Assessment of nutritional knowledge and food skills in talented adolescent athletes

A thesis presented in partial fulfillment of the requirements for the degree of

Master of Science
in
Human Nutrition

at Massey University, Palmerston North, New Zealand.

Sarah Jane Burkhart

2010

Assessment of nutritional knowledge and food skills in talented adolescent athletes

Sarah Burkhart

2010

Abstract

There is very limited research on the nutrition knowledge and food skills of elite athletes in New Zealand. Adolescent athletes are moving through an important physiological stage of life, as well as training and competing in their chosen sports. These athletes are the future New Zealand sporting representatives and therefore need adequate nutrition knowledge for performance, as well as health and wellbeing. This research investigated the basic and sports nutrition knowledge of 100 talented adolescent athletes, aged 13 – 20 years from five team sports using a questionnaire and a focus group. The focus group involved 9 rugby players and investigated currently available nutrition resources. While the participants had a reasonable level of basic nutrition knowledge, their sports nutrition knowledge was not as high. They struggled with the concepts of sports drinks, muscle growth and supplements. Most participants had received some nutrition education and indicated that in the future they would prefer individual sessions with a sports nutritionist, written resources, as well as group sessions including cooking sessions and group workshops, and using a high profile athlete as a role model. The participants were very clear that their coaches and parents needed to be involved in their nutrition education. More research is needed to assess the overall knowledge of New Zealand adolescent athletes and the most appropriate, and effective methods of education for this group.

The author gratefully acknowledges:

- the athletes who so willingly participated in this study
- the National Sporting Organisations; Basketball New Zealand, Netball New Zealand, New Zealand Rugby Union, New Zealand Football and New Zealand Underwater Hockey for their support
- SPARC (Sport and Recreation New Zealand) who awarded this project a Research Grant
- Dr Jane Coad, student supervisor
- Dr Janet Weber
- Mrs. Chris Booth, who worked as the independent third party researcher on this project
- Registered dietitians; Richard Swinbourne and Rachel Svenson who provided feedback on the project

Table of Contents

List of figures and graphs

Figures

Graphs

List of tables

Introduction

Adolescents are simply not ‘miniature adults’ and have very specific nutritional requirements due to the period of change that they are moving through. The effect of peer pressure, the role of independence and the increased need for energy requirements means that many adolescents have eating habits which are less than desirable. An athlete, whether adult or adolescent, needs an optimal diet for both health and wellbeing and optimal performance. Research has shown that eating habits track from adolescence to adulthood. This research project aims to determine the level of knowledge that these young athletes currently have, and identify the educational needs for this group as they move into adulthood and through their sporting careers.

The project “Assessment of Nutritional Knowledge and Food Skills in Talented Adolescent Athletes” (ANKAA) is the thesis topic for a Master of Science (Human Nutrition). This project was chosen for the reason that the student researcher has worked with adolescent athletes who are deemed to be elite or talented (defined as having future or current potential to be National/World Champions) through the former New Zealand Academy of Sport Central as a provider for carded athletes and with the Regional Talent Development squads based in Wellington, Gisborne, and New Plymouth. This work has identified a dearth of nutritional information available for use with this group of athletes and that there is a need for specific resources and guidelines for working with athletes who are adolescents competing at an elite level. This topic was discussed with other sports nutritionists and sports dietitians at a regional workshop and received very favorable comments as these other sports nutrition professionals have also detected a need for information which is specifically targeted at this group.

The specific aims of this research are:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences this population in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this population,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

This project is designed to assess the knowledge of talented New Zealand adolescent athletes and investigate how adolescents would prefer to be given sports nutrition advice. Currently there is also a lack of resources designed specifically for this group and it is anticipated that this research project will not only identify the level of nutritional knowledge of this group but also develop an educational curriculum and accompanying resources which should be produced for this group.

Literature Review

Talented adolescent athletes are a select group of the population who have very specific needs. Adolescence is a period of the lifecycle where many changes occur in the body (ADA, 1996). When an adolescent is also an athlete there are many important factors to consider in terms of nutrition for both growth and sports performance. Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al, 2006). Coupled with the fact that when the athlete is an adolescent they have further energy and nutrient needs due to the large period of growth that this period entails, including the adolescent growth spurt (ADA, 1996, Story et al, 2002, Hinton et al, 2004, Croll et al, 2006), this creates a significant nutritional challenge. Adolescents may have dietary practices which are undesirable (Story et al, 2002), which include skipping meals (Lytle, 2002), eating more takeaway and convenience foods such as soft drinks (Lytle, 2000, Neumark-Sztainer et al, 1999) and engaging in dieting behaviours (Neumark-Sztainer et al, 1998). These changes may be related to the fact that they are progressing through a major developmental stage of life where they are able to exert more control over their intake through more involvement in the preparation of food, and having access to more money to spend on food. Undesirable dietary practices may also be determined by the adolescent's nutritional knowledge. A number of researchers suggest that nutritional behaviour is related to nutritional knowledge and that if an individual is educated on healthy eating, they are more likely to do this in practice (Wardle et al, 2004, Pirouznia, 2001, Read et al, 1988, Saegert & Young, 1983, Cho & Fryer, 1974). Conversely, there is also research that demonstrates that nutritional knowledge is not linked to healthy eating behaviours (Stafleu et al, 1996, Shepherd & Towler, 1992, Harrison et al, 1991, Halverson, 1987, Shepherd & Stockley, 1987, Story & Resnick, 1986, Axelson et al, 1985). It has been proposed that although nutrition education may increase an individual's knowledge of nutrition, an improvement in nutrition behaviour does not necessarily follow (Chapman & Toma, 1997, Schlicker, Borra & Regan, 1994, Contento, Manning & Shannon, 1992, Potter & Wood, 1991).

Another major feature of adolescent nutritional behaviour is a high incidence of supplement use. Adolescents, as well as adults, often believe that taking nutritional supplements will improve health and sporting performance (O'Dea, 2003, Sobal & Marquart, 1994, Haymes, 1991, Krowchuk et al, 1989, Douglas and Douglas, 1984). Up to 98.6% (Kristiansen et al, 2005) of adolescent athletes may be taking at least one nutritional supplement, which is commonly seen to be a vitamin or mineral supplement.

In terms of performance it could be assumed that the more talented and more successful an athlete is, the more nutrition knowledge they will possess and the better their nutritional behaviour will be, however there is a lack of research investigating whether elite athletes have higher levels of nutritional knowledge or dietary practices compared to non-elite athletes or sedentary individuals. Nonetheless adolescent athletes have been identified as a group which requires information to be produced for both the athlete and for associated parties such as coaches and parents in order to maximise performance and increase the nutritional knowledge of all of these groups (Chapman & Toma, 1997, Benardot, 1996).

Important questions to be answered in future research are; what is the level of nutritional knowledge in adolescent athletes who are considered talented or elite?, does this knowledge influence their behaviour?, and what is the best way to educate this group on sports nutrition? Findings would greatly enhance the nutritional environment for the adolescent athlete by providing information on the factors which influence food choice and how to best improve nutritional knowledge. Ultimately this may improve performance through nutrition education of the athlete and support team (parents and coaches).

1.0. The Period of Adolescence

1.1. An introduction to the period of Adolescence

Adolescent athletes have to contend not only with the numerous developmental changes occurring in the body (Hoelscher et al, 2002, Neumark-Sztainer et al, 1999), but also fuel for performance. Adolescence is characterised by the hormonal and biological changes that begin at puberty (ADA, 1996) and adolescents are generally defined as aged between 13 to 18 years (ADA, 1996). This is one of the greatest physiological and psychological periods of change throughout the lifecycle (Hoelscher et al, 2002, Spear, 2002, Lytle, 2002). Adolescents are moving through a period of rapid growth and development where the body is changing in shape and size, which can be defined more clearly as growth and maturation (Burke, 2006), as well as changing socially and psychologically (Hoelscher et al, 2002). Changes in psychological and biological status throughout adolescence do not occur in the same time frame for all adolescents and they do not correlate with behavioural changes (Sigman-Grant, 2002). It is known that during this period adolescents are more likely to be involved in experimental behaviours and be subjected to the effect of peer-pressure (O'Dea, 2003, Crockett & Petersen, 1993). The personality and character traits of an adolescent are often formed during this period of rapid growth and development (Turconi et al, 2003, Neumark-Sztainer et al, 1999), and the adolescent often starts to exert control over their own dietary intake (Turconi et al, 2003, Hoelscher et al, 2002, Coates et al, 1982). The independence which starts to be seen in adolescence (Truswell & Darton-Hill, 1981), as well as the concerns that can arise over body image during this period (ADA, 1996, Hinton et al, 2004), are often associated with dietary patterns which may be unconventional.

1.2. Changes in dietary practice in adolescents

As an individual moves into adolescence there are clear ways in which their nutritional practices change. Breakfast is often displaced (Lyttle 2002, Lin et al, 1996) and since breakfast is shown to have beneficial effects on health and nutritional status (Schlundt et al, 1992, Guthrie et al, 1986, Benton & Sargent, 1992), there may be a decrease in total nutrient and/or energy intake (Nicklas et al, 1998) of the adolescent. Contrary to Nicklas et al, (1998), other researchers suggest that throughout the day there is an increased risk of overeating (Schlundt et al, 1992, Guthrie et al, 1986, Zabik, 1987) to compensate for a reduced intake of energy in adolescents who skip breakfast. Decreased concentration levels (Centres for Disease Control and Prevention, 1996, Smith et al, 1992, Benton & Sargent, 1992) and a poorer performance in mental tasks (Pollitt et al, 1982) may also be seen. As well as skipping breakfast, adolescents often engage in dieting behaviours (Neumark-Sztainer et al, 1998) which is seen particularly in females (French et al, 1995). Individuals exhibiting extreme dieting practices have been observed to decrease their intake of fruit and vegetables (Story et al, 2002), although it has been noted that during adolescence, even in non-dieting adolescents, there is a general decrease in fruit and vegetable consumption as well as in fruit juice and milk intake (Lytle et al, 2000, Hoelscher et al, 2002). There is also an increase in soft drink (Lytle et al, 2000) and fast food (Neumark-Sztainer et al, 1999, Lytle et al, 2000) consumption seen in this period along with a high intake of saturated fat (Hoelscher et al, 2002, Neumark-Sztainer et al, 1999).

1.3. Long term health consequences and determination of this due to diet

It has been seen that eating habits can track from adolescence into adulthood (Kelder et al, 1994, Shepherd et al, 2006) and therefore long term consequences on health may be determined during this period (Turconi et al, 2003). This is especially important in that researchers have shown that the growth of atherosclerotic plaques begin in childhood and track though to adulthood. These plaques are a major risk factor for heart disease and coronary heart disease (CHD) later in life (Berenson et al, 2002). It has been shown that the factors which are predisposing to coronary artery disease (CAD) such as unfavorable lipoprotein levels, begin in childhood, and along with other factors increase the individuals risk of developing CAD later in life (Berenson et al, 2002). Neumark-Sztainer et al (1999) and Story et al (1986) found that adolescents are not concerned with how their current nutritional habits may affect their future health. In research conducted by Neumark-Sztainer et al (1999), adolescents were interviewed in a focus group situation and when asked about the importance of healthy eating in the present sense, and the effect that it had on long term health they replied that they had more important things to think about and that it did not rank highly. As well as this response on the importance of future health some of the adolescents stated that "they were too young to worry about their health, and they will worry about that when they get older and have heart problems" (pg. 932). This is mirrored by research from Nowak et al (1998) who found that adolescents were not interested in long term health implications but were more concerned with current weight, looks, wellbeing and energy levels. This has important implications in terms of designing interventions for adolescents as it gives a good indication of what focus nutrition professionals need to use with this group to make them pay attention. It also provides information on what is unlikely to capture their attention.

2.0. The link between nutritional knowledge, beliefs and nutritional behaviour

Food choice and behaviour among individuals is a well researched topic. Factors which are considered to influence the choice of dietary intake in adolescents are nutritional knowledge, nutritional beliefs and environmental factors which impact on behaviour (Pirouznia, 2001).

2.1. The impact of nutritional knowledge on food choice

Research is inconclusive on whether nutritional knowledge impacts on the choice of healthy foods. Read et al (1988), Saegert and Young (1983), and Cho and Fryer (1974) have shown that nutritional knowledge has a positive impact on the choice of foods in individuals. Pirouznia (2001) found that there is a positive relationship in preadolescent students between nutrition knowledge and eating behaviour which indicated that eating choices could be influenced by nutritional knowledge. Wardle et al (2000) found a positive relationship between nutritional knowledge and the consumption of fruit and vegetables and other healthy foods in adults. They state that nutrition knowledge is an important part of health education and has the capability to contribute to enhancing dietary quality. The methods used in these studies may play a role in the results reported. Wardle et al (2000) used a postal survey with 1040 participants, the mean age was 51.5 years and the ethnicity of the subject group was defined as mostly European. Although this is a relatively large sample size, the average age indicates that the results may be skewed slightly. Older individuals may be more likely to apply nutrition knowledge as they are at an age where numerous health and nutrition related concerns often become apparent, for example high HDL cholesterol and its role in heart disease. A postal survey may have influenced who responded to the survey as those who were more interested in nutrition may have been more inclined to make the effort to complete and return the questionnaire as opposed to others who are not as interested in nutrition. Pirounzia (2001) used 532 students who were 11 – 13 years of age which is a large number of subjects but they are younger than many other studies such as Wardle et al (2000). The questionnaire for Pirounzia (2001) was administered during a language art class to subjects and there were a different number of questions depending on the school grade of the subject. Those subjects who were in the 6th grade answered a total of 30 questions (20 on nutrition knowledge and 10 on eating behavior). 7th and 8th grade subjects answered 35 questions (25 on nutrition knowledge and 10 on eating behaviours). The conditions in which subjects answered the questionnaire in language art class are not clear. There is no indication of whether the subjects were able to discuss the questions with others or if they were given guidance to complete the questionnaire. Any discussion or guidance may have influenced the results.

Many researchers have not found knowledge to impact on positive food choice (Stafleu et al, 1996, Schlicker, Borra & Regan, 1994, Contento, Manning & Shannon, 1992, Shepherd & Towler, 1992, Potter & Wood, 1991, Halverson, 1987, Shepherd & Stockley, 1987, Story & Resnick, 1986, and Axelson et al, 1985). Many of these studies have found that although nutrition education programmes do increase nutritional knowledge it is doubtful if that increase in knowledge actually corresponds to a change in behaviour (Chapman & Toma, 1997, Schilcker, Borra & Regan, 1994, Contento, Manning & Shannon, 1992, Potter & Wood, 1991). The difference in increasing knowledge and changing behaviours is likely to be influenced by many factors. An example given by Wardle et al (2000) demonstrates this well; the topic of dietary fat and the consequences that it has on health has been evident for a number of years but Wardle et al (2000) report many of the studies which have shown no association between dietary fat knowledge and behaviour (McDonnell et al, 1998, Stafleu et al, 1996). As many individuals know that fat is bad, but have not changed their behaviour it is likely that there is another factor which hinders a behavioural change in terms of fat intake. If the dietary topic under investigation was a nutrition factor other than fat, it may show that a lack of knowledge has a greater impact on behaviour as many of the general public may not have been exposed to information around this topic. In fact Wardle et al (2000) found that there was a stronger association between knowledge and behaviour for fruit and vegetable intake than for fat intake indicating that knowledge is unlikely to be a key factor in the change to a low fat diet.

There is conflicting information on this area of research it could be that these studies show the true effect that increasing knowledge does not improve behaviour, or it could be that the instruments, such as questionnaires, being used in the assessment of dietary behaviour change were not appropriate. There is some debate about the reliability of previous research, since some of the instruments used to assess knowledge were not validated or assessed for reliability (Wardle et al, 2000). In addition aspects of nutrition evaluated and subject groups were not consistent. For example Stafleu (1996) used Dutch adults as a subject group and looked at general nutrition knowledge, whereas Bergman et al (1992) investigated knowledge of caffeine in adults. Resnicow et al (1997) looked at knowledge of fat, fibre and cholesterol in adults, and Steenhuis et al (1996) investigated the knowledge of fat in Dutch adults. If a study looks at only one component of nutrition knowledge, for example fibre or fat, this cannot give an indication of overall nutrition knowledge. A number of studies in this area also use measures of knowledge that were not scientifically validated, namely McDougall (1998), Anderson et al (1998) and Shepherd & Stockley (1987) (Wardle et al, 2000).

Wardle et al (2000) suggests that the majority of the studies that have shown no effect of knowledge on behaviour have used measures of knowledge that are not consistent. These measures of knowledge are normally created specifically for the study (Wardle et al, 2000). It is also thought that the statistical models and processes used may have an effect on the interpretation of results. Even though results were not statistically significant at $P<0.05$ in a small study population, small study effect size might still have a substantial true effect in a wider population (Wardle et al, 2000). Worsley (2002) also echoes these findings by stating that poor knowledge measurement techniques may have been used, there may have been a lack of relevant knowledge in tested subjects, that a "poor conceptualization of nutritional knowledge" (pg. 89) was used and the studies may have been statistically underpowered to see actual changes. It is proposed that when larger sample sizes are used with much more sophisticated analysis that the association between knowledge and behaviour will become clearer (Wardle et al, 2000).

Most of the previous research used to assess nutrition knowledge have used questionnaires (McDougall, 1998, Rosenbloom et al, 2002, Harrison et al, 1991, Johnson et al, 2002, Parr et al, 1984, Turconi, 2003). A major issue with the design of a questionnaire is the validity of this document. There is no 'gold standard' for the measurement of validation of nutrition knowledge questionnaires (Zinn, 2004). Validity and reliability can be tested. Validity can be tested through the use of content validity and construct (using a T- Test for 2 groups or the ANOVA measure for 2 or more groups). Reliability can be assessed by the test-retest method (using Pearson's product moment correlation of $r>0.7$) and internal consistency (using Chronbach's alpha for several possible answers ($\alpha>0.7$), the Kruder-Richardson formula (KR20) for dichotomous answers ($\alpha>0.7$) and Spearman' rho (Zinn, 2004). A number of research studies not use any of these measures to ensure validity while some use only some of these.

When investigating previous research that has focused on nutrition knowledge in adolescents or in the field of sports nutrition there are varying standards of validation. Rosenbloom et al (2002) notes using content validity but does not report using any other measures to test validity or reliability. Harrison et al (1991) reported that the questions used in their research were currently being examined for validity and reliability. Turconi et al (2003) reported an internal consistency of $\alpha=0.56$ and a test-retest reliability of $r=0.8$. Parr et al (1984) did not report any measure of validity and reliability as did McDougall (1998). Johnson et al (2002) used questions that were based on Parmenter and Wardle (1999) who developed a questionnaire that was tested with content validity, had a construct validity of $p<0.001$, and internal consistency of $\alpha=0.7$-0.97 and a test-retest reliability of $r=0.8$-0.97. Zinn et al (2004) developed a questionnaire to be used to assess sports nutrition knowledge. The development of the questionnaire included the input of 6 expert sports dietitians and questions were based on the guidelines recommended by Sports Dietitians Australia (Zinn et al, 2004). The questionnaire had construct validity, was tested for test-retest reliability and had a correlation coefficient that ranged from 0.74 – 0.89. The authors concluded that the questionnaire was reliable for the assessment of sports nutrition in New Zealand.

Additionally, the studies reviewed (apart from Pirouznia, 2001, and McDougall, 1998 who used adolescents, although not classified as athletes) did not use a subject group that were specifically recruited as adolescent athletes, so the research may not be directly applicable to the ANKAA study.

2.2. Athlete knowledge and behaviour

There is limited research specifically on athlete knowledge and behaviour. Douglas & Douglas (1984) found that athletes had limited nutrition knowledge, and females in particular were susceptible to basing food choices on factors other than nutritional knowledge. It was observed that nutrition knowledge was lower in athletes than non-athletes by Benson, Gillen & Bourdet (1986). However more recent research by Cuspiti et al (2002) found that adolescent female athletes have better nutritional knowledge than non-athletic adolescent females. Calvadini et al (2000) reported that Swiss athletic adolescents had healthier nutritional habits than non-athletic adolescents including a higher consumption of cereals, fruit, fruit juices, salads, and dairy products, possibly indicating a higher level of knowledge. Harrison et al (1991) investigated New Zealand elite and non-elite athletes and determined the differences in knowledge between these two groups. This research showed that elite athletes may have slightly higher levels of nutrition knowledge than non-elite athletes and more commonly had dietary practices which were consistent with the New Zealand Guidelines for Nutrition (Harrison et al, 1991),. However this study did not use adolescent athletes as a subject group. Harrison et al (1991) argued that this increase in knowledge and the improved nutritional practices could possibly be attributed to the fact that elite athletes may have had “a greater desire to perform well” (pg 126) so they could be more conscious about improving their nutrition knowledge or dietary intake. However, adolescent athletes who are competing at a lower level of competition may maintain the recommended levels of nutrient intake more than athletes who are competing at an elite level (Harrison et al, 1991). Whether this is due to the nutritional requirements of elite athletes being higher than non-elite athletes or due to a difference in level of knowledge is uncertain and is something which could be determined in further research.

One area in particular that shows a lack of knowledge is that of the role of protein in the body. In Rosenbloom et al (2002) 47% of males and 39% of females incorrectly agreed that “protein was the main energy for the muscle” (pg 419) and 35% of males and 31% of females incorrectly agreed “that protein supplements are necessary” (p. 419). 36% of elite and 37% of non-elite athletes stated that “protein supplements build larger muscles and make you stronger” in Harrison et al’s research (1991). Rosenbloom et al (2002) had a reasonable sample size of 237 men and 91 women and an average age of 19 years. The subjects were given a self directed questionnaire and participated in the following sports; track and field, football, baseball, basketball, swimming, golf, volleyball, softball and tennis. The subjects in Harrison et al (1991) participated in basketball, hockey, power-lifting, netball (women only) and rugby (men only). The average age of the male subjects was 24.4 years of age, and the women were 23.1 years of age. Harrison (1991) had a smaller sample size with less females (n = 53) and less males (n = 69). The subjects were given the questionnaires to either fill out at a practice session or they were able to take them home and fill them in and then return back to the coach. This may have had an impact on the results – authors of the study do not discuss whether all of the questionnaires were returned (possibly indicating that those more interested in the topic may have been more likely to take part) and it is not known if those who completed the questionnaire at home could have had extra help to complete it. It is also not known specifically how the subjects in Rosenbloom et al (2002) completed their self directed questionnaire and whether they were able to discuss questions and answers with other subjects or if they had to complete it while at their yearly physical supervised by the director of sports medicine. It has been seen that males may be more likely to perceive protein to provide an immediate energy source, be involved in weight gain and used to increase muscle strength and size (Jacobsen et al, 2001). This indicates a potential area for resource and educational development.

