing weight. However, it is interesting to note that subjects intending to “lose fat” were by the far majority, females.

In contrast, the vast majority of those who chose the intent to “increase muscle mass” were males. The predominance by gender in these 2 body composition intentions (losing fat and increasing muscle mass) may be partly due to the ideal body image imposed on man (and woman) by society and the media rather than a prerequisite for their particular sport. Leit et al. (2002) suggest that media’s representation of the ideal male body can affect men’s views of their bodies.

4.2.2 BMI

Amongst the various sports disciplines analysed in this pilot study, football refereeing seemed to be made up of the heaviest participants (median BMI of 25 kg/m²) whereas long distance athletes had the lowest BMI (21 kg/m²). It is an established fact that endurance athletes such as those participating in long distance running have a low BMI.

In spite of football refereeing not being a sport in its own right, these subjects have to pass a physical fitness test which is carried out 3 times per year. It is understandable
that football referees have to be physically fit so as to keep up with the match. The physical fitness test consists of a 12-minute run in which the referee has to cover a minimal distance of 2,700m and 4 sprint distances (2 of 50m and 2 of 200m). The sprint distance of 50m has to be covered in no more than 7.5 seconds whereas those of 200m in no more than 32 seconds. In order to achieve the desired level of fitness, organised, 1-2 times weekly obligatory, training sessions are held by their association. Most referees also train on their own initiative on other days. However, their BMI still classified them in a class of their own!

Section 4.3: Nutritional Knowledge and Nutritional Attitude

This section refers to the data presented and described in Section 3.3.1 through to Section 3.3.7. Data was gathered from subjects in response to a series of questions which reflect their knowledge on nutrition and their dietary attitude.

4.3.1 Relationship between Gender and Nutritional Knowledge

Various researchers have worked on nutrition knowledge and gender of athletes and reported that there is poor nutritional knowledge among female athletes (Werblow et al, 1978; Hickson et al, 1986; Cho et al 1974). Others have found better knowledge of nutrition amongst female athletes (Douglas et al 1984).

Knowledge on nutrition has been found to be independent of gender in the sample population of this pilot study. There was no significant difference between genders on nutritional knowledge.
The research methods used and the tools with which authors measure the variables vary between the different studies and could therefore contribute to the varying results.

4.3.2 Relationship between Gender and Nutritional Attitude

In this pilot study attitude on nutrition was independent of gender. Studies have yielded conflicting conclusions on this issue. Variam et al (1998) found that women (from the general population and not just athletes) scored better in healthy eating practices. Douglas et al (1984) concluded that male athletes had better food practices than female athletes.

4.3.3 Relationship between Age and Nutritional Knowledge

Age was not a variable upon which nutritional knowledge was dependent. This is reported in section 3.3.3 as tested by the Chi-Squared Test of Independence. In a study on schoolchildren and their parents by Niciforovic-Surkovic (2002) it was concluded that nutritional knowledge increases with age. However, it is understood that one may gain more knowledge on nutrition as one grows from a child to an adult parent. In the population of this pilot study, the ages ranged from teenage years to adulthood (14 years to 52 years).

4.3.4 Relationship between Age and Nutritional Attitude

There was no relationship between age and nutritional attitude in this pilot study. The various age categories in which the population was distributed did not result in a variance for nutritional attitude.
4.3.5 Relationship between Sport Discipline and Nutritional Knowledge

Douglas et al (1984) found significant relationships between sport forms and nutritional knowledge as well as nutritional practices in high school athletes. In this pilot study nutrition on knowledge was independent of sports discipline.

4.3.6 Relationship between Sport Discipline and Nutritional Attitude

There was no dependency between the various sports disciplines and nutritional attitude in this pilot study. Studies comparing nutritional behaviour among various sports disciplines seem to be scarce. A study on food habits in athletic and non-athletic adolescents has however concluded that athletic adolescents display healthier food habits than non-athletic adolescents (Cavadini et al, 2000). Healthy behaviour seems to cluster. Thus engaging in physical activity and eating well seem to go hand in hand irrelevant of the sport in question (assuming that the knowledge on nutrition is there on which one bases his dietary attitude).

4.3.7 Relationship between Nutritional Knowledge and Nutritional Attitude

It can be concluded from the data gathered here that good knowledge on nutrition implied good dietary practice, wrong knowledge on nutrition implied bad dietary practice and neutral knowledge on nutrition implied neutral dietary practice. There was therefore a positive correlation in all categories of these 2 variables. Amongst other authors who have demonstrated a positive correlation between nutritional knowledge and attitude were Werblow et al (1978) and Perron et al (1985). Both these sets of authors, however, studied only female athletes.
Knowledge on nutrition and nutritional behaviour of schoolchildren and their parents were studied by Niciforivuc-Surkovic (2002). It was then concluded that there was a significant discrepancy between knowledge and behaviour. Although children know which food is healthier, they often consume less healthy food. The lack of positive correlation between nutritional knowledge and behaviour contrasts to results in this pilot study. However, the population in both studies is different. Children are more bound to please themselves and less likely to sacrifice their eating pleasures than athletes.

Section 4.4: Limitations of this Study

4.4.1 Sample Size

The sample size was small and it was therefore more difficult to draw a statistically significant result especially given the variability in the population. However, inferences about the whole population were made (using the Chi Squared Test and the Wilcoxon Signed Rank Test and the 95% confidence interval). It might be the case that with a larger sample size, statistically significant differences between the various sub groups would have emerged.

4.4.1.2 Response Rate

Overall response rate was 29.5% i.e. 59 of 200 questionnaires distributed (1 was discarded since it was left practically blank). The fact that the questionnaires were sent out shortly before Christmas could have influenced the response rate. It is known that cultural or societal events can impact the response rate. There were unequal response rates amongst the various sports disciplines (44% football referees, 34% track and field athletes, 28% volleyball players, 12% basketball players). This could also have affected the results.
4.4.2 Subjects from Various Sports Disciplines

Subjects were recruited from various sports disciplines as it was thought that it could make the pilot study more interesting. However, no significant differences resulted amongst the various sports disciplines. Recruiting subjects which are unequally distributed in various groups could have led to confounding factors. Perhaps, there could have been a better outcome had the study been conducted on a greater number of athletes from one discipline. Limiting the variables might have helped in giving a clearer picture of the issue of nutritional knowledge and behaviour.

4.4.3 Tools to Measure Variables

The tools used with which the dependent variables of nutritional knowledge and attitude were measured were not standard, validated tools. They were adapted from answers to questions put in the questionnaire which were then translated into scores according to the knowledge and attitude reflected therein. However, the method by which they were translated was generally based on established literature.

4.4.4 Information Bias

Another possible site of error could lie in the method of data collection. One may question the reliability and validity of self-reported height and weight amongst other information. Different instruments would have been used by the subjects (if any at all). Some could have relied on memory for recording their weight on the last occasion they weighed themselves. There is a potential of non-random bias (differential bias), which could have obscured any relation between variables.
Section 4.5: Conclusion

The data collected and analysed in Chapter 3 has been discussed and interpreted in this chapter. The chapter ends with a discussion of the limitations of this study. The next chapter will emphasize the major conclusions and recommendations for future research in this area.
Chapter 5

Conclusion and Recommendations
CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

Section 5.1: Project Summary

The project has examined some important issues regarding nutritional attitudes of athletes. The main aim of the project was to investigate the relationship between athletes’ nutritional knowledge and nutritional attitude. The primary objective of the work has been to determine whether knowledge on nutrition would lead to better dietary practice. This primary objective has been achieved by accomplishing the following secondary objectives:

- To study the pertinent medical literature in order to understand the nutritional requirements of athletes. To examine work done by others in the use of ergogenic aids so popularly used by athletes.

- To formulate a questionnaire which includes a series of questions indicative of one’s knowledge and attitude to nutrition. Other questions included helped in identifying the subjects better in relation to their sport and demographic data.

- To develop a survey method, chose appropriate subjects and explain to them the aim of the study so as to be in a better position to improve athlete’s nutritional attitude which may enhance their performance.
• To collate and analyse all data and draw inferences on the relationship of nutritional knowledge and attitude amongst athletes.

The major hypothesis of this study was that dietary practices of athletes are influenced by a number of factors, in particular by their knowledge on nutrition. The findings of this study support the fact that dietary practices of athletes are influenced by their knowledge on nutrition but are not influenced by other factors such as age, gender and sports discipline. In fact, good nutritional knowledge reflected good dietary practice, neutral nutritional knowledge reflected neutral dietary practice and poor nutritional knowledge reflected poor dietary practice. Thus, having good nutritional knowledge seems to be the mainstay for having athletes practicing good nutritional patterns. All subjects were given the opportunity to receive feedback on the conclusions of the study. 62% of the subjects participating in the study have opted to receive such feedback.

Section 5.2: Suggestions for Future Work

Knowing that nutritional knowledge affects athletes' dietary attitudes is only the first step. One's aim would now be how to increase athletes' knowledge on nutrition. Future work should investigate what educational programmes work best at increasing athletes' nutritional knowledge. Such work should not only investigate how one gains but also how one retains such knowledge.

Social, ecological, physiological and cognitive processes all influence choices among foods that cumulate in dietary intake (Wilson CS 2002). One would therefore aim to change those cognitive processes by means of well-designed educational programmes.
It might be the case that one would also need to increase knowledge on nutrition in coaches and trainers as these have a lot of contact time with athletes and athletes tend to give considerable weight to their coaches' views.

It might also be considered to include the use or abuse of supplements and ergogenic aids in education programmes aimed at athletes and coaches. Aside from training, nutrition may be the most important influence on athletic performance (ADA 2000). However, in seeking a competitive edge, athletes are often susceptible to fad diets or supplements that have not been scientifically validated.

Another possible area for future work is the determination of whether better knowledge on nutrition leads to better dietary practices in the local non-athletic population and not just in athletes. This is a vital step in public health promotion through good dietary practices.
Bibliography
Bibliography


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Appendices
APPENDIX A-1
Questionnaire

QUESTIONNAIRE ON NUTRITIONAL ASPECTS OF ATHLETES

Kindly tick the appropriate box or fill in where necessary:

Section A – General Questions

1. What is your sport? Track and Field ___ Football Refereeing ___ Basketball ____ Volleyball ___
   What is your role / position / event (for Track and Field) in your sport?
   ____________________________

2. Age: ____

3. Sex: Male ___ Female ___

4. Height (please specify if cms/m or inches/feet) ____

5. Weight (please specify if pounds/stones or kilos) ____

6. Do you presently think of yourself as being: underweight __, at a healthy weight __, mildly overweight __, moderately overweight __, very overweight __?

7. Would you like to: maintain your present weight __, Gain weight __, lose weight __, lower your percentage of body fat __, increase muscle mass __?

8. If you would like to gain or lose weight, what would you like to weigh? ____
   In what amount of time would you like to achieve your desired weight: ____ weeks, ____ months?

9. Has your weight been stable over the time you have been an established athlete? Yes __, No ___.
   If you answered “No”, by how much has your weight fluctuated _____?
   If you answered “Yes”, What do you think has helped you maintain stable weight?
   ________________________________

10. Marital status: Single ___ Married ___ Separated/Divorced ___

11. Where do you live? (town / village only) ______________
12. Kindly specify which category of the following 7 best fits you:

a) Upper Middle Class i.e. Higher Managerial, administrative or professional __
b) Middle Class i.e. Intermediate managerial, administrative or professional __
c) Lower Middle Class i.e. Supervisor or clerical and junior managerial, administrative or professional __
d) Skilled Working Class i.e. Skilled manual worker __
e) Working Class i.e.Semi and unskilled manual worker __
f) Unemployed (out of job, housewife, pensioner, etc) __
g) Student __

13. Typical number of hours spent each day in sports activity: _____ hrs

14. How many times a year do you compete overseas? _____

15. How long have you been practicing your current sport? _____ years

Section B – Nutrition History

1. Are you pleased with your present eating habits? Yes __  No __

2. Are you following a special diet? If yes, kindly fill in as appropriate the following table:

<table>
<thead>
<tr>
<th>Diet</th>
<th>Doctor</th>
<th>Dietitian</th>
<th>Coach</th>
<th>Other health care professional</th>
<th>Other nonlicensed person</th>
<th>Self</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Calorie</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Calorie</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Diabetic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Low fat/ low cholesterol</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Vegetarian</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>High carbohydrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low fibre</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>High fibre</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Low sodium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet for low blood sugar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet for allergy</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Other</td>
<td></td>
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<tr>
<td>Self</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
3. Do you feel your diet is nutritionally balanced? Yes _ No _
   If you answered "No", what do you feel is lacking / excessive in your diet?
   __________________ (please specify whether lacking or excessive)

4. Do you take vitamin or mineral supplements? Yes _ No _
   If yes, please name the vitamin or mineral and the dose you take:
   ________________________________________________________________
   ____________________________

5. Do you take supplemental protein? Yes _ No _
   If yes, please name the product and amount taken:
   ____________________________

6. Do you take any sports-specific, carbohydrate-rich drinks? Yes _ No _
   If yes, please name the product and amount taken:
   ____________________________

7. Do you have any food allergies? Yes _ No _
   If yes, name the food/s you are allergic to:
   ____________________________

8. Who usually prepares the food at home? ____________________________

9. Who usually does the grocery shopping for the household? ____________

10. Is it difficult to obtain the kinds of foods you prefer eating? Yes _ No _
    If yes, why is it difficult? ____________________________

11. How are most of your foods prepared? (Circle one or more) Fried, Boiled, Roasted, Grilled, Raw, Steamed

12. How many meals (including snacks) do you eat per day? _____

13. Approximately how much time do you leave between one meal / snack and the next? ___________

14. How many times a week do you eat at a restaurant? _____

15. How many times a week do you eat at a fast-food outlet? _____

16. What types of food are your least favourite? ____________________________

17. What is your favourite meal? ____________________________

18. What is your favourite snack? ____________________________

19. Are your eating habits consistent ____ or do they change frequently ____?

20. What time of day are you most hungry? ____________________________

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21. Do you eat more on weekends? Yes ___ No ___

22. What eating habits would you like to eliminate, change or include in your diet?
   ______________________________________________________________
   ______________________________________________________________

23. Do you usually follow a special meal plan one week or so prior to an event? Yes ___ No ___

   If yes, what main changes do you make?
   ______________________________________________________________
   ______________________________________________________________

24. What do you usually eat / drink as the last meal before an event and how much time before the event do you have ____________

25. When in particular do you consume fluids (circle one or more): prior to exercise, during exercise, after exercise?
# APPENDIX A-2