The role of vitamins and minerals in the body is also often an area of confusion in athletes. 67% of men and 53% of women believed vitamin and mineral supplements will increase energy in Rosenbloom et al (2002) and in Harrison et al (1991) 36% of elite athletes and 50% of non-elite athletes incorrectly agreed to the statement “extra vitamins and minerals are vital for top sporting performance” as well as 30% of elite athletes and 44% of non-elite athletes incorrectly answering that “vitamins give you energy” (pg 125).

It has also been shown that athletes may have inadequate knowledge about hydration and the benefits and problems associated with this. Nichols et al (2005) found that although there was a positive correlation between knowledge, attitudes, and behaviour in collegiate athletes who participated in a questionnaire on hydration, many of the athletes had incorrect perceptions of this topic. The study examined the athlete’s knowledge of the National Athletic Trainers Association (NATA) and the American College of Sports Medicine (ACSM) hydration statements, and found that the athletes lacked knowledge of these. The questionnaire contained questions from prior research, and newly developed questions based on the NATA and ACSM position statements, although it is not clear which questions are from the previous questionnaires, or newly developed. Previously used research questions were taken from Cuspiti et al (2002) and Rosenbloom et al (2002) which are also discussed in this review. The study questionnaire had true/false options for the knowledge based questions which may have lead athletes to guess the answer if they were unsure. A ‘maybe’ response may have been appropriate in this instance to stop athletes guessing answers. One hundred and thirty nine athletes were involved in the questionnaire and only 5.8% achieved 100% correct responses. 33.1% of the athletes did not correctly answer 80% or more of the knowledge questions. What is interesting is that 87.1% of the athletes had received nutrition advice in the past (this included “taken a nutrition class in college, sat in on a nutrition lecture given by a dietitian in college, or had nutrition education at freshman orientation” (pg. 520)). Only 52.5% of the athletes knew that a sports drink was a better option than water when exercise lasted longer than one hour. Harrison et al (1991) found that 79% of elite athletes and 65% of non elite athletes knew that “endurance athletes (who exercise for more than 60 minutes at a time) should try to drink fluids during exercise” (pg. 125), although they did not ask what these fluids should be (sports drink or water). There was no significant difference in the knowledge of males and females in Nichols et al (2005), and no significant differences in attitudes or behaviours of the genders. This study only used 139 athletes from one southeast NCAA division I institution, and the questionnaires were distributed through different methods. For example, questionnaires were handed out to participants at team meetings, treatment appointments, and practice sessions which may have had a bias on the results as those members who missed trainings and meetings did not take part in the study. This may have meant that those athletes who took their sport more seriously and attended practice sessions and meetings may have had better nutrition knowledge. The range of athletes may have also been a limitation, more endurance athletes (n = 86), completed the questionnaire than skill athletes (n = 53), golf players did not get the opportunity to take part as they practiced off campus, and the school did not have a football team.

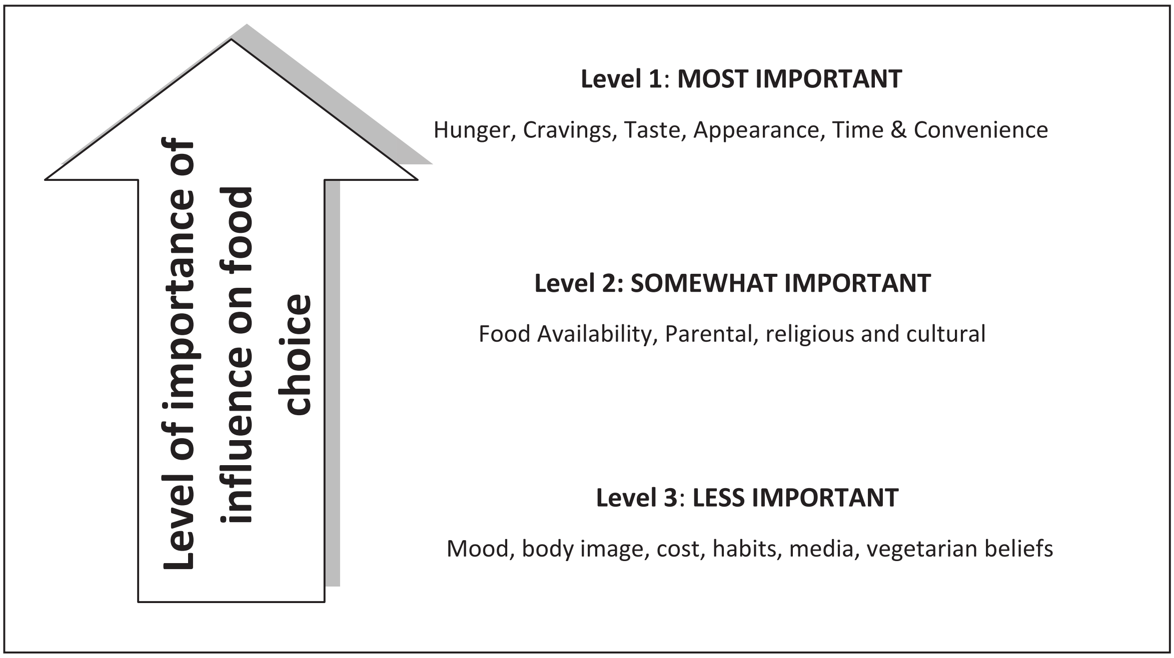
Clearly there is not enough evidence to conclude whether elite athletes have more sound nutritional knowledge than non-elite athletes or sedentary individuals. One could argue that it is even more important for adolescent athletes to have a higher level of nutritional knowledge due to the fact that they are both moving through a rapid period of growth and exercising at a high level so the importance of a healthy diet is even more so.

2.3. Factors, beliefs and attitudes

As well as nutritional knowledge, there are factors, beliefs and attitudes which impact on food choice. These have been proposed in a variety of models. Neumark-Sztainer et al (1999) examined the factors which influence food choice in a group of adolescents ranging from 12 to 19 years of age. It is seen that the factors which influence food choice in this population group can be defined into three levels. These levels are based on the frequency and depth of discussion of factors in the focus groups conducted, with level one factors being discussed more frequently and in more depth and therefore seen to be more important to the subject group. The first level included; hunger and cravings of food, the appeal of the food (especially taste and appearance), consideration of time and convenience of the food. The time consideration and convenience issues were expressed in terms of both involving the adolescent and their parents. Level two included the factors of food availability, effects of foods that may be beneficial, influences on eating behaviour (particularly parental influence as well as the influence of religion and culture) and "situation-specific" (pg. 931) factors. Level three factors were discussed less frequently and in less depth, and included "mood, body image, habit, cost, media and vegetarian beliefs" (pg. 931). A summary of this model can be seen in Figure One.

It is also known that in addition to these factors; social norms, fast foods and personal experiences, mass media, peer influences and the influence of parents' dietary habits have an effect on food choice in adolescents (Pirounzia, 2001. Neumark-Sztainer, 1999).

Figure 1: A summary of the theory proposed by Neumark-Sztainer et al, (1999) with the three levels of influence on eating behaviour in adolescents.



2.4. Models used in previous research

When studying human behaviour, models are often used to determine influences on the individual and the environment. Two models which relate to the influences on food choice are discussed in more depth here.

2.4.1. The model of Story et al (2002)

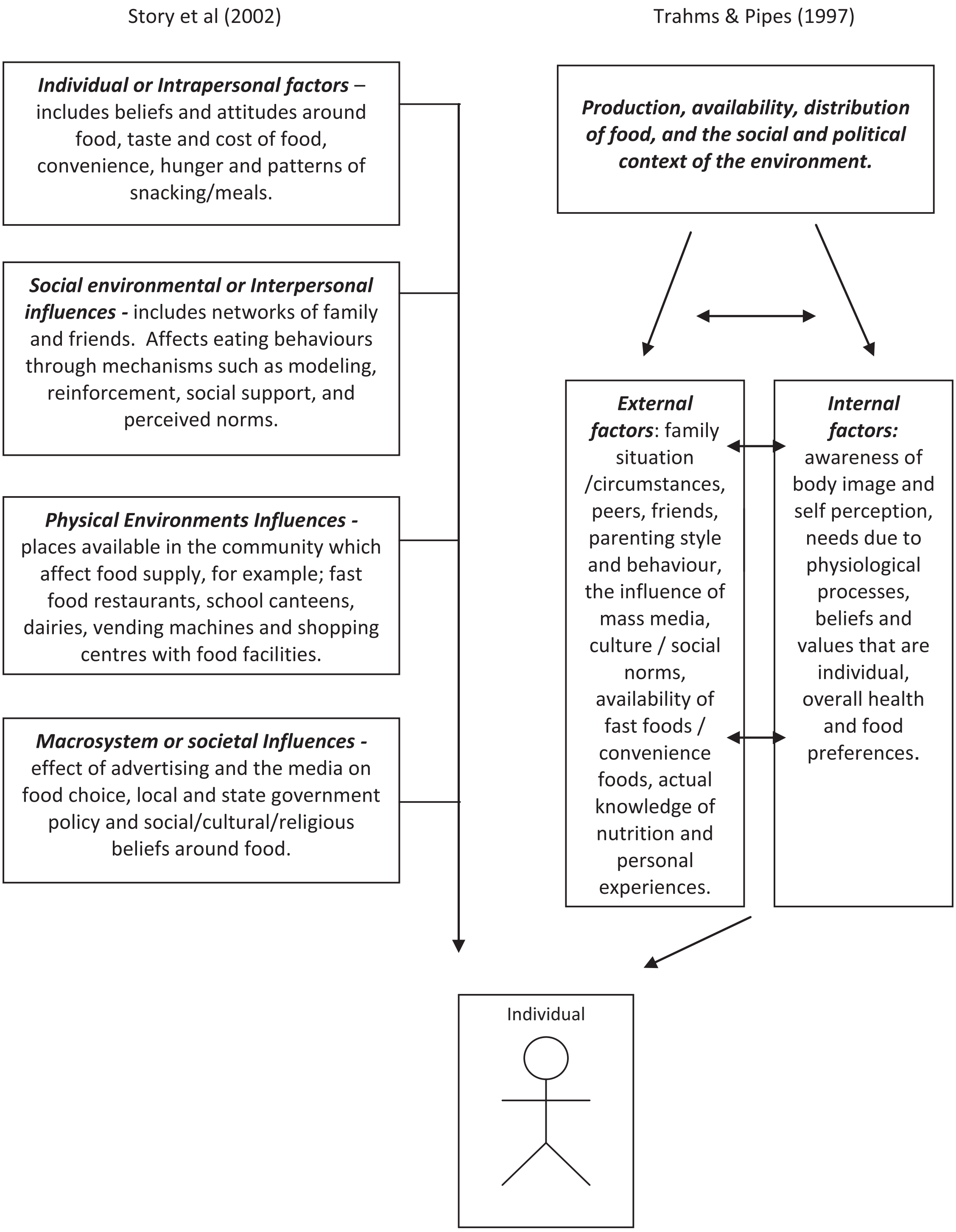
Story et al (2002) combined the social cognitive theory and the ecological model to construct a model of behavioural influences in adolescents when making dietary choices. Story et al (2002) describes a central theme of reciprocal determination in the social cognitive theory and the ecological model. This means that the environment and the individual's behaviour are reciprocal in that the individual can control the environment in which they are located and that the environment also plays a role in determining behaviour. This model described four levels of influence on eating behaviours in the adolescent population which are the following; the first level is defined as individual or intrapersonal influences. This level includes factors which are seen to have greater impact on an individual level. These include; personal beliefs and attitudes around and to food, the taste and cost of foods, how convenient a food is, the effect of hunger and normal patterns of snacking and/or meals (Story et al, 2002). The second layer of the model is the level of social and environmental influences or interpersonal influences on the individual. This level includes how family and friends can impact on the eating behaviour of an individual. An individual's eating behaviours can be influenced through methods including modeling, reinforcement, social encouragement, and the use of apparent norms. The third layer includes environmental influences, society and public influences on food supply and availability. These include; fast food restaurants, school canteens, dairies, vending machines, shopping centre's with food facilities and any other food supply store in the community. The final layer of influence is the wider scheme of influences or communal and organisational influences which are the more indirect influences on eating behaviour such as the effect of advertising and the media on food choice, local and state government policy and social/cultural/religious beliefs around food (Story et al, 2002). This model is strongly correlated with the ecological model in which it is postulated there is a reciprocal relationship between multiple layers of the individual's environment impacting on their food choice and the individual is able to exert an influence on their environment (in each of the different layers) in turn (Bronfenbrenner, 1979). This model by Story et al (2002) relates to the ANKAA study (this study titled the assessment of nutritional knowledge and food skills in adolescent athletes) as the ANKAA study aims to look at the initial knowledge of adolescent athletes and what determines the sports nutrition knowledge and practices of these athletes. It is hypothesized that adolescent athletes have a variety of influences on food choice – their knowledge, support (parents, coaches, team members) and systems (for example organisational educational programs and guidelines, training camps) impact on food choice, and that if the systems can be used to an advantage the athlete will have an improved food choice and consequently positive effects on performance.

2.4.2. The model of Trahms and Pipes (1997)

Another basic model which has been proposed for adolescent eating behaviours is that of Trahms and Pipes (1997) where it was seen that there is a sequence of external and internal factors which influence lifestyle and therefore food choice. The external factors involve the family situation/circumstances, peers and friends, parenting style and behaviour, the influence of mass media, culture and social norms, the availability of fast foods and convenience foods, actual knowledge of nutrition and personal experiences. The internal factors include; awareness of body image and self perception needs due to physiological requirement, beliefs and values that are individual, overall health and food preferences. These external and internal factors are influenced by the production, availability, and distribution of food, as well as the social and political context of the environment. It is also noted that the internal and external factors are closely interrelated and overall lead to an affect on lifestyle. This lifestyle then translates into food choice and behaviour in individuals. This model is similar to that of Neumark-Sztainer et al (1999) and Story et al (2002) in that it involves a lot of similar influences even if the models are not continuous. The differences in these two models is that the model proposed by Trahms and Pipes is based on factors being described as external or internal factors, as compared to Neumark-Sztainer (1999) who groups the factors influencing food choice in adolescents into categories of importance, rather than where the influences originate. Story et al (2002) categorises the influencing factors into groups which describe the origin of the influences for example influences from the physical environment as compared to influences from the individual. A comparison of the models proposed by Trahms and Pipes (1999) and Story et al (2002) is shown diagrammatically in Figure Two.

Although the models used to describe influences on eating behaviour are often different structurally in some aspects, it is clear that many of the influences on adolescent eating behaviour are seen in a variety of models and it can be seen that food choice is very complex and not determined by one single factor. The views on what factors influence adolescent eating behaviour are more apparent than the concept of whether knowledge affects behaviour. Further research in this area will help to define if knowledge does indeed affect behaviour and if environmental influences impact on this.

Figure 2: A comparison of the models proposed by Story et al (2002) and Trahms & Pipes (1997)



3.0. The relationship between nutrition and sports performance in adolescents

3.1. A basic introduction to Sports Nutrition

It is clear that nutrition has an effect on sports performance (Croll et al, 2006, Burke, 2006). Sports nutrition is a rapidly growing field and is the science of improving sporting performance by tailoring specific food and fluid recommendations to an athlete. It is known that factors such as dehydration and a lack of energy supply can limit performance (Burke, 2006).

Dehydration can limit performance as a lack of fluid increases the strain on physiological processes including an increase in core temperature, an increase in heart rate (and consequently increased cardiovascular strain), potential altering of metabolic function and increased utilisation of glycogen (also contributing to muscle fatigue as a source of fuel) (Sawka et al, 2007). Mental and cognitive performance (especially important for athletes who participate in skill based sports) is additionally compromised by dehydration (Sawka et al, 2007). It is possible that cramps in skeletal muscle may be attributed to dehydration, and the risk of an athlete suffering heat exhaustion (especially in hotter climates) is increased by dehydration (Sawka, 2007).

As carbohydrate is a source of fuel for working muscles, a lack of exogenous carbohydrate supply can limit the capacity of muscle to work as the glycogen stores in the muscle are depleted (Burke, 2006). Total body stores of carbohydrate are limited (Burke et al, 2001) and as carbohydrate is stored as glycogen in the muscle and liver an inadequate intake may lead to premature fatigue, Although there is an abundance of literature on sport nutrition practices in adults there is a dearth of research on sports nutrition in adolescent athletes (Bar-Or, 2001).

3.2. Age/Maturation differences in adolescent athletes

Although the same sports nutrition issues and strategies (hydration and fuel supply) are important to both adult athletes and younger athletes, there are certain age related factors which are different between these groups.

Children and adolescents have differences in metabolism compared to adults as an adult requires less energy for certain activities compared to a child or adolescent (Bar-Or, 2001). Bar-Or (2001) suggests that when using adult energy expenditure values (expressed in calories or kilojoules needed per day) in children one should add on 20 – 25% to the values for an 8 – 10 year old child, and 10 – 15% on to the values for a child who is 11 – 14 years old. An intake with inadequate amounts of energy for the adolescent may lead to protein being used as a source of energy as opposed to being used to synthesise muscle mass (Petrie et al, 2004). The child and adolescent athlete may also utilise less carbohydrate at the sub-maximal level of exercise and use more fat than an adult due to the fact that it is thought that children do not exhibit full glycolytic capacity (Eriksson, 1972, Eriksson et al, 1974). Most studies show differences in energy expenditure, but it has yet to be determined conclusively whether differences in substrate utilisation exist. Insulin sensitivity may be decreased in children and adolescents, glycogenolysis is also reduced and therefore these factors may play a role in explaining why children and adolescents exhibit different substrate oxidization roles. Montfort-Steiger and Williams (2007) reports that there may be an increase in the oxidation of pyruvate in these younger individuals and this therefore enhances their ability to provide energy through oxidative pathways (Armstrong & Welsman, 1994). However there have been differences in results from substrate utilisation studies and these may have been due to the research methodology. There may be factors which have not been considered or taken into account including whether the menstrual cycle was standardized for female participants, if participants had a different training status, the intensity and mode of the exercise performed, gender and whether the participants were in a post-absorptive or fasted state (Montfort-Steiger & Williams, 2007). Studies looking at the different substrate utilisation in response to low and high carbohydrate diets in children and adolescents have also only been performed at rest (Montfort-Steiger & Williams, 2007) and therefore more information is needed to definitively show how children and adolescents may differ in substrate utilisation as compared with adults during exercise. However, it could be possible that fat is just as important as an energy substrate for young athletes as carbohydrate is, and it is yet to be determined whether a young athlete benefits from a high carbohydrate diet (Montfort-Steiger & Williams, 2007, Petrie et al, 2004) like an adult athlete does.

Additionally, due to the period of growth that occurs in this life stage in the skeletal system (in both mass and length of the bones) there is an increased need for calcium (Petrie et al, 2004). Peak bone mass is usually obtained within the developmental period of 9 – 20 years of age (New Ministry of Health, 1998). The New Zealand Ministry of Health recommends that male adolescents (aged 12 – 15 years) consume 1200mg of calcium a day, whereas males 16 – 18 years of age are recommended to have 1000mg a day. Females aged 12 – 15 years have a recommended dietary intake of 1000mg a day and females 16 – 18 years of age 800mg a day. However Matovic (1992) suggests that an intake of up to 1600mg a day may be needed during adolescence. The adult recommendation for females and males aged 19 – 50 years of age is 1000mg (Commonwealth of Australia and New Zealand Ministry of Health, 2006). As noted further in this review, calcium intake in adolescents is often lower than recommended (ADA, 1996, Wright et al, 1991). Another of the age (or maturation) related differences seen with younger athletes is that younger adolescents need a greater amount of protein due to the period of growth that they are going through and the requirements due to this (Bar-Or, 2001) compared to adults. This is also discussed further in this review in section 3.3.