## Questionnaire

### Nutritionist Five Food Frequency Questionnaire

<table>
<thead>
<tr>
<th>Serving Size</th>
<th>Food Name / Description</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 SLICE</td>
<td>Whole grain breads (whole wheat, rye, pumpernickel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 SERVING</td>
<td>White breads (French-1 slice, burger/hot dog bun-1/2 item)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5 ITEM</td>
<td>English muffin, bagel, pita bread</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 SERVING</td>
<td>Whole grain crackers: Triscuits, Wheat Thins, etc (4-6 each)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 SERVING</td>
<td>Other crackers: Saltines, Ritz, etc (4-6 each)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ITEM</td>
<td>Tortilla, corn, 6 inch diameter (medium)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ITEM</td>
<td>Muffins</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 SERVING</td>
<td>Pancakes (2), waffles (1 – 7 inch diameter)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5 CUP</td>
<td>Whole grain hot cereal: rolled oats, rolled wheat, Roman Meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5 CUP</td>
<td>Instant or quick hot cereal: cream of wheat, cream of rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.75 CUP</td>
<td>Cold cereals: shredded wheat, raisin, bran, or bran flakes</td>
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<tr>
<td>0.75 CUP</td>
<td>Cold cereals: Frosted Flakes, Sugar Smacks, etc</td>
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<tr>
<td>0.5 CUP</td>
<td>Rice, cooked</td>
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<tr>
<td>0.5 CUP</td>
<td>Pasta, cooked</td>
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<tr>
<td>1 ITEM</td>
<td>Apple or pear, fresh, medium</td>
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<tr>
<td>1 ITEM</td>
<td>Banana, medium</td>
<td></td>
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<tr>
<td>1 SERVING</td>
<td>Orange (1 item) or grapefruit (1/2 item)</td>
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<tr>
<td>1 SERVING</td>
<td>Peach (1), nectarine (1/2), or apricots (2)</td>
<td></td>
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<tr>
<td>0.75 CUP</td>
<td>Berries (in season)</td>
<td></td>
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</tr>
<tr>
<td>0.25 ITEM</td>
<td>Cantaloupe, medium (in season)</td>
<td></td>
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<tr>
<td>1 CUP</td>
<td>Other melon (watermelon, honeydew, casaba)</td>
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82
<table>
<thead>
<tr>
<th>Serving Size</th>
<th>Food Name / Description</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Never</th>
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<tbody>
<tr>
<td>0.5 CUP</td>
<td>Pineapple, fresh</td>
<td></td>
<td></td>
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<tr>
<td>0.25 CUP</td>
<td>Dried fruits: raisins (2 Tbsp), dates (2), prunes (2), dried apricots (4)</td>
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<tr>
<td>0.5 CUP</td>
<td>Canned fruit or frozen fruit</td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Orange or grapefruit juice</td>
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<tr>
<td>0.5 CUP</td>
<td>Tomato juice or vegetable juice</td>
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<tr>
<td>0.5 CUP</td>
<td>Other juices: apple, grape, pineapple, or cranberry</td>
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<tr>
<td>0.5 CUP</td>
<td>Fruit drinks: lemonade, punch, Koolaid</td>
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<tr>
<td>1 TBSP</td>
<td>Vegetable oils: corn, safflower, soy, etc.</td>
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<tr>
<td>1 TBSP</td>
<td>Olive Oil</td>
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<tr>
<td>1 TBSP</td>
<td>Shortening</td>
<td></td>
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<tr>
<td>1 TBSP</td>
<td>Lard</td>
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<tr>
<td>1 TSP</td>
<td>Margarine</td>
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<tr>
<td>1 TSP</td>
<td>Butter</td>
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<tr>
<td>1 TBSP</td>
<td>Mayonnaise</td>
<td></td>
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<tr>
<td>1 TBSP</td>
<td>Regular salad dressings</td>
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<tr>
<td>1 TBSP</td>
<td>Low-calorie dressings</td>
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<tr>
<td>1 TBSP</td>
<td>Sour cream</td>
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<tr>
<td>1 TBSP</td>
<td>Cream cheese</td>
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<tr>
<td>1 TBSP</td>
<td>Half &amp; Half, table cream</td>
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<tr>
<td>1 CUP</td>
<td>Skim milk or low fat milk</td>
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<tr>
<td>1 CUP</td>
<td>Whole milk</td>
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<tr>
<td>1 CUP</td>
<td>Chocolate milk</td>
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<tr>
<td>1 CUP</td>
<td>Yogurt</td>
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<tr>
<td>1 OUNCE</td>
<td>Cheese: Cheddar, Colby, American, Monterey jack, etc</td>
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<tr>
<td>1 OUNCE</td>
<td>Other cheeses: Swiss, mozzarella, ricotta, string, etc</td>
<td></td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Cottage cheese</td>
<td></td>
<td></td>
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<tr>
<td>1 CUP</td>
<td>Salads: lettuce, celery, green peppers, onions</td>
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<tr>
<td>Serving Size</td>
<td>Food Name / Description</td>
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<tr>
<td>0.5 CUP</td>
<td>Dark green leafy vegetables, raw or cooked</td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Carrots, raw or cooked</td>
<td></td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Tomatoes, fresh, medium</td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Starchy vegetables, cooked: corn, peas, mixed vegetables</td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Other vegetables, cooked: green beans, beets, zucchini</td>
<td></td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Cauliflower, broccoli, brussel sprouts, cabbage</td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Winter squash, cooked: acorn, butternut, hubbard</td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>White potato, baked, boiled, or mashed</td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Sweet potatoes or yams, cooked</td>
<td></td>
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</tr>
<tr>
<td>12 FL OZ</td>
<td>Cola drinks (1 can = 12 fl. oz)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>12 FL OZ</td>
<td>Diet cola drinks (1 can = 12 fl. oz)</td>
<td></td>
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<tr>
<td>12 FL OZ</td>
<td>Non-cola drinks: 7-up, Sprite, Slice, etc (1 can = 12 fl. oz)</td>
<td></td>
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<tr>
<td>12 FL OZ</td>
<td>Diet non-cola drinks (1 can = 12 fl. oz)</td>
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<tr>
<td>8 FL OZ</td>
<td>Coffee or tea (1 cup = 8 fl. oz)</td>
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<tr>
<td>8 FL OZ</td>
<td>Decaffeinated coffee or teas: Sanka, herbal tea, etc</td>
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<tr>
<td>1 CUP</td>
<td>Hot chocolate or cocoa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 FL OZ</td>
<td>Beer (1 can = 12 fl. oz)</td>
<td></td>
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<tr>
<td>4 FL OZ</td>
<td>Wine, dry or table (red, white or blush)</td>
<td></td>
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<tr>
<td>1.5 FL OZ</td>
<td>Liquor: vodka, whiskey, gin, rum, etc</td>
<td></td>
<td></td>
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<tr>
<td>1 CUP</td>
<td>Legumes: lentils, pinto beans, navy beans, cooked</td>
<td></td>
<td></td>
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<tr>
<td>0.25 CUP</td>
<td>Nuts and seeds: peanuts, almonds, sunflower seeds, etc</td>
<td></td>
<td></td>
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<tr>
<td>1 TBSP</td>
<td>Peanut butter, nut butters</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Tofu or other meat substitutes</td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Beef: rib roast, steak, pot roast, veal, etc</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3 OUNCE</td>
<td>Beef, ground, cooked</td>
<td></td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Pork: chops, roast, ham</td>
<td></td>
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<tr>
<td>Serving Size</td>
<td>Food Name / Description</td>
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<td>Weekly</td>
<td>Monthly</td>
<td>Never</td>
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<tr>
<td>3 OUNCE</td>
<td>Lamb: chops, roast</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Poultry: chicken, turkey, duck</td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Fish, canned with oil: tuna, sardines</td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Tuna, water pack</td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Fish, fresh or frozen, no breading: trout, halibut, sole, etc</td>
<td></td>
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<tr>
<td>3 OUNCE</td>
<td>Shellfish: shrimp, scallops, lobster, clams</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1 ITEM</td>
<td>Eggs, whole, large</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25 CUP</td>
<td>Egg substitutes or egg whites</td>
<td></td>
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<tr>
<td>1 OUNCE</td>
<td>Lunch meats: bologna, salami, etc</td>
<td></td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Frankfurters or sausage link (4 in x 1 1/8 in)</td>
<td></td>
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<tr>
<td>2 ITEM</td>
<td>Cookies: chocolate chip, oatmeal, peanut butter, etc</td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Brownies, 2 in.</td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Doughnut or sweet roll</td>
<td></td>
<td></td>
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<tr>
<td>1 SLICE</td>
<td>Cake, 1/12 of 9 in.</td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Granola bars (1 item) or granola (1/2 cup)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1 SLICE</td>
<td>Pie, 1/8 of whole pie</td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Gelatin, flavored</td>
<td></td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Pudding or custard</td>
<td></td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Ice Cream</td>
<td></td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Ice Milk</td>
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<tr>
<td>0.5 CUP</td>
<td>Sherbet</td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Candy bar, chocolate bar (1 bar), M&amp;Ms (1 pkg.)</td>
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<tr>
<td>1 ITEM</td>
<td>Hard candy, gum drops, Lifesavers</td>
<td></td>
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</tr>
<tr>
<td>1 SLICE</td>
<td>Fast food – pizza</td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Fast food – hamburger or cheeseburger</td>
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<tr>
<td>1 ITEM</td>
<td>Fast food – burrito or taco</td>
<td></td>
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</tr>
<tr>
<td>2 SLICE</td>
<td>Bacon</td>
<td></td>
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<tr>
<td>2 CUP</td>
<td>Popcorn, popped</td>
<td></td>
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<tr>
<td>1 OUNCE</td>
<td>Potato chips, corn chips, tortilla chips</td>
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<tr>
<td>Serving Size</td>
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<tr>
<td>1 TBSP</td>
<td>Catsup or chili sauce</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.5 CUP</td>
<td>Tomato based sauce (spaghetti sauce)</td>
<td></td>
<td></td>
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<tr>
<td>1 TBSP</td>
<td>Pickles or pickle relish (1Tbsp)</td>
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<tr>
<td>5 ITEM</td>
<td>Olives</td>
<td></td>
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<tr>
<td>0.125 ITEM</td>
<td>Avocado (1/8 item)</td>
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<tr>
<td>1 TBSP</td>
<td>Sauces: soy sauce, steak sauce, barbecue sauce</td>
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<tr>
<td>0.25 CUP</td>
<td>Brown gravy, giblet gravy, or white sauce</td>
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<tr>
<td>1 CUP</td>
<td>Soups, vegetable or noodle type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 CUP</td>
<td>Soups, cream</td>
<td></td>
<td></td>
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<tr>
<td>1 ITEM</td>
<td>Chewing gum</td>
<td></td>
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<tr>
<td>1 TBSP</td>
<td>Sugar, honey, jam, jelly, syrups</td>
<td></td>
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</tbody>
</table>
APPENDIX A-3

Covering Letter

Elizabeth Micallef B. Sc. (Hons.) Physio S.R.P.
30 Pope Pius XII Street, Mosta, MST 05
Tel: 21 413 048, 7905 4922
E-mail: micallefs@onvol.net

22nd November 2002

Dear Sportsman / Sportswoman,

I am reading for a postgraduate diploma in Nutrition and Dietetics. As part of the requirements, a research project is necessary.