In terms of sporting performance, dehydration is generally seen to be more harmful in young athletes compared to adults as the thermoregulatory strain is higher on the young athlete than that which is seen in an adult (Bar-Or, 2001). Although it is commonly suggested that a 2% decrease in bodyweight through fluid loss reduces physical performance by up to 20% in adults (Howe et al, 2002), it is thought that endurance performance is decreased in children by a 1% decrease in bodyweight, however the exact levels of dehydration and their effect on a young athletes performance are yet to be established (Petrie et al, 2001). A young athlete will generally produce more heat when exercising than an adult would but the transport of heat to the skin for transfer is less efficient in the young athlete. Because there is less heat transferred to the skin via vasodilation of blood vessels the corresponding sweat rate is lower in the young adult than what would be seen in an adult (Bar-Or, 2001, Petrie et al, 2004). Bar-Or (1996) also suggests that it is not that younger athletes have less working sweat glands than adults but the lower sweat rate seen is due to a smaller amount of sweat being produced per sweat gland in the younger athlete. It is thought that as the young athlete matures the sweat rate increases when looking at it compared to surface area (Petrie et al, 2004) and it has been shown that the sweat rate of an older adolescent is indeed higher than that of a younger one (Meyer et al, 1992, Iuliano et al, 1998). Sweat composition in younger athletes is also different to that of mature adults (Bar-Or, 2001). There is less sodium and chloride loss seen in children and young adolescents compared to adults (Bar–Or, 2001, ADA, 1996) and consequently recommendations (particularly the electrolyte formulations of sports drinks) set for adults may not be suitable for this group. Petrie et al (2001) notes that although the amount of sodium lost in the sweat from younger athletes is generally lower than that seen in adults it is very variable across individuals and the type of exercise that they are participating in. It has also been noted that a young athlete is more susceptible to heat stress as the greater surface area to body weight ratio that the athlete exhibits consequently absorbs more of the environmental heat than an adult would (Petrie et al, 2004)

3.3. *Current recommendations for adolescents*

Current recommendations for adolescent athletes are available but limited. There are no definite values for carbohydrate intake in terms of how many grams are recommended a day and no relation of carbohydrate intake to levels of activity for the adolescent athlete. The American Dietetic Association (ADA) (1996) states that the training diet should provide an individual with enough energy for physical and health needs. Carbohydrate should provide 55 – 60% of an individual's total energy needs, whereas protein should supply 12 – 15% of the total daily energy needs and fat should provide the remainder (approximately 25 – 30%) of the total daily energy needs (ADA, 1996). It has been suggested that the fat intake of an individual should not be lower than 15% of the total energy intake (Hellemans et al, 2008). Total energy intake is an important part of growth and development, as well as sporting performance as adolescents must maintain an ideal balance between energy and protein intakes for growth and performance (Thompson, 1998). Without adequate energy intake adolescents may be at a higher risk of stunted growth, delayed or irregular menstrual cycles (in females), decreased bone mass and an increased risk of injuries. The adolescent may also take longer to recover from injuries and experience deficiencies in nutrients and dehydration (Thompson, 1998). As mentioned above there are no specific guidelines in terms of grams of carbohydrate per kilogram of bodyweight for adolescent athletes however the carbohydrate recommendations for athletes in general are as follows:

Table 1: Amount of carbohydrate required per kilogram of bodyweight for different training needs (Jeukendrup & Gleeson, 2004 and Howe et al, 2002)

Exercise and Training Intensity	**Grams of CHO per kg of body weight a day**
Jenkendrup & Gleeson 2004 Moderate Intensity Training *Howe et al 2002* Sports that involve up to 60 minutes of moderate to high intensity daily training	5 - 7 g/kg BW/day 5 – 6 g/kg BW/day
Jenkendrup & Gleeson 2004 Increased Training *Howe et al 2002*	7 – 10 g/kg BW/day

Sports that involve 1 – 2 hrs of moderate to high intensity daily training	7 – 8 g/kg BW/day
Jenkendrup & Gleeson 2004 Extreme Endurance Training *Howe et al 2002* 2 – 5 hrs of endurance training (intense) More than 5 hours of extreme training daily	 10 – 13 g/kg BW/day 8 – 10 g/kg BW/day 10 g/kg BW/day

In light of the research which suggests that young athletes may not utilize as much carbohydrate during exercise (Bar–Or, 2001) as an adult would due to a decreased glycolytic capacity (Petrie et al, 2004, Montfort-Steiger & Williams, 2007), recommendations for a high carbohydrate diet may be premature in terms of benefiting sports performance in an exercising young athlete. Research however has not confirmed this and the young athlete should still be encouraged to eat a high carbohydrate diet. A diet high in carbohydrate also provides other essential nutrients such as fibre, vitamins and minerals, which young athletes need for health, growth and development (Petrie et al, 2004).

As mentioned earlier, the growing athlete has an increased need for protein due to the large amount of growth that is occurring during this developmental period and the amount of physical activity that they are taking part in (Bar-Or, 2001, Petrie et al, 2004). The suggested recommended amount of protein in the diet of an adolescent athlete is 1.1 – 1.2grams per kilogram of bodyweight a day (g/kgBW/d) for a 7 – 10 year old child and 1g/kgBW/d for a child 11 – 14 years of age (Ziegler et al, 1998). The New Zealand Ministry of Health recommends 0.8 – 1.6g per kg of bodyweight for adolescents, however this is not adjusted for athletic individuals. Other research recommends 2g of protein per kg of body weight a day for adolescent athletes (Tarnopolsky, in Burke 2006). In comparison to an adult the recommended intake for a New Zealand or Australian adult male (aged 19 – 70 years of age) is 0.84g/kgBW/d, and an adult female (aged 19 – 70 years of age) is 0.75g/kgBW/d (Commonwealth of Australia and New Zealand Ministry of Health).

Values for dietary intake are often given in percentages of energy intake with protein being recommended to make up 12 – 15% of the daily energy intake (Petrie et al, 2004, Willenberg & Hemmelgard, 1991). However if using this form of calculation the amount of protein that an adolescent is expected to eat can be different than the values given on a weight measure (for example grams per kilogram of bodyweight a day). It is important to be clear about how requirements are discussed - as Petrie et al (2004) shows; an 18 year old male who is very active, with a reference weight of 67.2kg, would have an intake of approximately 3804kcal/day which would mean that if he was to have 12 – 15% of his energy intake from protein he would be consuming 1.7 – 2.12g/kg per day. This is slightly higher than the recommended range for New Zealand adolescents given as 0.8 – 1.6g/kgBW/d and that of adult New Zealand men of 0.84g/kgBW/d (New Zealand Ministry of Health). This range does however fit within Tarnopolsky's recommendation of 2g/kg/BW/d. Berning et al (1991) found that adolescent males consumed 2.14 grams of protein per kg of bodyweight a day, and females consumed 1.84 grams per kg of bodyweight a day. The males intake of 2.14g/kgBW/d amounted to 12% of their energy intake coming from protein, and the females intake of 1.84g/kgBW/d meant that 12.6% of their energy intake came from protein. These amounts fit within the percentage recommendations of the American Dietetic Association (1996) that 12 – 15% of the energy of a training diet should come from protein. Rennie and Tipton (2000) have demonstrated that if an athlete is consuming 12 – 15% of their recommended energy intake from protein that they do not need supplementation with extra protein.

Fluid balance is a vital part of health and performance. Sports Medicine Australia's Guidelines for Fluid Replacement for children and adolescents are seen in Table 2:

Table 2 – Sports Medicine Australia's Fluid replacement guidelines for children and adolescents (Source: Burke, L. (2000) *Clinical Sports Nutrition*, McGraw Hill: Sydney, pg. 613).

Age (yr)	Time (min)	Volume * (mL)
Approx 15	45 (before exercise)	300 – 400
	20 (during exercise)	150 – 200
	As soon as possible after exercise	Liberal until urination
Approx 10	45 (before exercise)	150 – 200
	20 (during exercise)	75 – 100
	As soon as possible after exercise	Liberal until urination

* In hot environments, fluid intake may need to be more frequent.

3.4. Guidelines vs. actual intakes from research with a focus on New Zealand adolescents

Although guidelines for adolescents are available in terms of fluid, daily percentage of intake and recommended daily intake (RDI's) for vitamins and minerals for both sporting performance and general daily life, adolescents have been shown to be lacking not only in meeting the recommendations for general growth and health, but also those recommendations for sporting performance.

Adolescents who are involved in physical activity may have some dietary practices that are better than non-athletic adolescents. In one study it has been seen that athletic adolescents more frequently ate breakfast and had overall higher mean intakes of iron, zinc, calcium and protein than non-athletic adolescents, although still they may not meet the overall dietary recommendations for some of these nutrients (Croll et al, 2002). Clarkson (1991), ADA (1996), Lytle (2002) and Berning et al (1991) have shown that adolescents participating in exercise are more likely to be deficient in iron. Their calcium intake may also be lower than required (ADA, 1999, Wright et al, 1991, Berning et al, 1991). It is known that a deficiency in iron or calcium (which is often seen in females) can have a detrimental effect on performance (Petrie et al, 2004). A low intake of calcium could pose long term health issues in adolescent athletes. Calcium is needed to increase bone density and a lower bone density may induce a higher risk of stress fractures and bone related injuries (Petrie et al, 2004).

Research by Rankinen et al (1995) has shown that vitamin intake in adolescent athletes is very close to recommended intakes and is actually better than in non-athletes. However the athletes in Rankinen et al's study (1995) had mean ages of 12.4 (male control), 12.5 (male athlete), 11.5 (female control) and 11.4 (female athlete) years $\pm$ 0.5 and therefore may not be subjected to the same environment of that of the older adolescent (where an older adolescent may have more control over their intake and less parental involvement in food choice). Another study performed by Cupisti et al (2002) found that female adolescents, who were considered athletes had significantly higher intakes of fibre, iron and vitamin A, and additionally they ate a breakfast meal, consumed more energy from carbohydrates and less energy from lipids as compared to non-athletic female adolescents throughout the day. However like the study by Croll et al (2002) the athletic and non-athletic adolescents in Cupisti et al's (2002) study still did not meet the daily dietary requirements for iron, calcium and zinc. Aerenhouts et al (2008) found that all 60 athletic participants in their study ate breakfast every day, and had a slightly better intake than non athletic adolescents, however their fibre intake was generally low, and calcium intake was seen to be low, especially in females. These were sprint athletes only, and they used a 7 day food record which may have impacted on the results seen. Berning et al (1991) also found that intakes of Vitamin A were above the RDA in elite adolescent swimmers, as were the intake of Vitamin C, Thiamine, Riboflavin and Niacin, but that although some females did meet the RDA for iron and calcium a number did not consistently meet the RDA and this may consequently affect health and performance.

The way in which these studies were conducted should be taken into consideration when looking at the conclusions. Berning et al (1991) used a food record, and although the athletes attended a training session on using food records and were given food models to consider with portion size, they may have under or over reported intake. Stockley (1985) found that respondents using an estimated food record may underestimate energy intake by an average of 20 – 50%. Mertz et al, (1991) found that 81% of their subjects were under reporters. This is similar to Black et al (1993) who found that 80% of subjects in their research were under reporters. It is also known that a limitation of this method is food distortion (Stockley, 1985). As they knew they were taking part in research the subjects may have improved their diet, or it is possible that found it difficult to record their intake for 5 consecutive days and did not record accurately. Gersovitz et al (1978) has reported that there can be poor compliance after 4 days of recording. Berning et al (1991) also had a relatively small sample size which included 22 males and 21 females. Cupisti (2002) et al used a 3 day food recall, which may have been more accurate due to more compliance over a shorter time frame, and a questionnaire, with 50 non-athletic and 60 athletes, all of who were females. Possibly there may be a difference in recording between males and females with one gender more accurate.

New Zealand regularly conducts research on the nutritional habits of children and adolescents through the Ministry of Health's NZ Food NZ Children survey (New Zealand Ministry of Health, 1999). This survey is not designed to obtain data on adolescent athletes but does provide an insight into what young New Zealanders are consuming. Major points seen in the results from the 1997 survey are shown in Table 3.

Table 3: Major results from the New Zealand Ministry of Health's NZ Food NZ Children survey (1999).

Measure	Males	Females
Percentage of energy from protein	15%	16%
Usual daily median intake of protein	105g	71g
Percentage of energy from carbohydrates	46%	47%
Percentage of energy from fat (total) Percentage energy from - Saturated fat - Monounsaturated fat - Polyunsaturated fat	35% 15% 12% 11%	35% 15% 12% 11%
Iron intake	14.7mg (110% RDI) (aged 15 – 18 years of age)	10.1mg (100%) (aged 15 – 18 years of age)
Calcium	894mg of 1000-1200mg/day (75 – 89% RDI) (aged 15 – 18 years of age)	740mg of 800 – 1000mg/day (74 – 93% RDI) (aged 15 – 18 years of age)

Source: NZ Food NZ Children's survey MoH, 1999

Even though this research is not specifically athlete based, overall it indicates that for an exercising adolescent the intake of carbohydrate is too low (general recommendations indicate that 55 – 60% of total energy should come from carbohydrate, ADA 1996), protein is likely to be sufficient (ADA, 1996 recommends 12 – 15%), fat intake is high (ADA, 1996 recommends 25 – 20%) and too much of it is saturated fat (Pearce, 2004). This unbalanced ratio between the food components was also seen by Berning et al (1991) who showed that although elite adolescent swimmers consumed enough energy overall, the composition of their diet was not in line with a healthy diet for an athlete, as males consumed 42.7% of their calories as fat, 45.6% of their calories from carbohydrate and 12.6% of their calories from protein. Females consumed 41.4%

of their calories from fat, 47.9% from carbohydrates, and 12% from protein. These outcomes could have implications for sporting performance however the New Zealand survey involves the members of the general public and is not specifically targeted at adolescent athletes so cannot be directly associated to talented or elite New Zealand adolescent athletes, but as similar results have been seen in other research with adolescent athletes worldwide (Berning et al, 1991) this is of interest to those working with adolescent athletes.

3.5. Gender differences in adolescents meeting recommendations

There are a number of gender differences seen when observing adolescent athletes in terms of nutrient recommendations. It is often assumed that males are easily able to meet recommendations and to have a high enough intake to prevent deficiencies of vitamins and minerals (Hinton et al, 2004), whereas it has been proposed that females can struggle to consume enough in total intake to prevent nutrient deficiencies (Hinton et al, 2004, Benson et al, 1985, Loosi et al, 1986, Hellemans et al, 2008). Interestingly research by Hinton et al (2004) found that males were more likely to be deficient in nutrients as opposed to the females that were studied. It was noted that when analysing the diets of American collegiate athletes that the diets of male athletes were characterised by high intakes of sodium, cholesterol, and saturated fat whereas the diets of female athletes were generally characterised by a diet which is more likely to meet nutrient recommendations (Hinton et al, 2004). Males also tended to exhibit a lower level of nutrition and food knowledge and are less interested in health compared to females who had a greater interest in, and knowledge of nutrition and food generally (Nowak et al, 1998, Silverstein et al, 1998) which may have impacted on their choice of food.

3.6. Gender differences in factors which influence food choice

It is well known that adolescents are anxious and worried about their size and shape (Nowak et al, 1998, O'Dea, 1995). The overall factors which influence food choice in adolescents are the same in males and females but when the importance of different factors is examined, males have different rationalisations to females for food choice. Male adolescents are more likely to eat certain foods to try and change their look (getting more muscular, taller, losing body fat), whereas females adolescents only related their food choices to weight considerations (Neumark-Sztainer et al, 1999, Hinton et al, 2004). Males are likely to want to maintain their weight as opposed to females who are more likely to want to lose weight (Nowak et al, 1998). Knudsen et al (1988) found that females who participated in athletic and sporting events were not as concerned with the energy demands needed for their sport but they focused mainly on weight control. It is possible that this could be related to sport as many male dominated sports are physical, for example rugby where players are tackled and take part in scrums, whereas more female dominated sports may be more focused on looks and being small in size (for example gymnastics or diving), although it is unwise to completely distinguish sports by gender as many athletes take part in both. Hinton et al (2004) found that 62% of the females who participated in their research on American athletes wanted to lose at least 5lbs regardless of what sport they competed in. 76% of the female adolescents aged 14 – 18 years in Chapman et al's research (1997) also wanted to lose weight. Dummer et al (1987) found that adolescent female swimmers (and often their coaches) seem to have an obsession with losing weight, thinking that it will improve speed in the pool. Weight loss in female adolescent athletes may affect puberty and maturation if it is significant enough. The fact that the genders may focus on different components of body shape or size may also be valuable information when designing nutrition education for adolescents, especially females.

4.0. Supplement usage in athletes

4.1. Introduction to supplement usage

It is known that athletes can be more susceptible and vulnerable to taking on nutrition information that may not be correct or standard for their sport as they are continuously looking for a way to gain a competitive edge (Froiland et al, 2004, Pratt & Walberg, 1998). As athletes look for a competitive edge or a chance to be faster or stronger than a competitor, many consume supplements and the adolescent athlete (along with many adult athletes) often believes this may enhance performance (O'Dea, 2003, Sobal & Marquart, 1994, Haymes, 1991, Krowchuk et al, 1989, Douglas and Douglas, 1984). The reasons for athletes using supplements are described in detail in section 4.3**.** These supplements often include multivitamin and mineral supplements (ADA, 1999). Currently research does not support the view that athletes, including adolescents benefit from vitamin supplementation (Petrie et al, 2004**,** Singh et al 1992, Fogelholm et al, 1992, Haymes, 1991, Weight et al, 1988) as the need for vitamins and minerals is not thought to increase due to training or competition (Petrie et al, 2004). Furthermore, excessive supplementation with vitamins A, D, E and K (fat-soluble) can be harmful to health as these are not excreted like the water soluble vitamins C and B when consumed in excess, and can be toxic in large amounts (Willenberg and Hemmelgard, 1991). The New Zealand Dietetic Association's Position stand on Sports Nutrition discourages the use of supplements except in the situation of a diagnosed medical problem, for example supplementing iron for the treatment of iron deficiency anaemia (Hellemans et al, 2008). Alves and Lima (2009) also echo this finding by stating that adolescent athletes should not be using supplements except in the case of a recognized deficiency.

Low stores of iron in the body (and a low intake of iron) may compromise performance in the adolescent athlete (Petrie et al, 2004). An overall feeling of lethargy and fatigue is associated with iron deficiency in the body. An athlete has the potential to have a greater iron loss as iron is lost through excretion (feces and urine), intravascular heamolysis and through sweat loss (Alves and Lima, 2009). By supplementing with iron there may be an improvement in performance due to the fact that iron is used in the production of haemoglobin and myoglobin and consequently in the transport of oxygen around the body. Oxygen turnover is a crucial part of physiological performance as the cells are supplied by oxygen for cellular respiration (Tortora & Grabowski, 1997). Iron deficiency anaemia can additionally impact on physical performance by leading to an increased risk of catching infections (Hellemans et al, 2008).

There are points which need to be considered in respect to research on supplement usage in adolescents. Much of the research is not conducted on the same age groups so there could be discrepancies in translating the results to all adolescents. Differences in measurement tools such as food records and anthropometric measures versus questionnaires makes interpretation difficult. Section 4.6 discusses the methodology of supplement research in adolescents in more depth.

4.2. Prevalence of supplement usage

Previous research suggests that anything from 31% (Swirnzinski et al, 2000) up to 98.6% (Kristiansen et al, 2005) of adolescent athletes are using some type of dietary supplement. This higher level is similar to Jacobson et al (2001) who found that 79% of males and 65% of females and Burns et al (2004) with 88% of athletes used supplements. Froiland et al (2004) found 89% of participants had used at least one nutritional supplement during the period of their athletic careers. Krumbach et al (1999) found that almost 57% of the athletes surveyed for their research were taking dietary supplements. Kristiansen et al (2005) found that 98.6% of Canadian University athletes used supplements; however all of these athletes were over the age of 19 years (and the definition of supplements included sports drinks). Swirnzinski et al (2000) found that the majority of the athletes (90%) who were taking a dietary supplement were using creatine however other research has shown that vitamin and mineral supplements are taken by many adolescents.

Sobal and Marquart (1994) found that 38% of adolescent athletes used multivitamin supplements, which is alike to that of Chapman et al (1997) who found that 43%, and Parr, Porter & Hodgson (1984) that 46% of the athletes studied were taking multivitamin supplements. Out of the 89% of the adolescent collegiate athletes studied by Froiland et al (2004) that were currently, or had, taken dietary supplements 67% of these athletes were taking multivitamin supplements. Calcium (18.8%) and iron (10.6%) were the most popular (Froiland et al, 2004). Athletes who are taking part in two or more sports are more likely to be taking supplements than an athlete who participates in one sport (Scofield & Unruh, 2006). Burns et al (2004) found that 58% of respondents reported using two or more supplements at any one time (where 88% were using at least one supplement). Swirnzinski et al (2000) found that 13% of supplement users in their research used more than one supplement. The overall usage of supplements (both as general nutritional supplements and as vitamin/mineral supplements) is summarised in Table 4.

Table 4: Overall summary of research on the prevalence of supplement usage

Author, year and study name	Prevalence of overall supplement use	Prevalence of multivitamin use
Kristiansen et al (2005) *Dietary supplement use by varsity athletes at a Canadian university* Mean age males = 21.3 years Mean age females = 20.7 years	98.6%	51.7% men 62.9% women
Burns et al (2004) *Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutrition counselling* Mean age = 20 $\pm$ 1.1 years, *n* = 118 males, *n* = 118 females	88%	73.3%
Froiland et al (2004) *Nutritional supplement use among college athletes and their sources of information* *n* = 115 males, *n* = 88 females	89%	67%
O'Dea (2003) *Consumption of nutritional supplements among adolescents: usage and perceived benefits* Aged 11 – 18 years	Not noted	48.7%

Swirnzinski et al (2000) *A survey of sport nutrition supplements in high school football players* Aged 14 – 18 years	31%	3.7%
Jacobson et al (2001) *Nutrition practices and knowledge of college varsity athletes: a follow up* Ages given in American college years	79% men 65% women	18.9%
Kim & Keen (1999) *Patterns of vitamin/mineral supplement usage by adolescents attending high schools in Korea* Aged 16 – 19years, *n* = 926 males, *n* = 429 females	Not noted	35.8%
Krumbach et al (1999) *A report of vitamin and mineral supplement use among university athletes in a Division one institution* Aged 19 years or older, *n* = 266 males, *n* = 145 females	Not noted	56.7%
Chapman et al (1997) *Nutrition knowledge among adolescent high school female athletes* Aged 14 – 18 years, *n* = 72 females	Not noted	43%
Massad et al (1995) High school athletes and nutritional supplements: a study of knowledge and use. Mean age = 16.60 $\pm$ 1.45, *n* = 509	Not noted	41.7%
Sobal & Marquart (1994) Vitamin/mineral supplement use among high school athletes. *n* = 742 athletes, high school students	Not noted	38%

4.3. Reasons for supplement use and sources of information

Many athletes use supplements in the hope that they will improve performance (Froiland et al, 2004, O'Dea, 2003, Sobal and Marquart, 1994, Haymes, 1991, Krowchuk et al, 1989, Douglas and Douglas, 1984) however one of the most alarming points that is seen in discussing this research is that athletes and often those who encourage the athlete to take the supplement(s) such as parents, coaches and trainers do not have any substantial knowledge of the beneficial effects, risks or harms of the products (Jacobson et al, 2001) being promoted.

Athletes may also be unaware of the benefits and uses of supplements. Athletes were asked to define a supplement by Froiland et al (2004) and 34% of the respondents replied with all or part of the following statement: “a supplement is a product that helps to increase performance, strength, muscle, and enhance recovery” (Froiland et al, 2004, pg. 107). The other respondents stated that supplements are “something that improves health or the body”, “additional nutrition added to the diet”, “anything other than food”, or “something that helps you gain or lose weight” (Froiland et al, 2004, pg. 107).

Reasons for using supplements have been investigated in the majority of the research mentioned above. The reasons why adolescents choose to take dietary supplements are often seen to be different when comparing gender. Males are more likely to use supplements to gain weight or muscle and to improve athletic characteristics such as strength, power, agility and speed, whereas females choose to use supplements for improving overall health or to help an inadequate diet (Froiland et al, 2004). Kristiansen et al (2005) found that carbohydrate products were used by male and female athletes for “providing more energy” (pg. 200). Men in the study also cited “enhanced recovery and muscle strength” (pg. 200) as a reason for use, whereas females cited “enhanced recovery and taste” as the reasoning behind using supplements (pg. 201). 34.4% of users in Kim et al (1999) actually took supplements directly before or during a sporting event thinking that it would improve performance. O’Dea (2003) found that many of the participants in her research did not know why they were taking supplements except for the fact that they were given to them by their mothers. Interestingly, Massad et al (1995) found that the athletes who had greater knowledge about supplements were less likely to use them.

Swirnzinski et al (2000) found that 94% of athletes using supplements used these for the reason of increasing weight or building muscle, and the largest supplement used in this study was creatine, compared with multivitamins being most prevalent in other studies. It is known that creatine may enhance performance where there is a series of repeated high intensity bursts of activity and short recovery periods between these (such as that seen in football and some other team sports) due to the role of creatine phosphate and an increase in muscle size may also be seen (Burke, 2006). As only football players were used in this study this could explain why creatine was the major supplement used as the short high intensity bursts are characteristic of football and muscle size could also be very desirable in football due to the high impact nature of this game.

Growth, treating health problems and athletic performance improvement were reasons for multivitamin supplement use seen by Sobal & Marquart (1994). 66% of the respondents (especially males) in their study believed that taking supplements improved athletic performance. Krumbach et al (1999) found similar reasons for use of multivitamin supplements such as improvements in sporting performance, a friend or family member had recommended the use of the supplement and to increase muscle mass. Kim et al (1999) investigated the use of vitamin and mineral supplements in adolescent athletes attending high schools in Korea. The adolescent athletes stated that their reasons for using multivitamin supplements were "to recover from fatigue" (47.6%), "to maintain health" (20.2%), to avoid or treat sickness or illnesses (14.9%), and to maximise performance (4.7%) (pg.396). Supplying nutrients to supplement a possibly deficient diet was also a reason for use in Kim et al (1999)(12.6%) and the most popular reason in Kristiansen et al (2005). As well as these other reasons for use, adolescents also believe that taking supplements will give them the "ideal body" (Alves & Lima, 1999, pg. 287)

The reasons for supplement usage are summarised in Table 5.

Table 5: A summary of the reasons for use of various supplement and the group investigated.

Reason for use	***Gender***	***Group investigated***
Improve sporting and or athletic performance		
Krumbach et al (1999)	Both genders	University athletes at Division 1 institution
Sobal & Marquart (1994)	Both genders	High school athletes
Froiland et al (2004)	Both genders	College athletes (Division 1 University)
Kim et al (1999)	Both genders	Adolescents at high school in Korea
Neiper (2005)	Both genders	U.K. Junior track and field - 18 years of age
Zeigler et al (2003)	Both genders	Elite figure skaters - 16 years of age
O'Dea (2003)	Both genders	Adolescents 11 – 18 years of age

Overall/Maintain health		
Kim et al (1999)	Both genders	Adolescents at high school in Korea (16 - 19yrs)
Froiland et al (2004)	Both genders	College athletes (Division 1 University)
Neiper (2005)	Both genders	U.K. Junior track and field - 18 years of age
O'Dea (2003)	Both genders	Adolescents 11 – 18 years of age
Healthy growth		
Sobal & Marquart (1994)	Both genders	High school athletes
Build Muscle		
Krumbach et al (1999)	Both genders	University athletes at Division 1 institution
Swirnzinski et al (2000)	Males	14 – 18 yrs old High school football players
Froiland et al (2004)	Both genders	College athletes (Division 1 University)
O'Dea (2003)	Both genders	Adolescents 11 – 18 years of age
Kristiansen et al (2005)	Both genders	Canadian University varsity and non varsity athletes
Recovery from fatigue		
Kim et al (1999)	Both genders	Adolescents at high school in Korea (16 – 19yrs)
Recovery from illness		
Sobal & Marquart (1994)	Both genders	High school athletes
Kim et al (1999)	Both genders	Adolescents at high school in Korea (16 – 19yrs)

Prevent illness/strengthen immune system		
Neiper (2005)	Both genders	U.K. Junior track and field - 18 years of age
Zeigler et al (2003)	Both genders	Elite figure skaters – 16 years of age
O'Dea (2003)	Both genders	Adolescents 11 – 18 years of age
Helps an inadequate diet		
Froiland et al (2004)	Both genders	College athletes (Division 1 University)
Kim et al (1999)	Both genders	Adolescents at high school in Korea (16 – 19yrs)
Zeigler et al (2003)	Both genders	Elite figure skaters – 16 years of age
O'Dea (2003)	Both genders	Adolescents 11 – 18 years of age
Kristiansen et al (2005)	Both genders	Canadian University varsity and non varsity athletes

Many of the studies that have investigated supplement usage in adolescents have also investigated how adolescents receive knowledge on nutritional supplements. Athletes receive information about supplements from a wide range of people and resources (Burns et al, 2004). Froiland et al (2004) found that males were seen to choose and receive information on supplements on the advice of a shop nutritionist, a coach, other athletes or friends. This corresponds with research from Jacobson et al (2001) who found that males obtained nutritional knowledge from strength and conditioning trainers and athletic trainers. Conversely, females were more likely to obtain advice and information on supplements from other family members (Froiland et al, 2004) or university classes and nutritionists (Jacobson et al, 2001). Krumbach et al (1999) found that males received information on supplements from nutritionists/dietitians and from self, whereas females obtained information from family members, friends, physicians and pharmacists. Kim et al (1999) found that information on supplements came from physicians/pharmacists/nurses (27.6%), family/relative (25.4%), friends (17.7%), TV/magazine/newspaper (15.1%) and managers/coaches (13.4%). Jacobsen et al (2001) also found that 11% of supplement information came from coaches, and over 21% collectively from magazines (10%), family members (3.5%), friends (3.9%), and television (2.3%). Burns et al (2004) found that athletic trainers were the biggest source of information for university level athletes at one American university (39.8%), followed by strength and conditioning coaches (23.7%) and dietitians (14.4%), 29.9% attended classes, brochures were used by 33.2% and individual counseling was cited by 17.9% of the athletes in addition to this. Exact sources of information were not shown in the results of Sobal & Marquart (1994) however the subjects did respond that parents, doctors and coaches had the biggest influence on them in terms of supplement use. This is an area that would benefit from more research to identify in more detail where adolescents are obtaining information on supplements as the popularity of them warrants supplements being included in education for this group and those who work with them. More research should also be undertaken to assess how reliable and correct the information is, that these sources provide.

4.4. Frequency of supplement usage and justification

The frequency at which adolescents use supplements is a cause for concern. Many supplements lack proof of efficacy, regulation of quality control is inconsistent and there is risk of over consumption. Frequency of supplement usage was reported by Froiland et al (2004) and this showed that 23% of the athletes regularly used supplements, which was defined to be usage of more than five times a week. 16% used supplements occasionally (defined as two to four times a week), 22% used supplements seldom (defined as less than two times a week) and 39% were not using any supplements. Krumbach et al (1999) found that 18% of athletes took supplements greater than or equal to five times a week, 21.2% took occasionally, (which was defined as two to four times a week), 21.2% seldom (once a week) and 43.3% never had vitamin or mineral supplements. Kim et al (1999) found that 72.7% of subjects took supplements on a daily basis.

4.5. The use of energy and caffeinated drinks in adolescent athletes

O'Dea (2003) found that adolescent participants in her research regularly consumed supplements including sports drinks, caffeine and stimulating energy drinks, high protein formulas, multivitamins and other substances such as guarana, coenzyme Q10, echinacea and ginseng. The adolescents had varying reasons for using these supplements. In terms of sports drinks the participants often had these instead of soft drinks and used them as "thirst quenchers and (as) drinks that taste good" (O'Dea, 2003, pg 103). The participants also stated that the sports drinks could be used to enhance sports performance, although none of them identified using a sports drink specifically as a rehydration tool or gave specific reasons why it would improve sports performance Energy drinks were found to be very popular among the participants. The subjects were enthusiastic about using energy drinks and sports drinks and the perceived benefits of consuming them on their physical performance and their bodies. Males especially were using the energy drinks as stimulants for sport with two of the participants stating the following: "…I wanted an energy boost so I had five cans of Red Bull before playing soccer" and "I had a can of 'V' for soccer. I don't think it does anything for me. I take it just before playing, but it might make a difference if I take five cans" (O'Dea, 2003, pg. 103). Participants used the justification of being provided with energy for using guarana, ginseng and coenzyme Q10, whereas immunity and heath were the reasons for using echinacea and ginseng. The part of O'Dea's (2003) study which could be the most cause for concern is that many (the actual number was not given) of the adolescents using these supplements do not know the side-effects and risks of taking these supplements. This again highlights a topic which is of high importance in educating adolescents about sports nutrition.

4.6. A discussion on the methodology of supplement research papers

Many of the studies conducted on supplement use differ in methodology and structure. It has been shown that the studies which have a larger sample size show lower rates of supplement usage as compared to the higher rates seen in studies with smaller sample sizes (McDowell, 2007). This may give some indication as to why the published rates vary so much from 31% (Swirnzinski et al, 2000) to 98.6% (Kristiansen et al, 2005), as when considering the sample sizes these vary greatly. Sobal and Marquart (1994) used 742 subjects and saw a prevalence of dietary supplement usage of 38%. Similarly, Kim and Keen (1999) used 1355 subjects and found a prevalence of 35.8%. Conversely, Neiper (2005) used only 32 subjects in their research and saw a prevalence of 62%, while Ziegler et al (2005) used 105 subjects and found a prevalence of 62%. Froiland et al (2004) used 203 subjects and saw a prevalence of 89%. An exception to this is Schofield and Unruh (2006) who used 139 subjects and had a prevalence of 22.3%.

Many of the studies also vary in the age of the subjects. Some studies give clear ages (O'Dea, 2003), whereas other studies use school levels or grades to distinguish the subjects (Jacobsen et al, 2002). The range of ages also differs with adolescents as young as 11 years of age being studied (O'Dea, 2003) up to those who are 20 years of age or older (Kristiansen et al, 2005, Burns et al, 2004). There is thought that supplement usage may be higher in older adolescents as they have more control over supplement usage. An older adolescent may have more access to supplements as they may be more likely to have the money to buy supplements themselves, and the ability to buy these. They may also be exposed to more publicity surrounding supplements by being more likely to read magazines, and gather information from other sources (for example the internet). They may also be subjected to more pressure to use supplements than younger adolescents (McDowell, 2007). While it has been shown that younger adolescents often state that their parents encourage them to use supplements (O'Dea, 2003), older athletes may have less pressure from parents and parental involvement in their diet so may feel that they can experiment more with supplements.

The sporting level of the athletes also varies in research conducted on supplement usage. The sporting levels of the subjects in the studies discussed above vary from recreational and regional/provincial level athletes to athletes who are competing at a professional/international level. It is possible that the higher the level of competition, the more pressure an athlete feels to use supplements as performance is crucial at these levels, where the athlete may be in a paid situation. Anecdotally in situations where supplements are sponsored (for example by the team's or individual athlete's sponsors) this may lead to usage that normally would not have occurred. This may also occur with sports drinks, where teams are supplied with a certain product and the team members are expected to use it. Higher ranked teams and individuals who have access to fitness trainers may also be encouraged to use supplements by these members of team management.

The sports which have been used in previous research are not consistent and while some studies focus on one sport (Swirnzinski et al, 2000, Zeigler et al, 2003) other studies use athletes from a combination of sports (Krumbach et al, 1999, Sobal & Marquart, 1994, Froiland et al, 2004, Kim et al, 1999, Kristiansen et al, 2005). The type of sport that an athlete takes part in may influence supplement use**.** It is clear that adolescents see supplements as a tool to improve performance (Krumbach et al, 1999, Sobal & Marquart, 1994, Froiland et al, 2004, Kim et al, 1999, Neiper, 2005, Zeigler et al, 2003 and O'Dea, 2003). Sports which rely more on strength and size may correspond to the number of subjects who use particular supplements as they try to improve performance. For example athletes who are involved in sports which are based on size, strength and involve physical contact may be more inclined to use supplements which are claimed to increase size and muscle strength (for example creatine or protein powders). Athletes who participate in aesthetic sports where a small body shape and lower body weight is desirable (such as gymnastics or diving) or those required to 'make weight' may be more inclined to use specific supplements (McDowell, 2007) such as weight loss formulas or weight loss supplements.

It is clear that the assessment tools used in previous research to evaluate supplement usage in adolescents differs and therefore no clear interpretation can be made on this basis. It is clear however that more research is needed into this area on the influences on adolescents using supplements and the potential effects (both positive and negative) that supplementation may be having on adolescent athletes.

A major point of importance, and one that athletes may not be aware of, is that of returning a positive drug test after consuming contaminated supplements (Hellemans et al, 2008). This would be a point that needs to be considered when designing education on supplement usage.

5.0. Targeting nutrition education at adolescents

5.1. Introduction to nutrition education

It is clear that there is a need for sports nutrition knowledge to be developed and disseminated to adolescents (Benardot, 1996), not only so that they have the best possible sporting performance, but also so that they maximise their growth and development potential. There is the potential to be able to influence the adolescent athlete's diet in order to improve basic nutritional status and that of sporting performance (Croll et al, 2006). As dietary behaviour has been seen to track over time (Hoelscher et al, 2002, Kelder et al, 1994, Shepherd et al, 2006) being able to influence sports nutrition behaviour in adolescence may eventually lead to an increase in sporting performances from individuals over their sporting career. This would possibly be of great benefit in terms of high performance sport as if adolescents can be educated on sports nutrition when they are at this stage of life they may be more inclined and motivated to take on this advice and use it in the future.

5.2. The optimal way of educating adolescents and areas to target

There is very little research into the optimal way of educating athletes about sports nutrition, however there is some debate about which could be the most beneficial method of athlete education with these practices (Potter & Wood, 1991). The overall objective of nutritional education is that the individual adolescent will have an increased knowledge of nutrition and be encouraged and have support to change and maintain healthy nutritional habits (Nowak et al, 1998). Researchers have suggested that the nutritional information must be targeted at areas which are of interest to the athletes. Werblow et al (1978) suggest that nutrition education should be targeted at maximising weight control (especially in females (Chapman et al, 1997)). The focus of weight management may be more effective in females as they are observed to be concerned about weight control rather than actual energy intake needed for physical activity (Knudsen, Nowak, & Schultz, 1988, Hinton et al, 2004). Sporting performance is also a focus that is likely to work (Werblow et al, 1987, Benardot, 1996). Litt, in her book “Fuel for Young Athletes” (2004) states that younger athletes are more motivated by an immediate performance focus, they are not interested in the way that food impacts on health. Educational strategies which are focused more on energy levels and looks may be more effective and beneficial for adolescents as compared to a focus on long term future health problems (Nowak et al, 1998) because of this.

When educating adolescent athletes it is also vital that the nutritionist understands the athlete’s sport and the physiological demands of the particular code. Some sports have cultural norms that may impact on nutritional status and behaviour in different ways (Benardot, 1996). For example in an aesthetic sport such as diving or gymnastics the athlete may feel more pressured to look a certain way, or in a weight category sport like judo, rowing, boxing or wrestling there may be pressure to make weight by certain methods, which are not always deemed healthy. The nutritionist must also understand that in a team situation each individual is different and may have specific needs (Benardot, 1996) and influences on them compared to another team member. The use of supplements is important in this area as some adolescents associate using specific supplements as a normal practice of certain sports (Alves & Lima, 2009).

5.3. Specific influences on the adolescent athlete

Coaches and parents are ideally placed to influence adolescent athletes due to their close association with athletes (Zinn et al, 2006) however the quality of nutrition information given can be poor. Coaches can have both a positive and negative effect on an athlete’s nutritional knowledge and practice depending on the quality and accuracy of advice that they give to athletes (Juzmiak and Ancona-Lopez, 2004)

Zinn et al (2006) investigated the nutrition knowledge of rugby coaches in New Zealand and whether they provided nutrition advice as part of their position in the team. They assessed the coaches’ knowledge through a validated questionnaire that was posted by mail or email to Senior A grade coaches. They had a response rate of 46% with a total of 168 coaches returning completed questionnaires. All the respondents were male and spread relatively evenly over the age groups of 30 – 39 years and 40 – 49 years of age. They found that the overall total mean score for correct answers to nutrition knowledge questions was 55.6%. This mean total score was similar to that seen by Bedgood and Tuck in 1983 (55%) and Graves et al in 1991 (53 – 64% depending on role). The average is slightly less than that seen by Rockwell et al (2001) who observed a score of 67%.

Eighty three point eight percent of the coaches in Zinn et al's (2006) study gave players advice on nutrition however it was concluded by the authors that the level of knowledge exhibited by the coaches was inadequate and that further training on nutrition would be of benefit to these coaches. Although 55.6% correctly answered nutrition knowledge questions only 37% identified the optimal amounts of fluid needed for a two hour session and only 14% were able to identify the correct carbohydrate range for a sports drink. The authors also noted that coaches were not clear on the effects of protein, and how it may play a role in development of muscle mass and performance. Just over one third of the coaches believed that protein powder was essential in increasing lean body mass. Zinn et al (2006) also found that the coaches answered the section on supplements most poorly. They showed that there were significantly more unsure responses than incorrect answers and worryingly, 43% (n= 7) rated their knowledge as poor but still gave advice to players.

Incorrect knowledge of protein needs and the role of protein for the athlete appears to be a universal issue with coaches. As mentioned above, over one third of Zinn et al's (2006) respondents thought protein powders were necessary for a gain in muscle mass. Baer et al (1994) found that from 135 high school coaches, 98% gave nutrition education about gaining lean body mass, and 30% thought that to gain muscle mass, protein powders were necessary. Interestingly 100% of the coaches in this study did not know the recommended protein range. Bedgood and Tuck (1983) also found that although 86% of the male high school coaches they surveyed gave nutrition advice to their players, 50% did not know the recommended range for protein. This is similar to Rockwell et al (2001) who found that over 60% of coaches and trainers did not know the recommended range of protein. Corley et al (1990) investigated the knowledge of 106 college coaches and found that 2% recommended athletes take protein to increase their muscle mass.

Even while they are aware of low nutrition knowledge coaches may still give advice to players. Wolf et al (1979) investigated 137 coaches and found that 35% recommended supplements, 65% recommended weight loss diets, while 15% recommended protein supplements and 16% recommended a diet for weight gain although 78% of those coaches thought they required more knowledge. In Zinn et al (2006) 16.7% of the coaches did not impart nutritional knowledge to their players for reasons such as having little confidence in their nutrition knowledge (61%), there was someone else who gave players nutrition advice (29%) and some (14%) thought that providing nutrition advice was not important.

The biggest source of information for the school coaches in Baer et al (1994) was professional journals (66%) and popular magazines and newspapers (52%). Zinn et al (2006) found that coaches asked doctors (58.4%), physiotherapists (57.3%), dietitians (47%), trainers (29.2%), and 5.6% others (including nutrition shop owners, strength and conditioners and rugby academy managers) to impart nutrition knowledge if they did not. Dietitians and nutritionists were only cited by 7% of the coaches as a source of information for themselves. 0% of the coaches in Baer et al consulted a dietitian or nutritionist for advice on sports nutrition. This low result in seeking nutrition information from a nutritionist or dietitian was also seen in Corley et al (1990) where only 2% of the coaches used this source of information. These findings could be of concern as nutritionists and dietitians are trained specifically in this area and provide the best option for education. Rockwell et al (2001) found that coaches obtained most of their information from magazines (47%), Internet/television/food labels (42%) and books (40%) as compared to from dietitians (30%).

Juzmiak and Ancona-Lopez (2004) investigated coaches from judo, tennis, swimming and gymnastics and the nutrition advice that they gave these athletes. One of the most alarming points to come out of this research is that coaches may be swayed by trends or fads that are sport related. Three of the judo coaches stated that during training practice they do not allow the athlete to hydrate as it can "break concentration and interfere with discipline" (pg. 232). Judo coaches also promoted "wearing plastic/wool clothes, use of the sauna, and fasting for periods of greater than four hours" (pg. 232) as weight loss methods. These could have serious implications on the performance and health of the athlete. Although Zinn et al (2006) did not investigate the actual nutrition advice that coaches gave it was reported that almost one third of the coaches gave incorrect advice regarding weight management. Zinn et al (2006) also raised an important point that the link between nutrition knowledge and behaviour is not yet clear, so even if the coaches are imparting nutrition advice there is no guarantee that the athlete will use the advice and change their behaviour.

Parents also have an influence over the adolescent athlete. The attitude, beliefs and perceptions of nutrition and a healthy diet of parents plays an important role in the environment that they provide (O'Dea, 2005). Children and adolescents mimic or replicate behaviours that they are exposed to (Ells et al, 2005, Ritchie, et al 2005) so this is one way that parents influence nutrition behaviour. Parents are often responsible for the environment in which the adolescent lives. It is known that although many factors play a role in food choice and behaviour, the environment, which the parents play a role in creating, contributes many of these including; availability of food, networks of family and friends, parenting style and behaviour, availability of fast food or takeaways, and perceived norms (Story et al, 2002, Neumark-Sztainer et al 1999, Trahms & Pipes, 1997). Previous interventions that have been more successful have involved a parental component (Lytle, 1995, Parcel et al, 1988).