My research project is about the Nutritional Attitudes of Athletes. It would be greatly appreciated if you would kindly fill in the enclosed questionnaire and the Food Frequency Questionnaire. The former consists of two sections: Section A covers general questions whereas section B is about nutritional aspects. The Food Frequency Questionnaire aims to give an idea of the diet you consume. Please rest assured that anonymity as regards your answers is guaranteed.

My contact details are as above. Should you wish to contact me so as to clarify any question, please do not hesitate. Also, should you wish to receive some feedback on the results of the research project, kindly fill in the attached form accordingly. Such feedback would be in general and would not disclose any confidential information or individual answers to the questions.

The analysis on the questionnaires will commence on the 16th December 2002, therefore it is necessary that I receive the questionnaire by Saturday 14th December 2002. I am enclosing a stamped self-addressed envelope for your perusal. I thank you in anticipation of your participation.

Yours truly

Elizabeth Micallef
Dear Ms Micallef,

I would like to receive generalized feedback on the Nutritional Attitudes of Athletes at the end of the research project (approximately June – July 2003)

Name: __________________________________________________________

Address:
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
APPENDIX B-1

KNOWLEDGE SCORING LIST

For the purpose of this study, knowledge is defined as knowledge about nutrition. Subjects' responses to the questions listed in this section will be scored according to knowledge scoring rules (defined in Appendix B – 1b). The scoring regime has been developed to score respondents' answers to the following nutrition questions. These will fall into three distinct knowledge categories: Good, Neutral or Wrong with the following numerical scores of 1, 0 and –1 respectively.

Nutritional Attitudes Q. 6

Do you presently think of yourself as being: underweight __, at a healthy weight__, mildly overweight __, moderately overweight __, very overweight __?

BMI is used so as to gauge the correctness or otherwise of answers. Underweight is taken as BMI of < 17.5. Healthy weight is taken as BMI of between 17.6 and 25. Mildly overweight as BMI of 25.1 to 27.5. Moderately overweight as BMI of 27.6 to 30. Very overweight as BMI of >30. These ranges may vary to those referring to the normal population. This is attributed to the fact that the population in this study is of athletes.

Nutritional Attitudes Q. 7

Would you like to: maintain your present weight __, Gain weight __, lose weight __, lower your percentage of body fat __, increase muscle mass ____?

The answer to this question when seen in conjunction to the athlete’s BMI will reflect their knowledge on healthy weight. Therefore if BMI of >25 (over weight) or of <17 (underweight) and they want to maintain weight, then this is a wrong answer (reflects poor knowledge).

One would score a point for choosing maintain weight if BMI is between 17 to 22. BMI of between 22.1 to 25 and they want to maintain their weight would be translated as a neutral answer.

If BMI <18 and subject says she / he wants to lose weight, than this too is a wrong answer. Losing weight is regarded as a correct answer if the BMI is >22. A BMI of between 18.1 and 22 with ‘losing weight’ given as an answer would be regarded as a neutral answer.

Gaining weight is regarded as a correct answer if BMI is <17. BMI of between 17.1 and 19.9 with gaining weight being given as an answer would be regarded as a neutral answer. If BMI is 20 or greater and the athlete wants to gain weight than this is regarded as a wrong answer.
If lower body fat is chosen and the person's BMI is <18 then this is regarded as a wrong answer. A BMI of between 18.1 and 22 with this answer is regarded as neutral answer. A BMI of >22 with this answer is regarded as a correct answer. (as in wanting to lose weight)

Increase muscle mass will be regarded as a neutral answer in anyone with a BMI of <25 whereas a BMI of 25 or over would necessitate decreasing body fat rather than increasing muscle mass and this would therefore reflect poor knowledge.

Nutritional Attitudes Q. 8

If you would like to gain or lose weight, what would you like to weigh? ____ In what amount of time would you like to achieve your desired weight: ___ weeks, ___ months?

The answer to this question when compared to their BMI gives an indication to their knowledge on how much they think they should weigh. Rate of 0.5 to 1 kg wt loss or gain / week indicates a correct answer.

The answer to this question is in 2 parts.

Part 1 regards the amount of weight they should lose or gain. If this reflects a good weight according to their height then they would score a point for the correct answer. Losing weight to get into the BMI bracket of between 17 to 24.9 is correct. Gaining weight to get into the BMI bracket of between 17 to 20 is correct. Losing weight to a BMI of <17 is incorrect. Gaining weight to a BMI of between 20.1 to 22 is neutral. Gaining weight to a BMI > 22 is considered incorrect.

Part 2 regards the rate of weight loss or gain. In either case, weight change should be accomplished slowly and ideally during the off-season. Maintaining a healthful diet while reducing total energy intake to allow gradual weight loss of 0.5 to 1 kg / week is recommended (ADA et al, 2000). The rate of 0.5 – 1kg loss per week is used as correct in scoring. A rate of loss at 20% or less outside the range on either side (i.e. 0.4 to 0.49 and 1.1 to 1.2 kg per week) is considered as a neutral score. Any other rates of loss would be regarded as incorrect.

Realistic weight gains of 0.2 – 0.9 kg / week can be expected based on reasonable increases in energy intake (Manore et al, 2000). A rate of gain within this range would be regarded as correct. A rate of gain at 20% or less outside the range on either side (i.e. 0.16 to 0.19 and 0.91 to 1.08 kg per week) is regarded as neutral score. This would signify a slightly slower or faster rate of weight gain. A rate of gain at more than 20% outside this range on either side is wrong.

Nutritional Attitudes Q. 9

Has your weight been stable over the time you have been an established athlete? Yes __, No ____.

If you answered “No”, by how much has your weight fluctuated ____?
If you answered “Yes”, What do you think has helped you maintain stable weight?
________________________________________________________________________

Regarding what they think contributed to their weight being stable:

Correct answers may include: regular exercise and/or good eating habits. Any deviation from this answer that still entails eating and exercise will be judged on individual basis and may be classified into neutral or wrong answer according to established general nutritional recommendations.

**Nutrition History Q 4.**

Do you take vitamin or mineral supplements? Yes ___ No ___
If yes, please name the vitamin or mineral and the dose you take:
________________________________________________________________________

Do they know what vitamin or mineral supplements are? If they name a product that is neither a vitamin nor a mineral supplement, then this reflects wrong nutritional knowledge. If the product named is truly a vitamin or mineral then they score a point. Otherwise if the product is not truly a vitamin or mineral then they lose a point.

**Nutrition History Q 5.**

Do you take supplemental protein? Yes ___ No ___
If yes, please name the product and amount taken: ______________________________________________________________________

Do they know what supplemental protein is? If the product named is truly a protein supplement then they score a point. Otherwise if the product is not truly a protein supplement, then they lose a point.

**Nutrition History Q 6.**

Do you take any sports-specific, carbohydrate-rich drinks? Yes ___ No ___
If yes, please name the product and amount taken: ______________________________________________________________________

Do they know what CHO-rich drink is? If the product named is truly a CHOS supplement then they score a point. Otherwise if the product is not truly a CHOS supplement, then they lose a point.