5.4. Factors which need to be considered when developing nutrition education

As there are specific influences on the young athlete (namely the parent and coach) and nutrition education is clearly needed for this group it is important to acknowledge the factors which need to be considered when developing nutrition education. The following factors have been taken into account when designing the ANKAA study, specifically in the design of the questionnaire and in discussing the results.

5.5. Developmentally appropriate strategies and frameworks

When working with adolescents to improve nutritional knowledge and therefore aiming to improve dietary behaviour it has been suggested that a program which is based on having activities which are centered on, and developmentally appropriate to the group being targeted will be successful (Poolton, 1972). Simply imparting knowledge to an adolescent is not enough to elicit an immediate change in behaviour (Sigman-Grant, 2002). Hoelscher et al (2002) have stated that when designing interventions for adolescents, programs which are based on behavioural aspects, use theories to develop a framework, have a community aspect, are used in an appropriate dosage, and have an environmental concept are much more likely to be successful. It is also known that programmes which are designed to target other behaviours as well as dietary behaviours are more successful, especially if they are also based on a model (Lytle, 1995). It is clear that the focus of programmes for adolescents needs to be behavioural (Lytle, 2005, Perry, 1999, Bartholomew, 1998) and performance based to grab the attention of adolescent athletes as it has been seen that interventions which are based on the concept of attitudes, knowledge and behaviour are not as successful with this group (Lytle, 1995).

To have a successful intervention it is important to identify and clarify influences on adolescents (Sigman-Grant, 2002). Throughout the development of the ANKAA study questionnaire this was an area that was carefully considered. Section B of the questionnaire was designed to investigate the influences on food choices and food availability. Additionally Section C was developed with the aim of investigating what sports nutrition influences that athletes had been subjected to, and what influences they felt were important. When initially designing an intervention for adolescents a systematic approach is needed. This needs to combine education with behavioural change strategies as well as a plan to evaluate the program (Hoelscher et al, 2002). When working with adolescents a combination of group and individual sessions is preferred (Sigman-Grant, 2002) as when using group sessions facilitated discussions are an ideal way to get adolescents to partake in the activity (Abusabha, 1999) and gives the opportunity for them to explore issues in further depth, critically think about the topic and talk about situations and choices (Sigman-Grant, 2002). For this reason focus groups were used in the design of the ANKAA study.

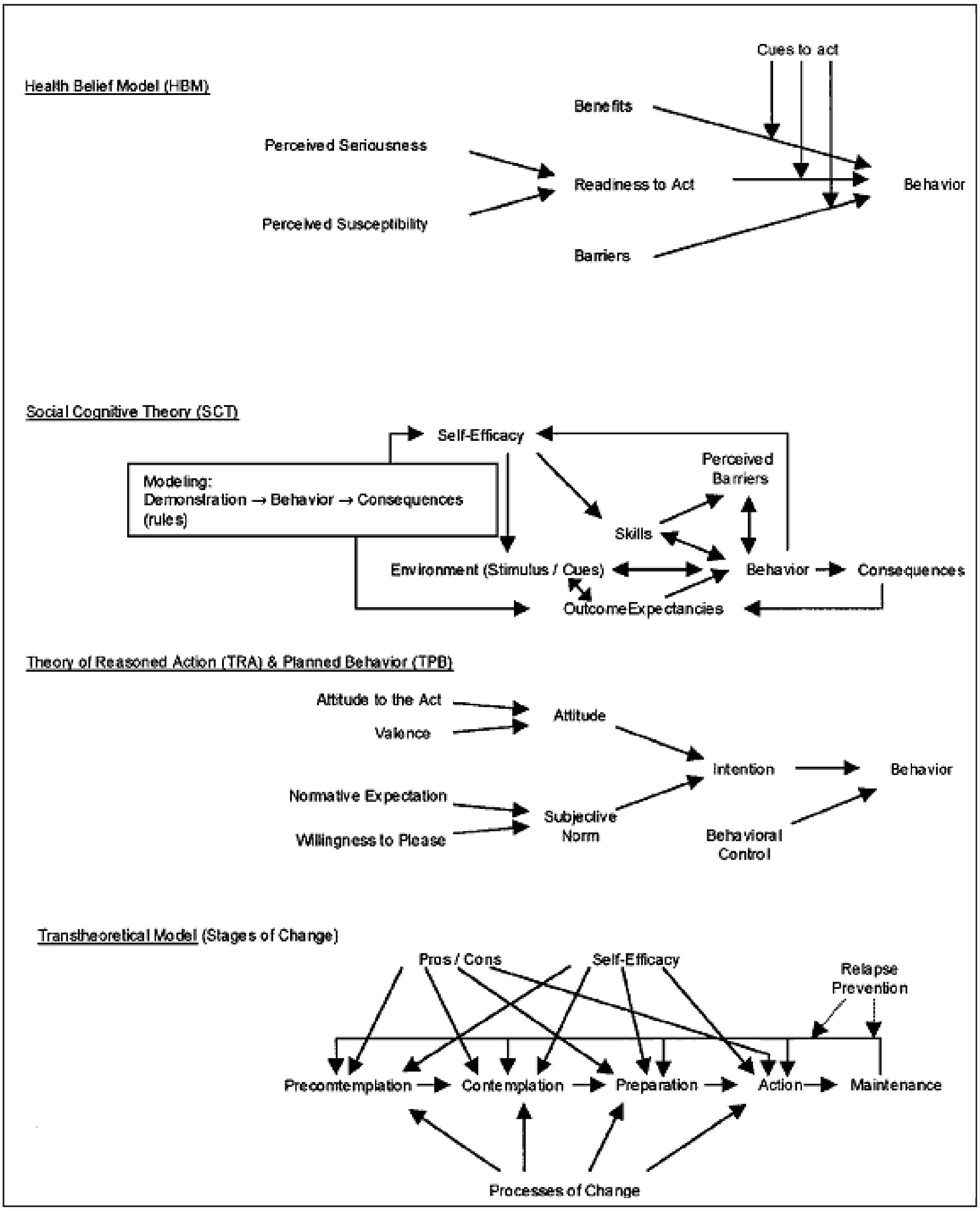
5.6. Theories/An introduction to theories previously used

A theory is defined as a concept which has interrelated definitions, propositions and ideas that give a clear, systematic view of circumstances, procedures and events that are used to identify or predict events in the future (Owen at el, 1999). Interventions which are theory driven and both emphasise a specific behaviour as well as considering the motivation needs and the skills that are needed to perform the behaviour are much more likely to be successful in working with adolescents (Lytle, 2005).

Previous research has mainly used four different models to define what influences food choice and behaviour (Baranowski et al, 1999). These four models are; the Social Cognitive Theory, the Health Belief Model, the Theory of Planned Behaviour, and the Transtheoretical Stage of Change Model. Each of these models are different in terms of structure but they contain many of the same components. The models summarised in a diagram by Baranowski et al (1999) in Figure 3.

Research is inconclusive on whether nutritional knowledge impacts on nutritional behaviour (Wardle et al, 2000). Educational programmes also have to take into account that factors and influences other than knowledge play a role in behaviour change. Some of the models take these influences into account more than others. The perceived outcomes and consequences of a behaviour are important to consider (as seen in the Theory of Planned Behaviour and the Health Belief Model) (Worsley, 2002), attitudes, beliefs and perceptions are vital (Worsley, 2002) and having the skill(s) to perform the actual behaviour are essential (Worsley, 2002). Worsley (2002) also states that having the confidence to perform a behaviour is important (as is seen in The Social Cognitive Theory and Theory of Planned Behaviour), taking the environment into consideration (also seen in The Social Cognitive Theory), and looking at motivating factors (as seen in The Social Cognitive Theory, and The Transtheoretical Stage of Change Model) will give a more rounded view of behaviour and the influences on it. The Social Cognitive Theory relates well to the hypothesis and aims of the ANKAA study.

Figure Three: A summary of the models used in Human Behaviour prediction (*from Baranowski et al, 1999, pg. 20).*



5.7. The Social Cognitive Theory

The Social Cognitive Theory (SCT) is a theory which is commonly used in behavioural change (Hoelscher et al, 2002). The key concepts in behavioural modification in terms of the social cognitive theory are: self efficacy, observational learning, reciprocal determinism, behavioural capability, expectations, functional meanings and reinforcement (Story, 2002, Owen et al, 1999). This model is an effective way of considering how successful previous interventions were and how these concepts need to be addressed in adolescents.

5.7.1 Self efficacy

Self efficacy is one of the major components of the SCT. It is defined as the confidence that an individual has to perform a particular behaviour (Owen at el, 1999). Self efficacy has two beliefs that are important to its success; firstly the belief of an individual that they can perform the behaviour and secondly beliefs about the final outcome of the behaviour (Owen at el, 1999). This is clearly important in designing an intervention as if an adolescent feels confident in their ability to perform a certain nutritional behaviour they may be more inclined to make healthier choices and hence improve sporting performance through using sports nutrition (O'Dea, 2003, Bandura, 1986). In terms of the professional application of this concept Owen at el, (1999) suggests pointing out strengths to the individual, using persuasion and encouragement with the individual and approaching behaviour change in small, manageable steps will be successful. It is envisaged that providing adolescent athletes with experiences that improve confidence in using particular skills (for example cooking) through an educational intervention will improve their overall nutrition behaviour.

5.7.2. Behavioural capability

Behavioural capability is the concept which notes the fact that the individual needs the knowledge and skills to be able to make a behavioural change (Owen at el, 1999). This could be related back to the point of whether nutritional knowledge affects nutritional behaviour. As research is inconclusive on whether nutritional knowledge impacts on nutritional behaviour this is a concept which needs more investigating in use with adolescents. However, if this concept is addressed along with the rest of those in the Social Cognitive Theory, an intervention may be more successful. Therefore adolescents should be given nutritional information so that they do indeed have the knowledge and skills to change their nutritional behaviour. However if nutritional education and information is to be given to adolescents it must be developmentally appropriate (Poolton, 1972). Younger adolescents do not have the cognitive skills and physical development that older adolescents have (Piaget, 1969) and consequently middle and older aged adolescents can make more decisions regarding food on the perceived outcome (Lytle, 1995) and have an ability to deal with more abstract ideas than younger adolescents who often have to deal in set, simple terms (Piaget, 1969). Adolescents in the age range of 12 – 20 years of age are often seen to be preoccupied with body appearance and functions, they exhibit independence in both food choice and personality, they can understand concepts about nutrition, and notice a conflict of health vs. taste when choosing foods (usually taste overcomes the decision making) and the opinion of friends and peers has a huge influence over food choice (Sigman-Grant, 2002). It has been noted that adolescents claim that they get their nutritional information from family (64.2%), the media for example magazines, television (49.7%) and school (38.4%) (Cupisti et al, 2002). This is important to consider in terms of designing interventions.

5.7.3. Expectations

Expectations are "beliefs about likely results of action" (Owen at el, 1999, pg. 184). These expectations about likely results may help to reinforce behavioural change. Interventions should give individuals information about likely changes that should occur as a result of the behavioural change. This relates back to the fact that adolescents are more likely to respond to the fact that their sporting performance may be improved as opposed to a change in risk of health problems which are seen later in life (Croll et al, 2006, Litt, 2004, Chapman & Toma, 1997, Knudsen, Nowak & Schultz, 1989, Poolton, 1972). The use of role models (as observational learning) may be appropriate in this concept as if an adolescent can see some of their expected results in another athlete, they may be more inclined to change their behaviour. It is suggested that this component of expectation can be demonstrated to individuals by describing others experiences, defining and measuring physical changes that occur, and identifying role models for the individual (Owen at el, 1999).

5.7.4. Observational learning

It is known that children and adolescents will mimic the behaviour of their parents (Ells et al, 2005, Ritchie et al, 2005). It is also proposed that a child's nutrition knowledge is increased when their parents know and acknowledge that nutrition is of large importance in a healthy lifestyle (Searles et al, 1986). This relates to the concept of observational learning which is defined as "beliefs based on observing others like self and/or physical results" (Owen at el, 1999, pg. 184). This is a valuable concept in adolescents as it is known that adolescents are generally impressionable and they may be able to be swayed in terms of knowledge and practice depending on the environment.

5.7.5. The role of the Environment

For successful interventions or programmes to occur with adolescents an intervention must target both the individual and the environment (Story et al, 2002). The family and friends (interpersonal level) of a targeted individual are an effective way of changing an adolescent's environment (Story et al, 2002, O'Dea, 2003). Interventions that have been used with adolescents in the past have clearly shown that if there is an environmental component targeted at parents the intervention is likely to be much more successful (Lytle, 1995, Parcel et al, 1988). The majority of interventions that have been successful in adolescents have been those that have made changes in the environment or have made educational efforts involving parents/caregivers (Hoelscher et al, 2002).

As well as parents, coaches are another influence that can be targeted when one is trying to influence the adolescent athlete and the environment in which they are situated. It has been suggested that scientifically correct nutrition information needs to be designed and targeted at coaches to increase their knowledge of specifically; fluid needs, supplement use and weight maintenance (Warren, Bonner & Stitt, 1985). It is clear that specific nutrition information needs to be developed for both adolescent athletes and their support personnel such as coaches and parents (Chapman & Toma, 1997, Benardot, 1996). This would ensure that coaches and parents can model ideal behaviour to adolescents. If the environment can be designed so that the coach, parents and nutritionist are all focused on encouraging dietary change in a way that emphasizes performance improvement the likelihood of a successful change is higher (Benardot, 1996). The use of high profile athletes as a role model here in designing interventions may also be useful.

The environment is not always a set location, it can mean the feeling of an environment and how this influences behaviour. Studies have shown that adolescents often associate healthy foods with being at home or with family, whereas unhealthy foods are associated with the relaxed environment of being with friends and a feeling of pleasure (Watt & Sheiham, 1997, Shepherd et al, 2006).

Another important environment to consider when looking at adolescents is that of the schooling environment. Friends and teachers are often thought of as providing nutrition education to adolescents however research suggests that friends and teachers have little influence in terms of providing nutrition information to this group (Watt & Sheiham, 1996). This could have implications in the design of a programme for adolescents as it may mean that education for a wider group of the athletes' community is needed.

5.7.6. Reciprocal determinism

Reciprocal determinism, as mentioned previously, is that the environment and the individuals' behaviour are reciprocal as the individual can play a role in controlling the environment in which they are located, but also that the environment also plays a role in determining behaviour (Story et al, 2002). The environment plays an important role in determining behaviour in adolescents as behavioural changes result from bidirectional flow between that environment and the individual (Owen at el, 1999). Owen at el, (1999) suggests that the professional application of this concept is to encourage the individual and significant others to change the environment and to stimulate and reward positive action. One such example of this is that adolescents have reported that if foods that were less expensive, better tasting and more convenient to them they would find it easier to make healthier choices (Neumark-Sztainer et al, 1999, California Project Lean, 1998, Story et al, 1986). Adolescents who eat lunch which is offered at school have often noted that the food is unhealthy and that they are not given healthier options to choose from (McDougall, 1998, Ross, 1995, Watt & Sheiham, 1996). They clearly perceive this to be a barrier to healthier eating (Shepherd et al, 2006). There have been interventions which have specifically targeted this change but it is not clear whether they have made substantial changes in dietary behaviour (Moon et al, 1999, Nicklas et al, 1998, Vartianen et al, 1991, Ellison et al, 1989, Perry et al, 1987, Vartianen et al, 1982).

5.7.7. Reinforcement

Reinforcement is an important part of the Social Cognitive Theory and is the "response to a person's behaviour that increase or decrease the chances of recurrence" (Owen at el, 1999 pg. 184). This is where to maintain or encourage a behaviour change it is important to provide responses to the individual to help them in determining behaviour. This includes giving praise, incentives or rewards, as well as encouraging self regard and confidence and trying to make sure that negative responses do not occur that deter the individual from making a positive change (Owen at el, 1999). As well as the sports nutritionist having a role here, parents/caregivers, coaches and other support personnel can play a role in reinforcing positive behaviour (Chapman & Toma, 1997). Friends have also been identified in one study as being the most unhelpful in terms of promoting a dietary change (Watt & Sheiham, 1996).

5.8. The Health Belief Model

The Health Belief model is a model which has a necessary component that the individual must believe that they have risk of developing a certain undesirable health condition because of their current behaviour, that the benefits of change outweigh the costs and that a change in dietary habits will lead to a decreased risk of that disease (Owen, 1999). The model contains a component of 'threat' which is determined by the individuals' perceived susceptibility to the disease/condition and the severity of which they perceive it could have (Owen, 1999). In addition to looking at a threat, individuals are encouraged to compare the benefits which may occur against the barriers or costs of change, and cues to action are used to encourage the individual or remind them of the threat (Owen, 1999).

Self-efficacy, as already mentioned as part of the social cognitive theory, is the confidence that an individual has to perform a certain behaviour (Owen, 1999), and is occasionally used as part of this model (Owen, 1999). Owen (1999) suggests that this model could be used with younger audiences by designing a model that presents specific information to show threats, and along with this add a strategy to change the risk of this threat. This would have to be considered carefully in designing for the adolescent group as it has been seen that adolescents are generally not motivated to change on the basis of a long term health consequence (Neumark-Sztainer et al, 1998, Nowak et al, 1998, Story et al, 1986). For adolescent athletes it may be more successful to modify the model so that the threat is not one of a health consequence but of a performance decrease and this may obtain more buy-in from the group.

5.9. The Theory of Planned Behaviour

The Theory of Planned Behaviour was introduced by Ajzen and Fishbein in 1980 after modifying the Theory of Reasoned Action which was developed in 1975. This model proposes that there are three main factors which impact on behavioural intention and eventually behaviour. The first of these is the attitude of the individual to the behaviour which is predicted by beliefs of the potential outcomes. The subjective norm is another important factor in this model and it describes the social pressure of what is normal behaviour on the individual. This may be influenced by others such as health professionals, friends, family and colleagues. The third important factor is that of self efficacy which has been described in the Social Cognitive Theory and the Health Belief model. This model has been used in studies where the consumption of foods can be predicted by the attitudes and beliefs that the individual holds about that food (Shepherd, 1988, Shepherd & Stockley, 1987, Axelson, 1985).

5.10. The Transtheoretical Stage of Change Model

The Stage of Change Model describes that there is a series of stages that an individual moves through when changing behaviour and that the factors which impact on the individual are often a unique mix (Worsley, 2002). These stages are; Pre-contemplation (where the individual has not thought about change and is unaware of any problems that may be present), Contemplation (where an individual is considering change in the future), Determination (as the individual is planning a behaviour change), Action (where the individual implements a specific plan for action), and Maintenance (where the individual aims to maintain the behaviour over time) (Owen, 1999). Although the Transtheoretical Stage of Change model has been used in behavioural change and interventions Sigman-Grant (2002) states that it has not been tested with adolescents so it would be "premature to expect this model itself to predict adolescent behaviour change" (pg S33), although the model could have an application when working with adolescents. As there are five distinct stages to this model it is possible to have specific applications for enhancing behaviour change for each of these (such as for the individual in the determination stage one can help by assisting in setting specific goals and developing a plan of action) (Owen, 1999) and this may be a way that this model could be used in full or part when designing interventions with adolescent athletes.

Conclusion

It is clear that adolescent athletes have nutritional requirements for growth and development, as well as sporting performance. Adolescent athletes are commonly observed with unsafe nutritional practices and they often fail to meet current dietary guidelines. It is unclear whether nutritional knowledge affects nutritional behaviour as research is conflicting on this topic. Part of the research on this topic shows that nutritional knowledge does have a positive impact on nutritional behaviour (Pirouznia, 2001, Wardle et al, 2000, Read et al, 1988, Saegert & Young, 1983, Cho & Fryer, 1974) however other research conflicts this by showing no association between knowledge and behaviour (Stafleu et al, 1996, Borra & Regan, 1994, Schlicker, Borra & Regan, 1994, Contento, Manning & Shannon, 1992, Shepherd & Towler, 1992, Potter & Wood, 1991, Halverson, 1987, Shepherd & Stockley, 1987, Story & Resnick, 1986, Axelson et al, 1985). The conflict in these results may be due to methods used in the research not being valid for the research being performed (Wardle et al, 2000, Worsley, 2002). The methods used to measure knowledge may not be tested psychometrically or validated (Wardle et al, 2000) and the size of the studies may not give statistically significant results (Wardle et al, 2000, Worsley, 2002).

Further research into how adolescent athletes rate and perceive sports nutrition is vital to improving sporting performance by designing interventions which work to improve both nutritional knowledge and practice. When designing interventions for adolescents there are behavioural concepts that need to be considered. Interventions with adolescents in the past have had mixed results (Story et al, 2002) and it is clear from limited previous research that adolescents do not respond to long-term risks on health, but are more likely to respond to a performance based goal. Therefore when designing interventions with this group this is a point which needs to be considered carefully. Clear factors which need to be addressed in interventions with adolescents are as follows: males are more interested in gaining or maintaining weight, whereas females are more concerned with weight loss and body shape instead of acquiring an adequate energy intake for their sport, adolescents model behaviour off other adults, are impressionable and interventions should be developmentally appropriate for the age of the adolescent individual.

Because of the variety of influences on adolescent nutritional knowledge and nutritional behaviour it is also clear that the approach to an adolescents nutritional behaviour and implementation of changes to it is necessary to be a whole team approach with the athlete having accurate and tailored support from the sports nutritionist, parents/caregivers, coaches and other team support staff to implement and maintain positive nutritional changes (Benardot, 1996). The ANKAA study is not a study designed to evaluate change in behaviour, nor is it an intervention study. It aims to investigate the current level of basic and sports nutrition knowledge and the nutrition education that adolescent athletes have received. A program can then be developed in conjunction with these results.