**Nutrition History Q 7.**

Do you have any food allergies? Yes ___ No ___
If yes, name the food/s you are allergic to
________________________________________________________________________
When compared to the FFQ, this question may reflect one's knowledge. Eg if they say they are allergic to peanuts and they take peanut butter, then poor nutritional knowledge is inferred.

**Nutrition History Q 11.**

How are most of your foods prepared? (Circle one or more) Fried, Boiled, Roasted, Grilled, Raw, Steamed

If the foods are mostly fried then a –ve score is drawn. Conversely, if the foods are mostly boiled, roasted, grilled, raw or steamed then a +ve score derived.

**Nutrition History Q 22**

What eating habits would you like to eliminate, change or include in your diet?

If their desired change is nutritionally sound, then this is regarded as a correct answer. If the desired change is not a nutritionally sound one, then this is regarded as a wrong answer. A nutritionally unimportant desired change or a vague answer is regarded as neutral.

The CINDI dietary guidelines will be followed to determine whether the desired change is nutritionally sound.
### Criteria for scoring points on knowledge

<table>
<thead>
<tr>
<th>N.A. Q6 Correct</th>
<th>U.W.</th>
<th>BMI &lt;17.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>H.W.</td>
<td>BMI 17.6 – 25</td>
<td></td>
</tr>
<tr>
<td>Mildly O.W.</td>
<td>BMI 25.1 – 27.5</td>
<td></td>
</tr>
<tr>
<td>Moderately O.W.</td>
<td>BMI 27.6 – 30</td>
<td></td>
</tr>
<tr>
<td>Very O.W.</td>
<td>BMI &gt;30</td>
<td></td>
</tr>
</tbody>
</table>

Correct if any of the weight perception categories do not fit the relevant BMI

<table>
<thead>
<tr>
<th>N.A. Q7 Maintaining Wt</th>
<th>Correct</th>
<th>BMI 17 – 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>BMI 23.1 – 25</td>
<td></td>
</tr>
<tr>
<td>Wrong</td>
<td>BMI &gt;25 or &lt;17</td>
<td></td>
</tr>
</tbody>
</table>

Lose Wt

Correct | BMI >23 |
Neutral | BMI 18.1 – 23 |
Wrong   | BMI <18 |

Gain Wt

Correct | BMI <17 |
Neutral | BMI 17.1 – 19.9 |
Wrong   | BMI 20 or >20 |

Lower % fat

Correct | BMI >23 |
Neutral | BMI 18.1 – 23 |
Wrong   | BMI <18 |

Increase muscle mass

Correct | n/a |
Neutral | BMI <25 |
Wrong   | BMI 25 and over |

NA Q8 Part 1 Correct

Losing enough wt to fit BMI 17 – 24.9
Gaining enough wt to fit BMI 17 – 20
Losing some weight to fit BMI >24.9
Gaining wt to fit BMI 20.1 – 23
Losing wt to fit BMI <17
Gaining wt fit BMI>23

Correct if rate of loss is of 0.5 – 1 kg / week
Wrong if rate of loss is outside this range

Correct if rate of gain is within range of 0.2 – 0.9 kg / week
Neutral if rate of gain is > 0.16 kg / week but < 0.2 kg/wk
Neutral if rate of gain is > 0.9 kg/ week but < 1.08 kg/ week
Wrong if rate of gain is < 0.16 kg/ week or > 1.08 kg / week
<table>
<thead>
<tr>
<th>Q</th>
<th>Correct</th>
<th>Neutral</th>
<th>Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.A. Q9</td>
<td>Any situation which contributes to weight being stable such as: moderate eating, regular exercise and / or eating habits, training / food intake balance</td>
<td>a vague answer eg knowing I have to be at a good wt as Subject 17 gave</td>
<td>Any situation which does not contribute to weight being stable.</td>
</tr>
</tbody>
</table>

Answers to this question (reason for stable wt) are subjective and will be individually judged as to their correctfulness.

<table>
<thead>
<tr>
<th>N.H. Q4</th>
<th>Correct</th>
<th>Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If product named is indeed a vitamin or mineral</td>
<td>If product named is not a vitamin or mineral.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N.H. Q5</th>
<th>Correct</th>
<th>Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If product named is indeed a supplemental protein.</td>
<td>If product named is not a supplemental protein.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N.H. Q6</th>
<th>Correct</th>
<th>Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If product named is indeed a CHO supplement.</td>
<td>If product named is not a CHO supplement.</td>
</tr>
</tbody>
</table>

If a complete meal supplement (eg Myoplex) is taken and the athlete says he does not have supplemental vitamins, minerals, proteins or CHOS, then a negative score is given under each relevant category.

<table>
<thead>
<tr>
<th>N.H. Q7</th>
<th>Correct</th>
<th>Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If subject is allergic to certain foods and this is avoided according to the FFQ</td>
<td>If subject is allergic to certain foods and this is consumed according to the FFQ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N.H. Q11</th>
<th>Correct</th>
<th>Neutral</th>
<th>Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If any or all of the following are circled: b.c.d.e.f</td>
<td>If 'a' and any other 2 are circled.</td>
<td>If 'a' alone is circled.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N.H. Q22</th>
<th>Answers to this question are subjective and will be analysed individually according to whether the desired change is nutritionally sensible or not. The answers will be categorised as follows:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correct</td>
<td>A nutritionally sound desired change.</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>A nutritionally unimportant desired change or a vague answer eg more balanced diet, CHOS and Proteins as Subject 12 gave. Subject no 23 said “eliminate nibbling” – This is regarded as neutral since it depends what the nibbles consist of and their frequency of consumption; They may be healthy between meal snacks.</td>
</tr>
<tr>
<td></td>
<td>Wrong</td>
<td>A nutritionally irrational desired change.</td>
</tr>
</tbody>
</table>
APPENDIX C-1

ATTITUDE SCORING LIST

Attitude for the purpose of this study is defined to mean, "the dietary practice adopted by the subject". Subjects' responses to the questions listed in this section will be scored (according to attitude scoring rules in Appendix B - 2b) to fall into three distinct categories: Good, Neutral and Bad Attitude each assigned respectively a numerical score of 1, 0 and -1.

Nutrition History Q.3

Do you feel your diet is nutritionally balanced? Yes ___  No ___
If you answered "No", what do you feel is lacking / excessive in your diet?
________________________ (please specify whether lacking or excessive)

If they feel that their diet lacks some nutrients, then good dietary practice would mean that this is compensated for by supplements (unless they can improve their diet). If they think it lacks a specific nutrient which can be compensated by supplements but is not being compensated for, then this is bad dietary practice. If they are compensating for the perceived lack by the right supplement, then this is good dietary practice.

Nut. History Q 4, 5, 6 provide info re the respondent’s attitude towards his nutritional intake / needs.

Nutrition History Q. 4

Do you take vitamin or mineral supplements? Yes ___  No ___
If yes, please name the vitamin or mineral and the dose you take:
________________________
________________________

Since these should not be necessary if the athlete’s diet provides adequate energy from a variety of foods (ADA et al 2000), then, having supplements reflects bad dietary practice. Not having minerals or vitamin supplements may be good dietary practice if the athlete’s diet is a well-balanced one. However, since from the limited data that is gathered in this pilot study it cannot precisely be determined whether the diet is a well-balanced one, then, not having these supplements will be regarded as a neutral answer.

Supplements may be required by athletes who restrict energy intake, use severe weight-loss practices, eliminate one or more food groups from their diet or consume high carbohydrate diets with low micronutrient density (ADA et al 2000).

In a table presented in the study by Ahrendt (2001) (reproduced in Appendix ?????) which provides a summary of current literature on the use of ergogenic aids, no benefits are listed in the inclusion of mineral or vitamin supplementation unless in
some cases there was a pre-existing deficiency (the only exception is Vitamin E where research gives mixed views on its supplementation with some positive conclusions). The scenario of a pre-existing deficiency could not be determined in this pilot study and thus the scores as described above were reached. Side effects to taking regular supplementation of vitamins and minerals as summarised in the above-mentioned table by Ahrendt (2001) range from none to mild to toxic at various doses.

**Nutrition History Q. 5**

Do you take supplemental protein? Yes ___  No ___  
If yes, please name the product and amount taken: ___________________________

Since there is no convincing evidence that supplemental protein enhances muscle anabolism or improves strength (Manore et al, 2000 pg 115), then athletes who take supplemental protein are considered as adopting bad dietary practice in this pilot study. Those who do not take supplemental proteins are considered as adopting good dietary practice.

Inadequate protein intake causes a negative nitrogen balance which slows muscle growth and causes fatigue (Ahrendt 2001). However, adequate protein consumption can be ensured through natural food items, which, will also deliver other micronutrients. Supplying adequate energy and nutrient (including protein) intake in the diet, and timing these to be efficiently used by the body, provides the most effective and safe results Chandler et al, 1994 & Coggan et al, 1992).

**Nutrition History Q. 6**

Do you take any sports-specific, carbohydrate-rich drinks? Yes ___  No ___  
If yes, please name the product and amount taken: ___________________________

Since the reasons to justify having a sports drink are various (Manore et al, 2000 pg 237) (eg to provide adequate carbohydrates, fluid intake, electrolytes, especially in high temperatures as often prevail in Malta, etc), then, having a sports drink is considered good dietary practice in athletes. Not having any, however, is not necessarily bad dietary practice and will be regarded as neutral practice.

Utter et al (1997) have demonstrated that carbohydrate-containing fluids may help delay fatigue. Another study found that ingesting a carbohydrate-electrolyte drink improved performance in cyclists (Jeukendrup et al, 1997).

**Nutritional History Q 11**

How are most of your foods prepared? (Circle one or more) Fried, Boiled, Roasted, Grilled, Raw, Steamed

This question is indicative of one’s attitude towards nutritional habits. If most foods are fried, then this is considered as bad dietary practice (the CINDI dietary guidelines by WHO (2000) are taken as nutritional guidelines). If most foods are fried and
steamed, then for the purpose of scoring, these are considered to cancel each other out since one method is recommended so as to reduce fat intake whereas the other is discouraged. It therefore reflects neutral dietary practice. If, however, the respondent answers that most of his foods are fried, steamed and grilled, then this indicates good dietary practice since the recommended methods of food preparation outweigh the discouraged one.

**Nutrition History Q. 12**

How many meals (including snacks) do you eat per day? ____

In order to maintain full muscle glycogen stores one should eat frequently, approximately once every three hours (Benardot, 2000). The following scoring criteria are observed in relation to this question:
3 – 5 meals per day reflects good dietary practice. 1 – 2 meals per day as well as 7 and over is bad dietary practice. 6 meals per day is regarded as neutral dietary practice.

**Nutritional History Q. 13**

Approximately how much time do you leave between one meal / snack and the next? ____________

In addition to consuming enough energy and nutrients, it is important to eat the foods at the times the body can benefit the most from them. The timing of meals is important for ensuring that muscles have enough energy and nutrients to hypertrophy and get stronger during training sessions (Benardot, 2000). Considering that it is recommended that athletes should eat once approximately every three hours, the following scoring criteria have been set:
A time frame of between 3 – 5 hours is good dietary practice. A time frame of < 2 hrs or > 6 hrs is bad dietary practice. A time frame of 2 to < 3 hrs as well as >5 hrs but less than 6 hrs is neutral dietary practice.

**Nutritional History Q 14 & 15**

How may times a week do you eat at a restaurant? ________

How many times a week do you eat at a fast-food outlet? ________

The number of times the respondent eats out at a restaurant or a fast food outlet reflects his attitude towards wholesomeness of food. Restaurant meals are usually higher in fats, sodium and cholesterol and lower in fibre than meals prepared at home (Variyam et al 1998). The following scoring criteria have therefore been set:
>1 wkly at fast food outlet reflects bad dietary practice and >2 wkly at a restaurant reflects bad dietary practice.

**Nutritional History Q 16**

What types of food are your least favourite? _____________________
Assuming that the respondent consumes the least favourite food rarely, then this question reflects one’s attitude. If fish or vegetables are one’s least favourite, it is assumed that he does not consume these regularly; therefore bad dietary practice is implied. If pastizzi or other highly fatty food is listed as least favourite, it is assumed that he does not eat these regularly and good dietary practice is implied. Should the respondent state that even though it is least favourite, he regularly eats that food then the stated assumption is obviously not made.

**Nutritional History Q 17 & 18.**

What is your favourite meal? ________________________________

What is your favourite snack? ________________________________

In a similar manner to Question 16, these 2 questions are used to assess one’s attitude re favourite snacks / meals. Here, it is assumed that favourite snacks or meals are consumed regularly. In such case nutritious favourite foods imply good dietary practice whereas calorie-dense foods being favourite imply bad dietary practice. Should the respondent state that even though the particular food is his most favourite, he rarely eats it, then, the stated assumption is obviously not made.

**Nutritional History Q 19**

Are your eating habits consistent ____ or do they change frequently ____?

There aren’t too many versions of a well-balanced diet! Therefore a diet that changes frequently is associated to bad dietary practice whereas a consistent diet is associated to neutral dietary practice since it can be a consistently good diet or a consistently bad diet.

**Nutrition History Question 20**

What time of day are you most hungry? ________________________________

One would presumably eat at the time he is very hungry. Hunger has been defined as a primarily physiological drive to find and eat food (Kreider et al, 1998).

If he is very hungry any time after 9 pm, it is therefore presumed that he has had his last meal a considerable number of hours before and that he will eat at that late hour. This implies bad dietary practice.

**Nutrition History Q 22**

What eating habits would you like to eliminate, change or include in your diet?

____________________________________________________

____________________________________________________

____________________________________________________
The answer to this question may reflect what their current practice is. If they say they would like to include vegetables, this shows that they do not consume vegetables; therefore it reflects bad dietary practice. If they say they would like to decrease or eliminate chocolate, then this means that they eat a considerable amount of it and therefore reflects bad dietary practice. If they want to decrease the intake of a nutritious food then the fact that they eat this food regularly indicates good dietary practice.

**Nutrition History Q 23**

Do you usually follow a special meal plan one week or so prior to an event?

- Yes __
- No __

If yes, what main changes do you make?

Loading or increasing the carbohydrate content of the diet several days before an event has been promoted as a means to prolong exercise endurance. Hawley et al (1997) evaluated its impact on continuous, short-term events of less than one hour and found no benefit because muscle glycogen content was not depleted at the end of the exercise.

Long-distance athletes whose exercise is longer than the one hour period studied by Hawley et al (1997) also have training sessions of periods in excess of one hour.

No special meal plan is necessary if they are eating a well-balanced diet. Due to their training, athletes still require the high carbohydrate intake and slightly lesser fat intake than the normal population. Therefore any special meal plan a week prior to event is interpreted as bad dietary practice whereas no special meal plan as good dietary practice.

**Nutrition History Q 24**

What do you usually eat / drink as the last meal before an event and how much time before the event do you have it?

A meal prior to exercise ensures that muscle and liver glycogen stores are maximized. Studies investigating a meal two to four hours prior to exercise have shown positive effect (Schabort 1999, Wee 1999).

Ingesting carbohydrates only 45 minutes prior to a two-hour exercise test revealed no benefit in a study by Febbraio et al (1996).

If a large proteinaceous or high-fat content meal is consumed close to the event, then this is interpreted as bad dietary practice. Both these would delay gastric emptying and can lead to dehydration since fluid is absorbed in the large intestine. If a mainly carbohydrate meal is consumed a few hours before event, then this implies good dietary practice.
Nutrition History Q 24

What do you usually eat / drink as the last meal before an event and how much time before the event do you have it?

Any milk drinks (due to their protein value) just prior to event is interpreted into bad dietary practice whereas any other drink (water or glucose drink) into good dietary practice.

Nutrition History Q 25

When in particular do you consume fluids (circle one or more): prior to exercise, during exercise, after exercise?

A body water deficit has been shown to have adverse effects and reduce exercise capacity (Buono et al, 2000). Fluid ingestion during extended exercise is regarded as a primary way of offsetting the detrimental effects of dehydration (Walsh, 1994).