Materials and Methods

6.1. *Subjects*

Letters were sent to ten national sporting organisations (NSO's) describing the study and asking if they would give permission for their athletes who met the entry criteria to take part in the study. The ten sports were chosen as they encompassed a range of both team and individual sports, and sports which are generally gender specific. Sporting organisations were asked to provide contact details of athletes who met the entry criteria for the project. The entry criteria included that athletes needed to be between the ages of 13 and 20 years old as at the 1st of January 2007, and be considered a talented or elite athlete in their chosen sport by being a carded athlete, or part of a High Performance Academy Group, Regional Talent Identification Group or an equivalent Development group. A carded athlete is an athlete that is provided with support from SPARC and is deemed to be of elite level. Sporting organisations who agreed to participate in the study were asked to forward contact details of athletes who met the criteria to an independent third party research assistant. This preserved confidentiality of contact details.

Five sporting organisations agreed to take part in this research; Basketball New Zealand, Netball New Zealand, New Zealand Football, New Zealand Rugby Union, and New Zealand Underwater Hockey. A total of 100 athletes took part in the research.

6.2. *Ethical considerations*

The study was given ethical approval by the Massey University Committee of Ethics (ref 07/52). Subjects who took part in the study were asked to sign a consent form indicating their consent for their results to be used in the ANKAA study. Subjects who were 16 years or younger were also required to have parental consent to take part in the research. Subjects who attended the focus group were considered to have given consent by participating in the activity. All consent forms, completed questionnaires and focus group question sheets were stored either by the author's supervisor or the author in a locked area to ensure the information remained confidential.

6.3. *The Questionnaire*

The questionnaire was developed to address four different aims. Section A aimed to assess the basic nutritional knowledge of the subjects. Section B aimed to investigate influences on food choice and food availability of the subjects. Section C was designed to assess the basic sports nutrition knowledge and practices of the subjects and section D gathered basic demographic information about the subjects.

The questionnaire was developed using previous research questions modified from Parmenter and Wardle (1999), Cuspiti et al (2002) and Turconi et al (2003) and newly developed questions. The questionnaire designed and validated by Zinn et al (2004) was not available at the stage of questionnaire development so was not used in the ANKAA study. A pilot trial of the questionnaire was conducted with athletes of the same age and who participated in the same ten sports as the targeted population and changes were made to questions which were unclear before sending to the actual subject group. Changes included rewording four questions so that they were appropriate for the age group in this study. Due to time constraints validity and reliability tests were not able to be performed. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge, and those who did not have any knowledge the questionnaire used 'yes', 'no' and 'unsure' answers. A copy of the questionnaire can be seen in Appendix 1.

6.4. *Procedure*

The independent research assistant used the contact details from NSO's to create two sets of address labels for each contact. The first set was used to send the initial questionnaire pack which included a participant information sheet, a participant consent form, a parental information sheet, a parental consent form, a questionnaire and a return envelope.

The questionnaires were coded to identify which participants had returned their questionnaire. The independent research assistant followed up the athletes who had not returned the questionnaire phone call. When the unnamed questionnaires were received by the independent research assistant they were removed from the envelopes and passed on to the student researcher to ensure confidentiality of the subjects and their responses.

6.5. *Focus groups*

The second set of address labels were used in the organisation of focus groups. One invitation to participate in the focus groups arranged in Christchurch, Wellington, Palmerston North and Auckland in December 2008 was sent out to all participants and did not receive any responses to attend. This may have been due to being in close proximity to Christmas so another round of focus groups was planned for February 2009. Although there were few respondents there were not enough to warrant a focus group at this time either. Instead the Manawatu Rugby Academy volunteered to run a focus group with their academy players (some of who had previously completed the questionnaire for this research). There were nine players, and their sports nutritionist present.

The author ran the focus group and asked the rugby players for information on a number of topics including; websites as a source of nutrition information, recipes books and cooking resources, written resources, presentations and group workshops, and other comments on nutrition education. The focus group investigated these questions as the time available was limited to 60 minutes and it was deemed that investigating resources with this group of athletes would add to the results of the questionnaire that all 100 ANKAA subjects completed. A number of questions were developed for use in the focus group by the researcher to prompt the athletes with the aim of initiating discussion. This question sheet was given to the players to make notes on throughout the focus group and can be seen in Appendix 2. Several props were used including cookbooks and pamphlets/booklets to promote discussion. The information provided by the rugby players was recorded with a recording device which was later transcribed by the author and used in conjunction with the answers that players had added on their question sheet.

6.6. Data analysis

Analysis of the questionnaires was carried out to provide results. The questionnaire results were coded as +1 for a correct answer, 0 for an incorrect answer and 'u' for unsure. The focus group answers were coded using a yes/no system (+1=yes, 0=no) where applicable or when comments were added these were separated into groups based on similar themes in answers. The data was input to Microsoft Excel and then imported into SPSS. The data was analysed with SPSS v14.0. The data was examined using a Chi-Squared (x^2) statistic test to assess the frequency and association between variables. Statistical significance was pre-determined as $p \leq 0.05$.

The main outcomes to be defined were:

- The number of correct answers for basic nutrition knowledge
- The number of correct answers for sports nutrition knowledge
- The relationship between food skills and nutrition behaviour
- Attitudes towards sports nutrition
- The most preferred source(s) of nutrition education
- The most favoured nutrition resources (through the focus group)

6.7. *Dissemination of results*

A summary of the results were sent to all of the participants and the NSO's who had athletes participate in the research. Summary sheets were also sent to sports nutritionists currently working in New Zealand.

Results

The results from the questionnaire were separated into nine distinct groups based on how they related to the research aims. These were 1) the basic demographics of the subject group; 2) results of basic nutrition knowledge; 3) results of food skills and influences; 4) supplement usage results; 5) attitudes towards sports nutrition; 6) sports nutrition knowledge and practice; 7) results of sports drink knowledge and usage; 8) previous sources of nutrition education, and 9) results of the focus group.

7.1. *Basic demographic results*

100 athletes from five sports returned questionnaires for this research. The distribution of sport, gender and age of the subjects are shown in table 7.1.1.

Table 7.1.1: The distribution of sport, gender and age of participants in study.

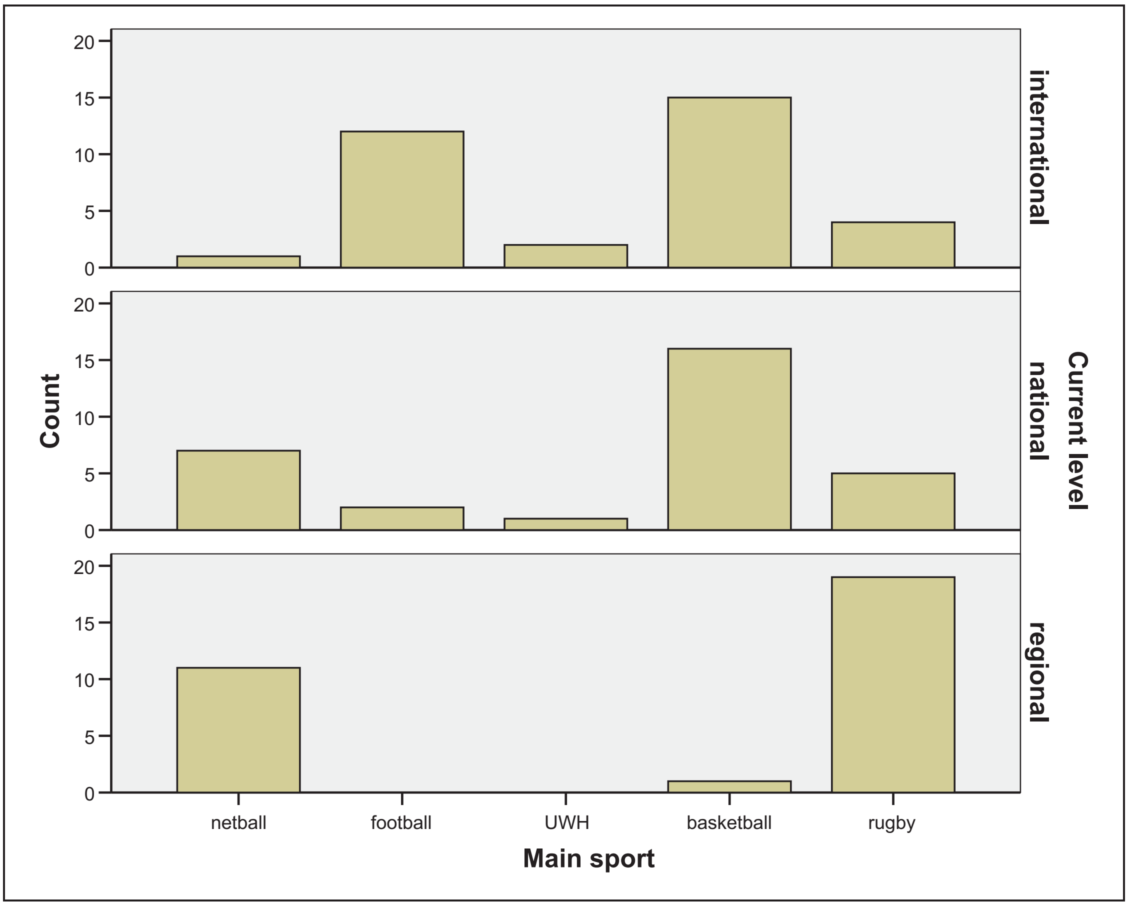
Sport	TOTAL	Male	Female	Mean age of athletes (years)
Basketball	34	1	33	15.26 (std error or mean = .25) std dev 1.44
Football	14	7	7	15.93 (std error of mean = .25) std dev 0.92
Netball	19	0	19	16 (std error of mean = .15) std dev 0.67
Rugby	28	28	0	19.04 (std error of mean = .22) std dev 1.12
Underwater Hockey (UWH)	3	3	0	18 (std error of mean = 0.0) std dev 0
TOTAL	100	39	59	16.6 years (std error of mean = .20) std dev 1.94

* 2 data cases missing

7.1.1. Mean age and level of competition

The mean age of all of the athletes was 16.6 years (standard deviation (std dev) 1.94). The subjects were spread relatively evenly over the three levels of competition, with slightly more competing at an international level. A breakdown of the sports and level of the subjects can be seen in Graph one.

Graph one: A representation of the level of competition in which subjects partake for each sport



7.1.2. Living situation and level of schooling

83% of the athletes live at home, while 11% live in a situation with others of the same age range in a rented home, and the rest live in a hostel or 'other' situation. The athletes had various education levels, defined by schooling level shown in table 7.1.2. The standard deviation is 7.59.

Table 7.1.2: Level of schooling of athletes * Finished school but not attending University, ** 3 cases missing

Year of schooling	Year 9	Year 10	Year 11	Year 12	Year 13	University	No Uni*
% of athletes	2.0%	11%	19%	23%	13%	10%	19%

7.1.3. Athletes who compete in more than one sport

55.8% of the athletes compete in more than one sport, with athletes from netball (68.4%) and basketball (61.76%) more likely to partake in more than one sport. Rugby (39.2%) and UWH (33.3%) were the least likely to take part in more than one sport. However, the UWH group is not large enough to get a clear result.

7.2. Basic nutrition knowledge

The subjects were asked a number of questions on basic nutrition knowledge with an emphasis on identifying food components and the role of these components in health and performance. The results of these questions are as follows;

7.2.1. Food components

When asked about the roles of a number of the food components, the subjects showed differing levels of knowledge. When asked which food component contained the most energy, 88% of the subjects incorrectly stated that carbohydrates, protein or alcohol had the most energy of the food component options given (alcohol, protein, carbohydrates and fat). Only 4 % were correct in agreeing that fat has the highest amount of energy with the remainder unsure.

7.2.2. Fat

91% of the participants knew that eating too much fat can increase your body fat levels. Sixty nine percent knew that most of the fat that an individual eats should be unsaturated fat and most were able to define each of the following foods in terms of if they were high in saturated fat as seen in table 7.2.1.

Table 7.2.1: Overall results of Question A.4. Are these foods high in saturated fat?

Food	**Yes, it is high in saturated fat**	**No, it is not high in saturated fat**	**Unsure**	**Standard deviation**	**Actual answer**
Almonds	31%	51%	18%	0.49	False
Chocolate	65%	16%	19%	0.40	True
Coconut cream	65%	13%	22%	0.38	True
Cream	60%	19%	21%	0.43	True
Olive Oil	38%	40%	22%	0.50	False
Potato chips	80%	10%	10%	0.32	True

7.2.3. Protein

Generally the participants had adequate knowledge about protein and its role in the body – when asked in question A3 76% knew that milk and dairy products were a source of protein, along with 76% knowing that meat was a good source of protein. When the participants were asked again to distinguish foods high in protein, 43% agreed that low fat milk was high in protein. 65% also knew that vegetarians could consume enough protein without meat products. Participants were generally correct in identifying high protein foods as seen in table 7.2.2.

Table 7.2.2: Overall Results of Question A.5. Are these foods high in protein?

Food	**Yes, it is high in protein**	**No, it is not high in protein**	**Unsure**	**Standard deviation**	**Actual answer**
Baked Beans	73%	15%	12%	0.38	True
Broccoli	39%	49%	12%	0.50	False
Chicken Breast	83%	5%	12%	0.24	True
Low Fat Milk	43%	40%	17%	0.50	True
Wholegrain Bread	37%	46%	17%	0.50	False

7.2.4. Carbohydrate

95% of the subjects knew that carbohydrates are found in the breads and cereals food group, but only 57% of the participants could identify that fruits and vegetables were also a good source of carbohydrate. 90% of the participants knew that carbohydrates are a main fuel source for the body and 42% knew that carbohydrates were stored as glycogen. 42% of the subjects were able to correctly identify that the glycaemic index is a ranking of "the rate of release of carbohydrate into the bloodstream". Results of overall basic nutritional knowledge questions, which included questions on each of the food components and vitamins and minerals, can be seen in table 7.2.3.

Table 7.2.3: Overall results of basic knowledge questions

Actual statement	**% who knew the correct answer**	**Standard deviation**	**Correct answer**
Carbohydrates are found in breads and cereals	95%	0.10	T
Carbohydrates are a main fuel source for the body	90%	0.26	T
Carbohydrates play a major role in muscle recovery	59%	0.47	T

Sugar is not a carbohydrate	45%	0.50	F
Eating carbohydrate can increase your body fat level	71%	0.40	T
Fruits and vegetables contain carbohydrates	57%	0.48	T
Lollies are a good source of carbohydrate	27%	0.50	T
Carbohydrates are stored as glycogen	42%	0.48	T
Potatoes should be avoided in your diet	83%	0.33	F
Fruit and vegetables are a good source of protein	46%	0.50	F
Protein plays an important role in muscle recovery	74%	0.40	T
Vegetarians cannot eat enough protein without meat	65%	0.37	F
Milk and dairy products do not contain protein	76%	0.34	F
Meat only contains very small amounts of protein	76%	0.46	F
Eating too much fat can increase your body fat levels	91%	0.36	T
Fat is used by the body when doing low intensity exercise	39%	0.50	T
Fat should be eaten during an event as a snack for energy	57%	0.49	F
Most of the fat that you eat should be unsaturated fat	69%	0.42	T
Water makes up 50% of the human body	48%	0.5	F
Water is used as a transport system in the body	48%	0.47	T
If you are thirsty you are already dehydrated	83%	0.27	T
The colour of your urine is a good indication of hydration status	93%	0.32	T
A calorie is the same as a kilojoule	42%	0.43	F

7.2.5. Vitamins and minerals

42% of the subjects correctly identified the function of vitamins and minerals to catalyze biological reactions. 73% of the subjects identified tiredness/fatigue to be one of the symptoms of iron deficiency. 55% identified a decreased athletic performance, while only 14% identified breathlessness as a symptom of iron deficiency.

7.2.6. Comparing the overall results for basic nutrition knowledge by sport and gender

The scores were tallied and compared for the groups of sports. UWH athletes had the highest number of correct responses but the very small sample size of this group means that this group is statistically underpowered. Football was seen to have the next highest correct response rate, followed by netball and then rugby. These results are given in table 7.2.4.

Table 7.2.4: Percentage of correct responses to questions on basic nutrition knowledge by specific sport.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	60.99 % Std dev 3.35	68.32 % Std dev 2.43	63.20 % Std dev 4.43	66.36% Std dev 2.96	78.26 %* Std dev 2.00

* UWH sample size much smaller

When comparing gender no significant difference (p=0.16) was seen in the basic nutrition knowledge between the females and males taking part in this research. The females scored a total of 62.71% correct answers (SD=3.12). The males had a total of 64.99% correct answers (SD=4.13).

7.3. Food skills and influences on food choice

Influences on food choice were investigated in the questionnaire and the subjects asked to rank the given influences in order of most important to least important. The results of the most important influence on food choice for each sport are shown in table 7.3.1.

Table 7.3.1: Number one influence on food choice by sport

Influence	Sports				
	BBall (n= 34)	**Football (n= 14)**	**Netball (n= 19)**	**Rugby (n= 28)**	**UWH (n= 3)**
Taste	44.1%	35.7%	36.84%	34.62%	33.3%
Appearance of the food	-	-	15.79%	7.69%	-
Cravings	11.76%	7.14%	5.26%	38.24%	-
Advertising	-	-	-	3.85%	-
Cultural aspects	8.82%	-	-	3.85%	-
Influence of parents	14.71%	7.14%	26.32%	3.85%	-
Influence of coach	-	-	-	-	-
Influence of friends	2.94%	-	-	-	-
Convenience	5.89%	14.3%	10.53%	3.85%	-
Other:					
Healthy	2.84%	14.3%			66.7%
No reason given	8.82%				
Nutritionist		7.14%			
Cost		7.14%			
Activity		7.14%	5.26%		

What I feel like				3.85%	

7.3.1. Involvement in food preparation

To gain an insight into adolescent athlete food skills the athletes were also asked to indicate if they were involved in food preparation. The results of this question are shown in table 7.3.2 along with results of an overall self ranking of cooking skills, the mean age of each group, and the percentage of gender. The results of the percentage of those subjects who had previously had a cooking session are also included in table 7.3.2. There was no significant difference between food preparation skills and sport (p= 0.49).

Table 7.3.2: Athletes who are involved in food preparation with age, gender, ranking of cooking skills and most prevalent living situation.

Question	**Sports**					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**Overall**
Percentage of athletes who prepare food	57.1%	71.4 %	50%	74%	66.7%	63.9% (SD= 0.48)
Overall rating of cooking skills (1= nonexistent, 10= excellent)	5.43	5.5	4.85	6.43	7.67	5.67 (SD= 2.27)
Percentage of males	3%	50%	0%	100%	100%	39% (SD= 0.49)
Percentage of female	97%	50%	100%	0%	0%	59% (SD= 0.49)
Mean age	15.26 years	15.93 years	16 years	19.04 years	18 years	16.6 Years (SD=1.94)
Most prevalent living situation	94.1% living at	92.8% living at	100% living at	60.7% living at	66.7% living at	85.57% living at

	home	home	home	home	home	home (SD= 0.35)
Percentage who have had a group cooking session	22.86%	7.69%	5.26%	17.9%	0%	39.4% (SD= 0.49)

7.4. *Supplement usage*

Subjects were asked to indicate if they used supplements, why they did or did not, and who recommended these. 19% of the subjects reported use of multivitamins and minerals, with 3% stating they used them sometimes. They were recommended to the athletes mainly by 'mum', 'parents' or 'family' (13%), whilst the coach had recommended them in 2% of the cases and the trainer and nutritionist 1% of the cases.

7.4.1. Reasons for supplement usage

Reasons for taking multivitamins were described by the athletes as; "to stay healthy and keep my vit C up", "to assist with intake of vitamins", "mum and dad make me", "gives me energy", "to get more energy or recover faster", "I think it might help", "keeps me healthy", "keeps you healthy", "to help recover when im sick", "to get bigger" (interestingly this athlete was advised by their trainer to take the multivitamin)", "just cause", and "to help recover and replace" (again interestingly this athlete was advised by a sports nutritionist). One athlete also said that they take Berocca® energy "to get hyped up and in the zone".

Two athletes were taking iron supplements. One of these athletes was a football player and noted that these were recommended by a doctor due to a diagnosed iron deficiency. The other athlete was a netball player and gave her reason for supplementing with iron as "I don't know - mum just said to take them if I want to, and they taste really nice!" One athlete took echinacea to "prevent sickness"

12% of the subjects reported using supplements other than multivitamins regularly and another 4% reported using them sometimes. These are shown in table 7.4.1.

Trainers were those who most recommended these supplements, recommending 5% of these cases, a nutritionist recommended 1%, and mum recommended 1% of the cases. 2% of the subjects were unsure of who had recommended that they take these supplements and the rest did not give an answer to this question. Four of the rugby athletes were advised to take supplements by their fitness trainer. These supplements included protein, creatine, iso stack, H blocker, and mutant mass. One rugby athlete stated that his fitness trainer and nutritionist had advised him to take protein as a supplement. Two other rugby athletes noted that they took protein, BCAA's, creatine but did not give details of who had recommended these supplements.

Table 7.4.1: Supplements used by subjects and who recommended these to the athlete.

Supplement	**Number of participants**	**Recommended by**
Creatine	3	2 - Fitness Trainer, 1 - Unknown
Protein	5	1 - Fitness Trainer and Nutritionist
BCAA's	1	Unknown
Isostack	1	Fitness Trainer
H Blocker	1	Fitness Trainer
Mutant Mass	1	Fitness Trainer
Berocca	1	Unknown
Echinacea	1	Unknown

7.5. Attitudes towards sports nutrition

The subjects were surveyed on their attitudes to sports nutrition with a large percentage showing a favourable attitude towards sports nutrition. The overall results of these questions can be seen in table 7.5.1.

Table 7.5.1: Overall results of attitudes to sports nutrition

Attitudes towards Sports Nutrition	**Percentage of athletes**
Importance of Sports Nutrition question: "How important do you consider sports nutrition to be in your sporting plans?"	
Very important Slightly important Very/slightly important Not important	79% 16% 2% 2%

Belief in Sports Nutrition to improve performance question: "Do you believe that specific sports nutrition strategies could improve your performance?"	
Yes definitely Maybe No Standard deviation	88% 12% - 0.29
Average rating of sports nutrition knowledge question: "How would you rate your sports nutrition knowledge on a scale of 1 (non-existent) to 10 (excellent)?"	
Rating Standard deviation Variance	5.87 1.58 2.51

The sport specific results of attitudes towards sports nutrition can be seen in table 7.5.2. Graph 2 shows athlete attitudes towards sports nutrition and rating of self knowledge. There was no significant difference in attitude towards sports nutrition by sport (p= 0.89). There was no significant difference in sports nutrition attitude by self rated knowledge (p= 0.59).