One should drink both prior to and after exercise (Manore et al, 2000). If they do so, this is therefore good dietary practice. If the duration of the exercise is longer than 1 hour (or even less in very hot weather), then one should also drink during exercise. Expected answers to earn the mark for good dietary practice are therefore (a) and (c), or (a), (b) and (c). If either (a) alone or (c) alone is given, then the given one cancels the absent one in points awarded on good dietary practice and they score 0. If the duration of activity is long and they do not drink on all occasions i.e. prior, during and after, then this translates to bad dietary practice since they should drink on all occasions. In this pilot study, basketball and volleyball are considered as sports of duration less than an hour. Athletics will be differentiated into Sprint and Middle Distance being shorter than an hour and long distance longer than an hour. Football refereeing or assistant refereeing is regarded as duration less than an hour since it usually consists of two halves of 45 minutes each with a fifteen minute break in between during which they could replenish fluids and it is not strictly during their activity. It is not continuous activity of longer than 1 hour as is normally long distance running.
APPENDIX C-2

Criteria for scoring points on attitude

N.H. Q3  Good Dietary Practice  If they think diet lacks a nutrient and they are compensating by the relative supplements.
         Bad Dietary Practice  If perceived lack of nutrient is not being compensated for by the relative supplement.

N.H. Q4  Neutral D.P.  No vitamin / mineral supplement taken
         Bad D.P.  Vitamin / mineral supplement taken

N.H. Q5  Good D.P.  No supplemental protein taken
         Bad D.P.  Supplemental protein taken

N.H. Q6  Good D.P.  Having a CHO-rich sports drink
         Neutral D.P.  Not having a CHO-rich sports drink

N.H. Q11 Good D.P.  If any or all of the following are circled b.c.d.e.f
      Neutral D.P.  If 'a' and any other 2 are circled.
       Bad D.P.  If 'a', and any of the rest is circled.

N.H. Q12 Good D.P.  3 – 5 meals (inc snacks) per day
      Neutral D.P.  6 meals (inc snacks) per day
       Bad D.P.  1 – 2 meals (inc snacks) per day

N.H Q13 Good D.P.  3 – 5 hours interval
       Neutral D.P.  2 to <3 hours interval
       Bad D.P.  >5 hours but less than 6 hours interval

N.H Q14 Good D.P.  < 2 weekly at restaurant
       Neutral D.P.  2 weekly at restaurant
       Bad D.P.  >2 weekly at restaurant

N.H Q15 Good D.P.  < 1 weekly at fast food outlet
       Bad D.P.  1 or >1 per week

N.H. Q16 Good D.P.  if least favourite food listed is a calorie dense food item
       Neutral D.P.  if food item/s listed are of mixed nutritional value or are unimportant in nutritional value (eg hot and spicy food)
       Bad D.P.  if least favourite food listed is a nutrient dense food item
N.H. Q17&18 Good D.P. nutritious favourite foods listed
Neutral D.P. a number of food items listed which have a mixed value regarding their nutritional content
Bad D.P. if calorie dense foods are listed

N.H Q19 Neutral D.P. consistent diet
Bad D.P. changes frequently

N.H Q20 Good D.P. any time of day but evening or night evening, later than 8pm, night
Bad D.P. Also bad d.p. if one is hungry late morning and states that he skips b/fast

N.H. Q22 Neutral D.P. if the desired change includes both good & bad dietary practice. Also if the answer is vague and cannot be interpreted as good or bad.
Bad D.P. include or increase any nutrient dense food / drink, water
Decrease or eliminate any calorie dense foods
Decrease or eliminate a bad dietary habit

N.H Q23 Good D.P. no special meal plan prior to event
Bad D.P. any special meal plan prior to event

N.H Q24 Good D.P. any meal which is mainly CHOS and consumed 1 hour or more prior to event
Bad D.P. any meal consumed at least 3 hours before any meal high in proteins and / or fat and 3 hours or less prior to event

N.H Q24 Good D.P. water or glucose drink
Bad D.P. milk drinks just prior to event

N.H Q25 Good D.P. a,c if duration of sport is less than 1 hour
a,b,c Neutral D.P. a - if duration of sport is less than 1 hour
c - if duration of sport is less than 1 hour
a, b - if duration of sports activity is less than 1 hr
b,c - if duration of sports activity is less than 1 hr
Bad D.P. a,b if duration of exs is longer than 1 hour
a, c if duration of exs is longer than 1 hour
b,c if duration of exs is longer than 1 hour
a - if duration of sport is longer than 1 hour
b - irrelevant of duration of sport
c - if duration of sport is longer than 1 hour
**APPENDIX D**

**Ergogenic Aids: A Summary of An Assessment of the Current Literature**

<table>
<thead>
<tr>
<th>Ergogenic aid</th>
<th>Action</th>
<th>Research on ergogenic effects</th>
<th>Side effects</th>
<th>Legality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Decreases anxiety</td>
<td>No benefits</td>
<td>Significant</td>
<td>Banned for shooting events</td>
</tr>
<tr>
<td>Amphetamines</td>
<td>Improve concentration, decrease fatigue and appetite</td>
<td>Mixed, some positive</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td>Anabolic steroids</td>
<td>Increase strength, lean muscle mass and motivation</td>
<td>Positive</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td>Androstenediol</td>
<td>Same as steroids</td>
<td>Limited, refutes</td>
<td>Unknown</td>
<td>Banned by IOC</td>
</tr>
<tr>
<td>Androstenedione</td>
<td>Same as steroids</td>
<td>Refutes, no benefits</td>
<td>Significant</td>
<td>Banned by IOC, NCAA</td>
</tr>
<tr>
<td>Antioxidants</td>
<td>Decrease muscle breakdown</td>
<td>Mixed, no clear benefits</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Arginine, ornithine, lysine</td>
<td>Stimulate growth hormone release</td>
<td>No benefit</td>
<td>None at doses used</td>
<td>Legal</td>
</tr>
<tr>
<td>Aspartates</td>
<td>Increase free fatty acid use, sparing muscle glycogen</td>
<td>Mixed, some positive benefits</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Aspirin</td>
<td>Decreases pain with muscle fatigue and muscle breakdown</td>
<td>No benefit</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td>Avena sativa</td>
<td>Increases steroid production</td>
<td>Limited, refutes</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>Bee pollen</td>
<td>Increases strength and endurance</td>
<td>Refutes, no benefits</td>
<td>Allergic reaction</td>
<td>Legal</td>
</tr>
<tr>
<td>Beta blockers</td>
<td>Decrease anxiety</td>
<td>Positive effect on fine motor control, negative effect on aerobic capacity</td>
<td>Significant</td>
<td>Banned by IOC</td>
</tr>
<tr>
<td>Beta_2 agonists</td>
<td>Increase lean muscle mass</td>
<td>Mixed, no benefit</td>
<td>Mild</td>
<td>Banned by IOC, legal when prescribed</td>
</tr>
<tr>
<td>Blood doping</td>
<td>Increases aerobic capacity</td>
<td>Supports</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td>Boron</td>
<td>Increases endogenous steroid production</td>
<td>Refutes, no benefit</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Branched chain amino acids</td>
<td>Decrease mental fatigue</td>
<td>Mixed, negative</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Supplement</td>
<td>Effect</td>
<td>Dosage</td>
<td>Legal Status</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
<td>--------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td><strong>Caffeine</strong></td>
<td>Increases muscle contractility and aerobic endurance, enhances fat metabolism</td>
<td>Supports</td>
<td>Mild</td>
<td>Legal to urine level of 12 to 15 µg per mL</td>
</tr>
<tr>
<td><strong>Calcium</strong></td>
<td>Increases muscle contractility, enhances glycogen metabolism</td>
<td>Refutes, no benefit</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Carbohydrates</strong></td>
<td>Increase endurance, decrease fatigue</td>
<td>Supports</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Carnitine</strong></td>
<td>Increases fat metabolism</td>
<td>Refutes</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Choline</strong></td>
<td>Increases endurance</td>
<td>Mixed, inconclusive</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Chromium</strong></td>
<td>Increases lean mass</td>
<td>Refutes, no benefit unless prior deficiency</td>
<td>Safe to 400 µg daily, potentially dangerous above this level</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Chrysin</strong></td>
<td>Inhibits aromatase, increases endogenous steroids</td>
<td>Limited, refutes</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Cocaine</strong></td>
<td>Stimulates CNS, delays fatigue</td>
<td>Mixed</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td><strong>Coenzyme Q₁₀ (ubiquinone)</strong></td>
<td>Delays fatigue, acts as antioxidant</td>
<td>Refutes, no benefit</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Coenzyme Q₁₂</strong></td>
<td>Increases aerobic capacity, speeds muscle repair</td>
<td>Refutes, no benefit</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Creatine</strong></td>
<td>Increases muscle energy, endurance, strength and lean muscle mass</td>
<td>Supports, insufficient data on long-term use</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>DHEA</strong></td>
<td>Increases endogenous steroid production</td>
<td>No benefit in healthy athletes</td>
<td>Potentially dangerous</td>
<td>Banned by IOC, some other organizations</td>
</tr>
<tr>
<td><strong>Diuretics</strong></td>
<td>Decrease body mass</td>
<td>Limited benefit</td>
<td>Potentially dangerous</td>
<td>Banned by IOC</td>
</tr>
<tr>
<td><strong>Ephedrine, other sympathomimetics</strong></td>
<td>Stimulate CNS, increase energy, delay fatigue, stimulate weight loss</td>
<td>No benefit</td>
<td>Potentially dangerous</td>
<td>Banned by IOC, some other organizations</td>
</tr>
<tr>
<td><strong>Ephedrine plus caffeine</strong></td>
<td>Increases energy, stimulates weight loss</td>
<td>Supports</td>
<td>Potentially dangerous, fatal at high doses</td>
<td>Banned by IOC, some other organizations</td>
</tr>
<tr>
<td><strong>Erythropoietin</strong></td>
<td>Increases aerobic capacity</td>
<td>Supports</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td><strong>Fat supplements</strong></td>
<td>Increase endurance</td>
<td>Refutes</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Fluids</strong></td>
<td>Increase endurance</td>
<td>Supports</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Folic acid</strong></td>
<td>Increases aerobic capacity</td>
<td>Refutes</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>GHB</strong></td>
<td>Stimulates growth hormone release and muscle growth</td>
<td>Limited, refutes</td>
<td>Significant, dose-related; abuse potential</td>
<td>Illegal</td>
</tr>
<tr>
<td><strong>Ginseng</strong></td>
<td>Increases endurance, enhances muscle recovery</td>
<td>Limited, refutes, no benefit</td>
<td>Mild, abuse syndrome reported</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Glucosamine</strong></td>
<td>Serves as NSAID alternative, enhances recovery</td>
<td>Limited, may have limited NSAID abilities</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Glutamine</strong></td>
<td>Boosts immunity and growth hormone levels</td>
<td>May boost immunity, no other benefits</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Glycerol</strong></td>
<td>Improves hydration and endurance</td>
<td>Limited, supports</td>
<td>Mild</td>
<td>Legal (oral)</td>
</tr>
<tr>
<td><strong>Guarana (herbal caffeine)</strong></td>
<td>Same as caffeine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HMB</strong></td>
<td>Decreases muscle breakdown, enhances recovery</td>
<td>Limited, some strength benefits</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Human growth hormone</strong></td>
<td>Anabolic effect on muscle growth, increases fat metabolism</td>
<td>Refutes, limited ergogenic benefits</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td><strong>Inosine</strong></td>
<td>Enhances energy production, improves aerobic capacity</td>
<td>Refutes, no benefit</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Iron</strong></td>
<td>Increases aerobic capacity</td>
<td>No benefit unless preexisting deficiency</td>
<td>Mild, toxic at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Leucine</strong></td>
<td>Decreases muscle breakdown and spare muscle glycogen stores</td>
<td>Limited, no ergogenic effect</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Ma huang (herbal ephedrine)</strong></td>
<td>Same as ephedrine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Magnesium</strong></td>
<td>Enhances muscle growth</td>
<td>No benefit unless preexisting deficiency</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Marijuana</strong></td>
<td>Decreases anxiety</td>
<td>Refutes, negative effect</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td><strong>Multivitamins</strong></td>
<td>Increases energy, endurance and aerobic capacity, enhances recovery</td>
<td>No benefit unless preexisting deficiency</td>
<td>None at RDA, some toxicities at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Narcotics</strong></td>
<td>Increase endurance by suppressing pain, decrease anxiety</td>
<td>Mixed, negative</td>
<td>Significant, dangerous</td>
<td>Illegal</td>
</tr>
<tr>
<td><strong>Niacin</strong></td>
<td>Increases energy and endurance</td>
<td>No benefit unless a preexisting deficiency</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Oxygen</strong></td>
<td>Increases aerobic capacity, enhances recovery</td>
<td>No benefit if given before or after activity</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td><strong>Phosphates</strong></td>
<td>Increase ATP production, energy and muscle</td>
<td>Mixed, negative</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Supplement</td>
<td>Description</td>
<td>Benefits</td>
<td>Concerns</td>
<td>Legal Status</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Phytosterols</td>
<td>Stimulates release of endogenous steroids and growth hormone</td>
<td>Refutes, no benefit</td>
<td>Little data, allergic reaction possible</td>
<td>Legal</td>
</tr>
<tr>
<td>Protein</td>
<td>Optimizes muscular growth and repair</td>
<td>Supports, increased need for protein with activity</td>
<td>None unless underlying medical condition</td>
<td>Legal</td>
</tr>
<tr>
<td>Pycnogenol</td>
<td>Boosts antioxidant levels, enhances recovery</td>
<td>Supports, dietary sources offer same benefit</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>Pyruvate</td>
<td>Increases lean body mass</td>
<td>Limited research, benefit only in specific cases</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>D-Ribose</td>
<td>Increases cellular ATP and muscle power</td>
<td>No human research</td>
<td>None known</td>
<td>Legal</td>
</tr>
<tr>
<td>Selenium</td>
<td>Enhances antioxidant functions</td>
<td>Limited, no benefit</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>Buffers lactic acid production, delays fatigue</td>
<td>Supports</td>
<td>Mild, dangerous at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Strychnine</td>
<td>Unknown</td>
<td>No research on ergonomic benefits</td>
<td>Significant, dangerous</td>
<td>Legal</td>
</tr>
<tr>
<td>Tribulus terrestris</td>
<td>Increases endogenous steroid production</td>
<td>Refutes</td>
<td>Potentially dangerous at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>Decreases pain perception, increases endurance</td>
<td>Mixed, no benefit in trained athletes</td>
<td>Mild, potentially dangerous</td>
<td>Legal</td>
</tr>
<tr>
<td>Vanadyl sulfate</td>
<td>Increases glycogen synthesis, enhances muscle recovery</td>
<td>Refutes, no benefit in healthy individuals</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td>Vitamin B1 (thiamin)</td>
<td>Enhances energy production, increases aerobic capacity, improves concentration</td>
<td>No benefit unless preexisting deficiency</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>Vitamin B2 (riboflavin)</td>
<td>Increases aerobic endurance</td>
<td>No benefit unless preexisting deficiency</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>Vitamin B3 (pyridoxine)</td>
<td>Enhances muscle growth, decreases anxiety</td>
<td>No benefit unless preexisting deficiency</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Vitamin B12 (cyanocobalamin)</td>
<td>Enhances muscle growth</td>
<td>No benefit unless preexisting deficiency</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>Vitamin B6 (dimethylglycine)</td>
<td>Increases muscle energy production</td>
<td>Mixed, negative</td>
<td>None proven, but concerns raised</td>
<td>Legal</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Acts as antioxidant, increases aerobic capacity and energy</td>
<td>No benefit unless preexisting deficiency</td>
<td>Mild at high doses</td>
<td>Legal</td>
</tr>
<tr>
<td>Supplement</td>
<td>Effect</td>
<td>Dosage</td>
<td>Strength</td>
<td>Legal Status</td>
</tr>
<tr>
<td>------------</td>
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<td>--------</td>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Acts as antioxidant, improves aerobic capacity</td>
<td>Mixed, some positive</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td>Yohimbine</td>
<td>Increases endogenous steroid production</td>
<td>Refutes, no benefit</td>
<td>Mild</td>
<td>Legal</td>
</tr>
<tr>
<td>Zinc</td>
<td>Enhances muscle growth, increases aerobic capacity</td>
<td>Limited, negative</td>
<td>Mild</td>
<td>Legal</td>
</tr>
</tbody>
</table>

IOC = International Olympic Committee; NCAA = National Collegiate Athletic Association; CNS = central nervous system; DHEA = dehydroepiandrosterone; GHB = gamma-hydroxybutyrate; NSAID = nonsteroidal anti-inflammatory drug; HMB = calcium beta-hydroxy beta-methylbutyrate; RDA = recommended daily allowance; ATP = adenosine triphosphate.

*--References are available from the author.