Table 7.5.2: Sport specific attitudes to sports nutrition

	Sports				
Question	**BBALL**	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Importance of sports nutrition					
Very important	83.3%	78.6%	68.4%	78.6%	100%
Slightly important	11.1%	14.3%	21.1%	21.4%	-
Very/slightly important	2.8%	7.1%	-	-	-
Not important	-	-	10.5%	-	-
Belief in sports nutrition to improve performance					
Yes definitely	82.9%	85.7%	94.7%	96.4%	100%
Maybe	17.1%	14.3%	5.3%	3.6%	-

Rating of knowledge					
Average rating Standard deviation Variance	5.76 1.555 2.417	6.50 1.387 1.923	5.76 1.719 2.955	5.64 1.632 2.664	7.0 1.000 1.000

7.6. Sports nutrition knowledge and practice

As well as being questioned on basic sports nutrition the subjects were questioned on specific sports nutrition practices. The subjects were asked if the sports nutrition guidelines for adolescent athletes were different to those given to adults. 18.4% of the subjects stated that nutritional guidelines for adolescents were not different to those given to adults. 50% stated that the nutritional guidelines for adolescent athletes were different to those of adults, whilst 31.6% of the subjects were unsure of whether guidelines for adolescent athletes were different from adult athletes.

7.6.1 Overall sports nutrition knowledge

The overall results for sports nutrition knowledge are seen in tables 7.6.1 and 7.6.2.

Table 7.6.1. Results of Question C.4. Do these help improve sporting performance?

Do these help improve sporting performance?	Agreed YES	Agreed NO	Unsure	Standard deviation	Actual answer
Eating carbohydrates 2 - 4 hrs before an event	88.9%	7.1%	4.0%	1.62	TRUE
Eating protein 2 – 4 hrs before an event	52%	29.6%	18.4%	0.48	FALSE
Eating carbohydrates 1 – 2 hrs before an event	53.5%	33.3%	13.1%	0.49	FALSE
Taking a multivitamin before an event	22.2%	39.4%	38.4%	0.48	FALSE
Drinking water immediately before an event	60.6%	32.3%	7.1%	0.48	TRUE
Drinking a caffeinated energy drink before an event	14.1%	76.8%	9.1%	0.36	FALSE
Eating protein during the event	21.4%	62.2%	16.3%	0.44	FALSE
Eating carbohydrates during the event	63.3%	26.5%	10.2%	0.46	TRUE

Drinking a sports drink during the event	87.8%	7.1%	5.1%	0.27	TRUE
Drinking Coca Cola during the event	5.1%	87.8%	7.1%	0.23	FALSE
Drinking fruit juice during the event	21.6%	64.9%	13.4%	0.44	FALSE
Taking iron supplements without having iron deficiency	5.1%	59.2%	35.7%	0.28	FALSE

Table 7.6.2. Results of Question C.5. Are these TRUE or FALSE statements?

Are these statements TRUE or FALSE	**Agreed to True**	**Agreed to false**	**Unsure**	**Standard deviation**	**Actual answer**
There is 50grams of carbohydrate in a banana	21.6%	9.3%	69.1%	0.47	TRUE
Dehydration can affect sporting performance	96.9%	1.0%	2.0%	0.10	TRUE
Blury vision is a sign of dehydration	75.8%	5.3%	18.9%	0.25	TRUE
The 'stitch' is a sign of dehydration	27.1%	46.9%	26.0%	0.49	FALSE
Sports drinks contain carbohydrates	68%	15.5%	16.5%	0.39	TRUE
Sports drinks contain salt	63.3%	12.2%	24.5%	0.37	TRUE
Sports drinks contain fat	22.4%	56.1%	21.4%	0.46	FALSE
Caffeine improves running speed	76.5%	5.1%	18.4%	0.24	TRUE
Caffeine can improve concentration during a sports event	12.4%	56.7%	30.9%	0.39	TRUE
Having bacon and eggs for breakfast before an event is ideal.	11.2%	57.1%	31.6%	0.36	FALSE

The overall results for sports nutrition knowledge for each sport are shown in table 7.6.3. There was no significant difference in sports nutrition knowledge between the genders (p=0.16).

Table 7.6.3: Percentage of correct responses to questions on sports nutrition knowledge by specific sports.

Sport	**Basketball**	**Football**	**Rugby**	**Netball**	**UWH**
% answers correct	38.73% Std dev 0.50	37.1% Std dev 0.54	42.26% Std dev 0.50	43.86% Std dev 0.50	47.33%* Std dev 0.51

* UWH sample size much smaller

Table 7.6.4: Percentage of correct responses to questions on sports nutrition knowledge by gender

Gender	Female	Male
% answers correct	48.46% Standard deviation 0.5	54.29% Standard deviation 0.7

7.6.2. The role of protein in sports nutrition

74% of the athletes knew that protein plays an important role in muscle recovery however there were varying responses to the role of protein in increasing muscle, where 68.2% incorrectly thought that eating a high protein diet, and only 17.5% correctly knew that eating more overall increased muscle mass. The overall results of this question can be seen in table 7.6.5.

Table 7.6.5: Overall results on the role of protein in increasing muscle mass

Answer	Percentage who agreed to the statement	Correct answer	Standard deviation
Eating a very high protein diet	68.2%	False	0.47
Eating more overall	17.5%	True	0.38
Having protein shakes after every workout	40.2%	False	0.49
Weight training	63.9%	True	0.48
Eating egg whites after every meal	21.6%	False	0.41

7.6.3. Knowledge of recommendations for timing and amount of food or fluid

The subjects were also asked to identify the correct recommendations for timing associated with training and competing. The results of the knowledge of these recommendations overall and for each sport are shown in Table 7.6.6.

Table 7.6.6: The results of athlete's knowledge of the recommended guidelines for food and fluid before, during and after exercise.

Question	Sports					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**TOTAL**
Pre event food (Question C.13.)	8.82%	0%	15.79%	0%	33.33%	5.10%

During event fluid (Question C.15.)	17.65%	21.34%	26.32%	17.86%	0%	20.14%
During event food (Question C.16.)	14.75%	7.14%	10.53%	17.86%	33.33%	14.29%
Recovery food (amount) (Question C.19.)	17.65%	14.29%	42.10%	14.29%	0%	17.5%
Recovery food (when) (Question C.20.)	91.18%	64.29%	42.10%	71.43%	100%	77.1%

7.7. Sports Drinks

7.7.1 Reported use of sports drinks

85.7% of the athletes reported that they use a sports drink. 14.3% did not use sports drinks. The sports drinks that these 85.7% of the subjects used are shown below in table 7.7.1. 26.8% of the athletes reported using more than one sports drink.

Table 7.7.1: Percentage of athletes who report using specific named sports drinks

Sports Drink	Percentage of athletes who report using the named sports drink
PowerAde	82.9%
Horley's Replace	23.2%
Endura	1.2%
Gatorade	8.5%

* athletes often gave more than one response to this question

7.7.2. Reasons for using sports drinks

The subjects gave varied answers to question C18 which was used to identify the reasons for the subjects using sports drinks. These reasons (given for each different sports drink) are shown in table 7.7.2.

Table 7.7.2: Reasons that subjects use the named sports drinks

Sports drink	A sample of athletes reasons for Sports Drink usage
PowerAde®	Taste Reputation Recommended or told to use it Electrolytes for faster rehydration and recovery Retain losses of water Unsure
Horley's Replace®	Helps or stops cramping Taste Knowledge that it works Avoid dehydration Replace electrolytes
Endura®	Replace electrolytes
V*	Helps personally

**V is not regarded to be a sports drink as it contains more than 8% carbohydrate but this answer is used in this table to demonstrate that young athletes may perceive it to be a sports drink.*

7.7.3. Identifying the functions of a sports drink

Subjects were also asked to identify the functions of a sports drink. Over 50% of the subjects knew that using a sports drink makes the body retain fluid and that it replaces carbohydrates. Only 37.1% knew that a function of a sports drink was to replace sodium, yet 50.5% agreed that a sports drink replaces sweat. When asked in another question 68% of the subjects stated that sports drinks contain carbohydrates, 63.3% stated that they contain salt (compared to 37.1% saying it replaces sodium), and 22.4% thought that they contained fat (in question C.23. 8.2% of the subjects thought that a function of a sports drink was to burn body fat). 24.5% were unsure whether sports drinks contained salt, whereas 16.5% were unsure if sports drinks contained carbohydrates. Just over half of the subjects knew that sports drinks did not contain fat (56.1%). Full results of this question can be seen in table 7.7.3.

Table 7.7.3: Results of questions on the functions of a sports drink

Answer	Percentage of athletes who agreed with the statement	Standard deviation	Correct response
It makes the body retain fluid	52.6%	0.52	TRUE
It helps to burn body fat	8.2%	0.28	FALSE
It replaces sweat	50.5%	0.50	TRUE
It tastes good compared to water	40.2%	0.49	TRUE
It replaces sodium	37.1%	0.49	TRUE
It replaces carbohydrates	58.8%	0.50	TRUE
It replaces protein	12.4%	0.33	FALSE
It is a source of water	35.1%	0.48	TRUE

7.8. Previous sources of nutrition education and methods of education for the future

7.8.1. Previous sources of nutrition education

47.9% of the athletes reported that they had had prior sports nutrition experience, whilst 52.1% stated that they had not had any prior sports nutrition experience. The sources of the subjects' previous nutrition education are given in table 7.8.1. Results of previous nutrition education by sporting code are given in table 7.8.2.

Table 7.8.1: Overall results of sources of previous nutrition information

Source of information	Overall percentage of athletes who have used this source of information in the past	Standard deviation
Sports nutritionist	77%	0.41
Coach	62%	0.49
Fitness trainer	49%	0.50
Parents	44%	0.50
School Teachers	32%	0.47
TV	30%	0.46
Dietitian	29%	0.46
Dr	26%	0.44
Fellow competitors	22%	0.42
Magazines	21%	0.41
Internet sites	18%	0.39

Friends	14%	0.35

Table 7.8.2: Results of what methods of nutritional advice/education athletes have received in the past by sport.

Session Type	Percentage of athletes by sport, who have received this method of nutritional advice				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	17.14% (SD= 0.38)	30.77% (SD= 0.48)	26.32% (SD= 0.45)	10.7% (SD= 0.50)	0% (SD= 0.0)
Supermarket Tour	25.71% (SD= 0.44)	30.77% (SD= 0.48)	10.53% (SD= 0.52)	57.1% (SD= 0.39)	33.3% (SD= 0.38)
Group cooking session	22.86% (SD= 0.43)	7.69 (SD= 0.28)	5.26% (SD= 0.23)	17.9% (SD= 0.48)	0% (SD= 0.0)
Group workshop	77.14% (SD= 0.43)	15.38 (SD= 0.38)	36.84% (SD= 0.50)	32.1% (SD= 0.51)	0% (SD= 0.0)
Menu plans developed	45.71% (SD= 0.51)	69.23 (SD= 0.48)	57.89% (SD= 0.51)	50% (SD= 0.42)	33.3% (SD= 0.58)
Hydration workshops	25.71% (SD= 0.44)	46.15 (SD= 0.52)	15.79% (SD= 0.37)	21.4% (SD= 0.42)	100% (SD= 0.0)
Athlete as a guest speaker	8.57% (SD= 0.28)	30.77 (SD= 0.48)	21.05% (SD= 0.42)	21.4% (SD= 0.44)	33.3% (SD= 0.58)
Nutrition Quiz session	51.43% (SD= 0.51)	69.23 (SD= 0.48)	26.23% (SD= 0.45)	25% (SD= 0.36)	33.3% (SD= 0.58)

7.8.2. Methods of education that the subjects have received and what they would like in the future

The subjects were asked to identify what nutrition sessions they had partaken in the past, and what they would like to use in the future. Table 7.8.3 shows the overall results for these questions and graph 3 diagrammatically shows these results.

Table 7.8.3: Overall results of what methods of nutritional advice/education athletes have received in the past and what methods of nutritional advice/education they would like to receive in the future.

Session Type	**Percentage of athletes who have had this method of nutritional advice**	**Percentage of athletes who would like to receive this method of nutritional advice**
Individual session with a sports nutritionist/dietitian	35.4% (SD= 0.48)	73.68% (SD= 0.48)
Supermarket Tour	16.2% (SD=0.37)	26.23% (SD= 0.45)
Group cooking session	39.4% (SD= 0.49)	31.58% (SD= 0.50)
Group workshop	47.5% (SD= 0.50)	47.37% (SD= 0.45)
Menu plans developed	35.4% (SD= 0.48)	N/A
Hydration workshops	17.2% (SD= 0.38)	15.79% (SD= 0.34)
Athlete as a guest speaker	40.4% (SD= 0.49)	52.63% (SD= 0.49)
Nutrition Quiz session	17.2% (SD= 0.38)	15.91% (SD= 0.29)
Lectures	N/A	15.79% (SD= 0.41)
Written resources	N/A	42.11% (SD= 0.48)
Recipe lists	N/A	31.58% (SD= 0.50)
Interactive website	N/A	21.05% (SD= 0.34)

It was important to ask the subjects what education methods they would like in the future and determine if any differences were seen between sports. The results of this question can be seen in table 7.8.4.

Table 7.8.4: Results of what methods of nutritional advice athletes would like to receive in the future by sport.

Session Type	**Percentage of athletes by sport, who have would like to receive this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	0% (SD= 0.0)	0% (SD= 0.0)	73.68% (SD= 0.45)	78.6% (SD= 0.42)	0% (SD= 0.0)
Supermarket Tour	59.24% (SD= 0.51)	46.15% (SD= 0.52)	26.23% (SD= 0.45)	57.1% (SD= 0.47)	0% (SD= 0.0)

Group cooking session	41.18% (SD= 0.50)	76.92% (SD= 0.44)	31.58% (SD= 0.48)	78.6% (SD= 0.50)	100% (SD= 0.0)
Group workshop	5.88% (SD= 0.24)	0% (SD= 0.0)	47.37% (SD= 0.51)	14.3% (SD= 0.44)	0% (SD= 0.0)
Hydration workshops	8.82% (SD= 0.29)	16.67% (SD= 0.34)	15.79% (SD= 0.37)	10.7% (SD= 0.36)	33.3% (SD= 0.58)
Athlete as a guest speaker	8.82% (SD= 0.29)	15.38% (SD= 0.38)	52.63% (SD= 0.37)	14.3% (SD= 0.44)	33.3% (SD= 0.58)
Nutrition Quiz session	23.53% (SD= 0.43)	30.77% (SD= 0.48)	15.91% (SD= 0.37)	28.6% (SD= 0.36)	0% (SD= 0.0)
Lectures	26.47% (SD= 0.45)	23.08% (SD= 0.44)	15.79% (SD= 0.37)	25% (SD= 0.39)	0% (SD= 0.0)
Written resources	14.71% (SD= 0.36)	53.85% (SD= 0.52)	42.11% (SD= 0.51)	17.9% (SD= 0.44)	0% (SD= 0.0)
Recipe lists	23.53% (SD= 0.43)	84.62% (SD= 0.8)	31.58% (SD= 0.48)	25% (SD= 0.49)	0% (SD= 0.0)
Interactive website	52.94% (SD= 0.51)	46.15% (SD= 0.5)	21.05% (SD= 0.42)	35.7% (SD= 0.31)	66.7% (SD= 0.58)

7.8.3. Using nutrition information that is provided

The subjects were asked to indicate if they used the nutrition information that they had been given previously. They were able to answer 'yes', 'no' or 'sometimes'. Overall 43% said that yes they did use nutrition information. Forty six point two percent stated that they sometimes used information, whilst 10.8% said they did not use information. Seven responses were missing for this question.

7.8.4. Nutrition competition plans

Subjects were asked if they had a nutrition plan for competitions. 30% of the subjects had a nutritional plan that was designed for use with trainings, whereas 45% of the subjects had a nutritional plan designed for use in competitions.

7.8.5. Who else should be involved in the adolescents nutrition education?

Subjects were also questioned on who should be involved in their nutrition education. The results are shown in Table 7.8.9.

Table 7.8.5: Results of question C.27 - Who else should be involved in your nutrition education?

	Parents	**Coaches**	**Other***
Overall percentage of athletes who thought others should be involved in their nutrition education	81.6% (SD= 0.39)	64.3% (SD= 0.48)	18% (SD= 0.44)
Basketball athletes only	47.1% (SD= 0.49)	94.1% (SD= 0.24)	76.5% (SD= 0.45)
Football athletes only	53.8% (SD= 0.52)	92.3% (SD= 0.28)	61.5% (SD= 0.58)
Netball athletes only	84.2% (SD= 0.37)	89.5% (SD= 0.32)	21.1% (SD= 0.42)
Rugby athletes only	25% (SD= 0.50)	60.7% (SD= 0.50)	39.3% (SD= 0.47)
Underwater Hockey athletes only	33.3% (SD= 0.58)	66.7% (SD= 0.58)	66.7% (SD= 0.58)

*Other responses were teammates and team members, members of the athletes flat, nutritionist, friends, friends in the same sport, teachers, the trainer, and partners.

7.9. The focus group

A focus group was conducted with nine rugby athletes from the Manawatu Rugby Academy programme. The focus group ran for one hour and was designed to ascertain the athlete's thoughts on nutrition resources. The sheet which was used during the focus group can be seen in appendix 2.

7.9.1. Use of a Website

There was a very strong general agreement that a website was not something that this group of athletes was interested in. They did not think that they had the time to use a website and were vary of how accurate the information would be on the site. They also stated that they did not spend a lot of time using computers and the internet.

If they were to use a website then they would be attracted to this most by words and headlines, (so long as they are precise), and if they had pictures of famous players. Colour and pictures of food and drink rated lower in preference. One player stated that if they were player endorsed or recommended by a known nutritionist they would use it – other players agreed to this statement.

If they were to have a website to use they would mostly use information on sports specific nutrition strategies, recipe lists, information on supplements, and information from higher level athletes (for example, they would like to see a menu plan of a top players). Information on cooking tips and sports drinks was also desirable. Only one athlete commented that the website should "have different sections so you can choose what information relates to you (maybe tabs)". They expressed concern in that they knew there was a large amount of unsuitable and incorrect nutrition knowledge, and were wary of using information off the internet.

7.9.2. Cookbook Resources

Most were familiar with the Edmonds Cookbook, but majority of the athletes had no association with any other cook book. When shown a NZ published cook book "Fit Food for Winners", the athletes stated that it "looked too flash" and said that they wouldn't be interested in using it as it looked like the recipe on the front needed lots of different ingredients, and would be hard and time consuming to make. The athletes were in agreement that instead of cookbooks with lists of recipes they would rather have suggestions of foods and how they could make simple meals that could be varied easily. They were also very concerned about food ideas and how they related to their budget – they suggested that they be given a number of food ideas e.g. what to do with pasta, and have corresponding shopping lists to go with them. They also would like information on how a meal compares in monetary values to fast food – for example a breakdown of how much it would cost to make a pasta meal compared to buying different fast foods. They noted that this would actually impact on their choice of having meals at home as compared to buying takeaways. The athletes were asked what meals they would like recipes for if they were to receive recipes as part of their nutrition education and they responded that lunch, dinner, and homemade takeaways were most important, but also stressed that they would like ideas for healthy baking and treat/dessert ideas. They were also really keen to have more ideas for snacks. Cultural issues were emphasized by some of the athletes who thought it was important that information was made available for all cultures.

7.9.3. Written resources

Fact sheets and posters were by far the most popular forms of written resources. Pamphlets were not liked at all by the athletes and there was a general consensus that books would not be used by the group – the reasoning for this is that they didn't want to sift through information, and they didn't know if the information was applicable to them. They did state that if they were to be given a specific rugby book that was endorsed by the NZRU, contained pictures and recommended by one of their nutritionists that they may read it. They were not keen on having to buy a book resource and would prefer if they were given one as part of their academy education.

The athletes would like fact sheets that compare factors such as the fat content between different takeaways. For example one athlete stated “I would like a sheet that had McDonalds compared to Burger King takeaways, and compared to what you could make at home”. Fact sheets should also be endorsed by a known nutritionist and be rugby related to make the athletes more receptive to them. It was also suggested and agreed that fact sheets should be handed out in the team environment and covered with the whole team instead of the athletes being asked to read and remember the information as the athletes said that if they were expected to read the information in their own time they most probably would not take the time to read it. Resources that the athletes had found helpful was a small booklet that one had received when they had brought eggs which gave more ideas on how to use eggs, and one athlete mentioned that he looks at the weekly menu planner in a women’s magazine for ideas (if the foods look simple enough).

When asked what written information should contain it was widely agreed that not too much information should be contained on the resource. Pictures were also highly liked. One athlete stated it was best to “keep it simple but interesting”.

7.9.4. Group presentations/workshops

The athletes suggested that group presentations should be limited to 30 – 45 minutes as they thought that it was too hard to concentrate for periods longer than this. They also stressed that it was important to them that the presentation was “short and sharp to the point”. They favoured a style where they were able to ask questions during the presentations, and where the presenter also asked them questions throughout the presentation. They were strongly against being lectured at, and thought that being given handouts from the presentation was very important in terms of recalling what they had learnt in the presentation. A good presenter was very important to the success of the presentation.

The athletes felt that the presenter needs to demonstrate knowledge and enthusiasm. Experience was also a quality that was important to the athletes. The athletes stated that the presenter should be in “shape”, they stated that they would not take a presenter who was not “sporty and fit looking” seriously if they were giving nutrition education to them. It was important that the presenter looked like they practiced what they preached. The age of the presenter was also discussed by the athletes. They felt that age often leads to a perception that the presenter would know what they were talking about, but they also stated that sometimes those who were older may not be "in touch" with them, and they also perceived that they may speak in a more monotone way with less enthusiasm. They perceived younger presenters to potentially have more enthusiasm for the topic but thought that sometimes they may not have as much experience. The gender of the presenter was not something that mattered to the athletes.

7.9.5. The use of consistent guidelines for supermarket tours and cooking sessions

Having consistent guidelines and structure for performing supermarket tours and cooking sessions was discussed with the athletes. They felt that there should be general guidelines as to what an athlete should learn through these activities, but they thought that they should not be strictly structured. One athlete summed up the groups opinion as "have guidelines but let the nutritionist put their own spin to it so that they are comfortable with what they are presenting".

7.9.6. Advice for others

Although the athletes had left home, they felt that if would have been helpful if their parents had been able to access sports nutrition advice. Examples of where they thought this was absolutely necessary were information on sports drinks, for example when young athletes should use sports drinks and what was a sports drink, and they also felt that it was important that their parents knew about appropriate foods and fluids for before a rugby game, and as recovery foods. They stated that this needed to be culturally based and needed to be looked at in terms of how it fitted a budget. They also stated that their parents were "old school and had their own thoughts on what was best to eat as that's what they had done back when they were playing, even if its not what we are told to do now".

Athletes were undecided on whether specific sports nutrition resources should be produced for their coaches. They were confused as to whether it was the coaches responsibility to know about sound nutrition practices, or if that was the role of the manager. They did however mention that back when they were playing club or school level, where there was generally only a coach available that it would have been helpful for that coach to have sound nutrition knowledge to help them with ideas of foods to eat before, during and after a game, and to give advice on fluids.

7.9.7. Having a team nutritionist

The athletes felt that when they were receiving nutrition education that although it was not essential that every member of their team received information from the same nutritionist, it was more helpful if they did, as that way they were assured of all receiving consistent messages. They thought that if they were in the situation where they are receiving advice from two or more different nutritionists that these nutritionists had to be in close contact and have effective communication to ensure consistent messages.

7.9.8. Other points raised

The athletes felt that information on alcohol would be beneficial in their nutrition education. They stated that simply being told that they were not allowed to drink alcohol would not stop them, but if they had access to information on alcohol and tips on how drink more safely that they would use these. They would like to know how alcohol intake affects dehydration and recovery, and wanted information on what volumes of alcohol were safe to consume and how to make sensible choices to avoid hangovers. They also mentioned that information on takeaways would also be useful here as many of them found themselves having takeaways during, and after drinking alcohol.

The athletes also wanted more specific information on sports drinks, including when they should drink them, how to choose an appropriate one and what they did. Supplements were also discussed by the athletes and they would like more information on supplements, especially where they were trying to build muscle mass. They related this back to their coaches and discussed that their coaches often ask them to increase their weight through building muscle mass, or lose weight by decreasing body fat, but do not have the information to help them do this in a healthy, sustainable way. From this part of the discussion the athletes decided that coaches should have knowledge about changing an athlete’s body composition, and should receive nutritional help in this area to make sure that they could provide advice around this if needed.

Discussion

The ANKAA study investigated a number of areas through the questionnaire and focus group to address these four aims:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences the members of this subject group in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this subject group,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

The results will be discussed in the following order; basic overall nutrition knowledge and its components including supplementation and baseline hydration, food skills and influences on food choice, sports nutrition knowledge, belief in sports nutrition and attitudes towards sports nutrition, and nutrition education. This is followed by an example of a successful nutrition program and the authors proposed educational program for this group with feedback. The success of this program was not evaluated in the ANKAA study. Finally, the limitations of the ANKAA study are discussed.

8.1. Basic overall nutrition knowledge

Based on the results of the ANKAA study, the subjects had reasonable levels of basic nutrition knowledge but there were certain areas that showed a lack of knowledge, specifically the food components. This is consistent with previous research (Berning et al, 1991).

Research cited in the literature is inconclusive on whether one gender has a higher level of knowledge. Previous research has suggested that males tend to exhibit lower levels of nutritional and food knowledge as opposed to females and that they are not as interested in health like females are seen to be (Nowak et al, 1998). The ANKAA study however demonstrated that there was not a significant difference in basic nutrition knowledge levels between the males and females. The ANKAA study is similar to that of Rosenbloom et al (2002) and Nichols et al (2005) which both showed there was no difference in overall knowledge between the genders when assessing nutritional knowledge. Rosenbloom et al (2002) and Nichols et al (2005) did use groups which were older than this research (in Rosenbloom et al, 2002 the average age was 19 $\pm$ 2.7 for males and 19 $\pm$ 1.3 for females, and in Nichols et al (2005) the average age was 19.8 $\pm$ 1.5 years). The average age of subjects in this study was 16.64 $\pm$ 1.9 years.

As the ANKAA study only investigated the knowledge of adolescent athletes it is unknown if the knowledge that these subjects possessed is better than adolescents of the general public. Previous research has shown that female athletes have better knowledge than female non athletes (Cuspiti, 2002) and Harrison et al (1991) found that elite athletes had a higher level of knowledge than recreational athletes. The implication of this is that more research needs to be performed on the nutritional knowledge of adolescent athletes using larger sample sizes to get results that are more accurate in determining if one gender does have a higher level of knowledge. As the focus on education for each gender may need to different (Neumark-Sztainer et al, 1999, Hinton et al, 2004) this is an important area of investigation.

In terms of overall scores for basic nutrition knowledge Underwater Hockey had the highest number of correct responses. However, as Underwater Hockey has a very small sample size it is unclear whether their percentage of correct results is truly representative of this group. Football athletes had the next highest overall percentage of correct answers ahead of Netball, followed by Rugby while Basketball had the lowest percentage of correct results for basic nutrition knowledge. Although it could be assumed that one gender had better basic nutrition knowledge and this could influence the individual sports results (as for example all of the netball players were female, all rugby players were male) there was no significant difference in the knowledge scores between males and females ($p=0.16$).

The differences in knowledge may be related to the amount of nutrition education that the subjects from each sport had received. For example Football subjects had the highest reported incidence of having an individual session with a sports nutritionist or dietitian (30.77%), menu plans developed (69.23%) and a nutrition quiz session (69.23%). This cannot be determined as significant however as Basketball, who had the lowest overall score for basic nutrition knowledge had the highest number of subjects who reported having a group workshop (77.14%) and a group cooking session (22.86%). This indicates that there are other factors which may influence the actual knowledge of the subjects such as the education information they were given, the way it was presented in the session type, and barriers to using the knowledge. The methods of education are discussed further in section 8.5.

8.1.1. Carbohydrates

As carbohydrates are essential to performance (Burke, 2006) the subjects were questioned on carbohydrate foods and their role in the body. 95% of the subjects correctly agreed that carbohydrates are found in breads and cereals, although only 57% correctly agreed that carbohydrates are found in fruit and vegetables. Only 45% knew that sugar is a carbohydrate, and 42% knew that carbohydrates are stored as glycogen.

Subjects were not aware of how the food components contributed energy to their diets. Only 48% of the subjects knew that the statement “a calorie is the same as a kilojoule” was false. Majority of the subjects (96%) could not correctly identify that fat contains the most energy per gram, whereas carbohydrates were thought to be the food component which contains the most energy by most of the participants. It is known that fat contains the most energy of the food components with 9 calories per gram, whereas carbohydrate and protein each contain 4 calories per gram. Potential reasons for this error by such a large number of athletes could be due to the low carbohydrate diet fad which has been evident in recent years. It is possible that with the low carb phenomenon that has been rife throughout society, and the misconception that protein has the biggest role in muscle building, that adolescent athletes are confused about food components, as well as the role of these components and how much energy they contribute to energy intake. This low carbohydrate fad could have potentially lead the athletes to believe that carbohydrate is the highest in energy as these diets are promoted to cause weight loss from a decrease in carbohydrate content in the diet. Another potential reason for this result is that young athletes are taking on the message that carbohydrates are an energy source when exercising and using this to rationalize that carbohydrates therefore contain more energy than fat or protein. 90% of the participants knew that carbohydrates are a main fuel source for the body which is higher than that seen by Rosenbloom et al, (2002) who found that 63% of males and 54% of women knew that the main sources of energy for exercising are carbohydrates and fat. Rosenbloom et al (2002) also found that 74% of males and 54% of women knew that eating carbohydrates would not make them fat. 71% of the subjects in this study agreed that eating carbohydrate can increase body fat, however this question could be changed to be worded more clearly as some respondents wrote “it depends”.

It is clear that adolescents need more education on carbohydrates and their role in the body. This should be included as a comprehensive part of an education program for this group as it obviously is an area of confusion for some athletes.

8.1.2. Protein

Previous research suggests that athletes may have incorrect knowledge on the role of protein (Jacobsen et al, 2001, Rosenbloom et al, 2002) so ANKAA study subjects were asked to identify sources of protein and the role that it plays in the body. Food sources of protein were easily identified by subjects however the role of protein in physical activity was misguided. Sixty five percent of the athletes thought that vegetarians could eat enough protein without consuming meat, 76% of the athletes knew that milk and dairy products contain protein, and 76% also knew meat was a good source of protein. When asked in a different question only 43% stated that low fat milk was high in protein. This may indicate that the subjects perceive a difference in the protein content of milk when it is termed low fat instead of milk and dairy products in general.

Protein is recognised as playing a major role in muscle growth and development (Burke et al, 2006) but is not considered to be a major preferential energy source for muscle activity (Burke et al, 2006, Girard Eberle, 2007). When the subjects were asked about the role of protein in muscle growth and development, an overwhelming 68.2% stated that eating a high protein diet would increase their muscle mass. Sixty three point nine percent stated that weight training would increase their muscle mass, while 40.2% said having protein shakes after every workout would increase muscle mass. The knowledge of protein and its role in the body may be a factor in this misconception on the role of protein. There could be a tendency for athletes to concentrate on the effects of protein and focus on this food component being essential to sporting performance by increasing muscle mass and strength whilst overlooking the importance of carbohydrate and overall energy intake. Some of this may be due to advertising and media attention.

Research has shown that one of the most important factors in muscle growth is eating a high enough energy intake (kilojoules) and it is likely that the timing and the protein composition may be more advantageous in muscle growth than simply consuming larger amounts of protein (Tipton & Wolfe, 2004). It has been seen that males may be more likely to perceive protein to provide an immediate energy source, be involved in weight gain and used to increase muscle strength and size (Jacobsen et al, 2001). Rennie and Tipton (2000) have demonstrated that if an athlete is consuming 12 – 15% of their recommended energy intake from protein that they do not need supplementation with extra protein. Interestingly only 17.5% of the respondents in the ANKAA study thought that “eating more overall” would help in increasing muscle mass. More (21.6%) thought that “eating egg whites after every meal” would help.

Other research shows a disparity in protein knowledge, in Rosenbloom et al’s (2002) research 47% of males and 43% of females incorrectly agreed that “protein was the main energy for the muscle” (pg 419) and 35% of males and 34% of females incorrectly agreed “that protein supplements are necessary” (p. 419). Thirty six percent of elite and 37% of non-elite athletes stated that “protein supplements build larger muscles and make you stronger” in Harrison et al’s research (1991). Seventy four percent of the athletes in this research correctly identified that protein plays an important role in muscle recovery.

The athletes in Rosenbloom et al's (2002) study competed in football, track and field, baseball, swimming, basketball, tennis, golf, softball and volleyball. Basketball is the only common sport between Rosenbloom et al's study (2002) and this research (it was not clear whether the definition of football in Rosenbloom et al (2002) was American football or football/soccer as seen in New Zealand). This could be responsible for some of the differences in the results seen. Rosenbloom et al's study also used 328 subjects of which a large proportion was males (237 males and 91 females). This ratio may have affected the results, especially in terms of knowledge about protein. The large proportion of males may have lead to the result seen as it has been observed that males may be more likely to perceive protein to provide an immediate energy source, be involved in weight gain and used to increase muscle strength and size (Jacobsen et al, 2001).

Because protein is a topic where there is confusion over its role in muscle recovery, as a source of energy and the role it plays in muscle growth, it needs to be addressed in an educational program for adolescents. It is clear that there is a large amount of information that is incorrect available for these athletes and they need to be provided with sound, correct information. This information is needed not just for sports performance but also general health. This was identified by the rugby athletes who attended the focus group. They were very aware that there was a vast amount of nutrition information available, especially in the area of protein and muscle gain and would like to know what the correct information was in this area.

There is very limited research and knowledge of protein requirements in the adolescent athlete. It is thought that protein needs may increase for the adolescent athlete due to the fact that children and adolescents must maintain a positive nitrogen balance (as opposed to adults who must maintain nitrogen balance) for the growth and development of body tissues and organs (Bar-Or, 2001). However, previous small scale studies in figure skaters have shown an adequate or more than adequate intake of protein is seen in these adolescent athletes (Zeigler et al, 1998 and Delistraty et al, 1992). It is also thought that it is relatively easy for athletes to obtain the needed amounts of protein daily so long as the athlete is consuming adequate amounts of energy from a varied diet. The major results from the New Zealand Ministry of Health's NZ Food NZ Children's survey (1999) showed that males obtained 15% of their energy from protein and females obtained 16% of their energy intake from protein. The actual amounts are unknown as they were not represented in grams per kilogram of bodyweight. Although these were not specifically recruited as athletes, it does show that overall children and adolescents do consume enough protein. It seems that in most situations the athlete will automatically increase their energy intake, and consequently protein intake, to meet any extra requirements (Petrie et al, 2004). However Bar-Or (2001) suggests that although adolescent athletes tend to acquire enough protein in their day to day intake, any adolescents who modify their intake, for example to deliberately change their weight (weight gain or loss) should be monitored. Although most adolescents consume enough protein for growth and development, there are concerns over very high protein diets as these may exacerbate pre-existing kidney conditions, displace other foods from the diet and they can increase urinary calcium excretion (Burke, 2006), which given that calcium is a vital mineral for developing bone strength during adolescence may pose other problems for the adolescent athlete.

These results on the knowledge of food components may potentially link to why adolescent athletes are often seen to have an incorrect distribution of food components (such as that seen in Berning et al, 1998), even though they often obtain enough total energy (Berning et al, 1991, Pearce, 2004). This is an area that needs to be investigated further and because 55.8% of the ANKAA subjects compete in more than one sport, it is important that adolescent athletes understand how carbohydrates and protein play a role in health, performance and recovery so that performance and development is not compromised.

8.1.3. Supplementation with vitamins and minerals

Current literature does not support the view that vitamin supplementation is beneficial, or performance enhancing for adolescents (Petrie et al, 2004, Singh et al 1992, Fogelholm et al, 1992, Haymes, 1991, Weight et al, 1988) as it is considered that the need for vitamins and minerals is not thought to increase due to training or competition in this group (Petrie et al, 2004). This is an area for which education may be needed for adolescents and their parents, as they clearly perceive that vitamin and mineral supplements will make up for an inadequate diet, when this is not the case.

Twenty two percent of the subjects in this study incorrectly agreed that taking a multivitamin supplement immediately before an event would improve sporting performance, and 38.4% were unsure. Kim et al (1999) found that 34.4% of supplement users in their research took supplements directly before an event in the hope that it would improve performance. Clearly this is an area of confusion for athletes. Five point one percent of the subjects in the ANKAA study also incorrectly agreed that taking iron supplements without having an actual iron deficiency would also improve sporting performance. Fifty nine point two percent did know that there would be no improvement in performance when iron supplements were taken without an iron deficiency. Only 42% of the subjects correctly identified the function of vitamins and minerals to be “to catalyze biological reactions”.

Although the subjects were not directly questioned on whether vitamin and mineral supplements would improve energy levels one participant stated that they take multivitamin supplements as “they give me energy”. Another participant stated their reason for taking a multivitamin supplement was “to get more energy or recover faster”. Previously Rosenbloom et al (2002) has shown that 67% of males, and 53% of women believed that their energy levels would be increased through taking vitamin and mineral supplements. Jacobsen and Aldana (1992) found that 77% of athletes believed that vitamin and mineral supplements would increase energy levels, whilst Heredeen et al (1999) found that 80% of athletes also believed this.

Research by Harrison et al (1991) showed that 36% of elite athletes and 50% of non-elite athletes incorrectly agreed to the statement “extra vitamins and minerals are vital for top sporting performance” (pg. 125) as well as 30% of elite athletes and 44% of non-elite athletes incorrectly answering that “vitamins give you energy” (pg 125). Harrison et al (1991) also found that there was also confusion over the role of vitamins and minerals in New Zealand elite and non elite athletes. Forty five percent of elite athletes, and 32% of non elite athletes in their research knew that the statement “extra vitamins and minerals are vital for a top sporting performance” (pg 125), and 50% of elite athletes, and 28% of non elite athletes knew that the statement “vitamins give you energy” was incorrect. Three of the sports in Harrison et al’s research are the same as used in this study (basketball, netball and rugby), however the subjects were older (23.2yrs for elite athletes and 24.3yrs for non elite athletes). Rosenbloom at al’s study included only one sport in common with this study.

Nineteen percent of the participants in the ANKAA study were regularly taking a multivitamin supplement, with 3% reporting use ‘sometimes’. This is consistent with the research of Jacobsen et al (2002) (18.9%) but lower than those seen by Parr et al (1984) with 46%, O’Dea (2003) who found 48.7%, Froiland et al (2004) with 67%, and Burns et al (2004) who had 73.3% of athletes reporting supplement usage. This study may have had smaller rates of reported use due to the sample size of 100 adolescents, although other research generally shows higher rates of reported use in those studies with lower participants, for example Neiper (2005), and Zeigler et al (2005), used 32 and 105 subjects respectively, and both found a rate of 62%. However, Schofield and Unruh (2006) found a reported use of 22.3%, which is much closer to that of this study, with a sample size of 139. This suggests that the methodology used, and specifically the question used to provoke an answer are exceptionally important.

The reasons for taking multivitamins were described by the athletes in the ANKAA study as; "to stay healthy and keep my vit C up", "to assist with intake of vitamins", "mum and dad make me", "gives me energy", "to get more energy or recover faster", "I think it might help", "keeps me healthy", "keeps you healthy", "to help recover when im sick", "to get bigger (interestingly this athlete was advised by their trainer to take the multivitamin)", "just cause", and "to help recover and replace" (again interestingly this athlete was advised by a sports nutritionist). One athlete also said that they take berocca energy "to get hyped up and in the zone". Previous research corresponds with this view. O'Dea (2003) found that athletes in her research were enthusiastic consumers of sports and energy drinks and one subject even stated that he would have an energy drink before a game to get an "energy boost" (pg. 103).

Other research shows similar views on the reasoning behind taking supplements – subjects often refer to a role in overall health status or maintaining health (Kim et al, 1999, Froiland et al, 2004, Neiper, 2005, O'Dea, 2003). Recovery from fatigue is also used as a reason (Kim et al, 1999) as well as recovery from illness (Sobal & Marquart, 1994, Kim et al, 1999). Subjects also often believe that supplementation helps an inadequate diet (Froiland et al, 2004, Kim et al, 1999, Zeigler et al, 2003, O'Dea, 2003). Reasoning also includes that supplementation will prevent illness or strengthen immune function (Neiper et al, 2005, Zeigler et al, 2003, O'Dea, 2003) or build muscle (Krumbach et al, 1999, Swirzinski et al, 2000, Froiland et al, 2004, O'Dea, 2003). As vitamin and mineral supplements cannot make up for an unbalanced diet there needs to be more education on these supplements.

It is noted that adolescent athletes are more likely to be deficient in iron than non-athletes (Clarkson, 1991, ADA, 1996, Lytle, 2002, Berning et al, 1991) and an iron deficiency has the capacity to inhibit performance (Petrie et al, 2004). Only 2% of the athletes in this study reported taking Iron supplements. This is lower than expected with more females taking part in the research than males. This may indicate that the subjects on the whole have a diet which supplies their iron needs or it may be that there are undiagnosed cases of iron deficiency. One of these athletes was a football player and noted that these are recommended by a doctor due to a diagnosed iron deficiency. The other athlete was a netball player and gave her reason for supplementing with iron as “I don’t know - mum just said to take them if I want to, and they taste really nice!” When subjects were questioned on the symptoms of iron deficiency 73% of the subjects identified tiredness/fatigue to be one of the symptoms, while 55% identified a decreased athletic performance, while only 14% identified breathlessness as a symptom. With athletic females being susceptible to the female athlete triad of menstrual dysfunction, disordered eating and osteopenia (Hellemans et al, 2008), it is important that nutrition education for female athletes involves information on the cause, symptoms and effects of iron deficiency.

Calcium and iron were reported to be the most popular supplements in research by Froiland et al (2004), interestingly this study showed only 2% using iron, and none reported use of calcium supplements, although the multivitamins that the subjects took may have contained calcium. A deficiency of calcium also has the capacity to decrease or inhibit performance (Petrie et al, 2004). The number of participants in this study means that it is statistically underpowered and had there been more participants then possibly more supplement use may have been observed.

It is clear that along with information on carbohydrate and protein, information on supplements needs to be provided for young athletes and their parents/caregivers. Many of them simply think that taking a supplement will make up for an inadequate diet which is not the case. With the supplement industry constantly pushing the use of the various supplements with large scale advertising and claims, athletes and parents/caregivers need to be provided with accurate advice so that they can make informed decisions.

The use and knowledge of sports related supplements are discussed in section 8.3.6.

8.1.4. Hydration

Majority of the questions relating to water and hydration were sports nutrition related and are discussed in the sports nutrition section 8.3.6. on page 110. However there were a number of questions on basic nutrition knowledge of water and hydration. Forty eight percent of the subjects knew that the statement “water makes up 50% of the body” was false, 48% also knew that water is used as a transport system in the body. Eighty three percent knew that “when you are thirsty you are already dehydrated” and 93% correctly agreed that urine color is a good indication of hydration.

8.2. Food skills and Influences on Food Choice

It is clear that more research is needed to clarify if nutritional knowledge is linked to nutritional behaviour, and if individuals will improve their food choice and nutrition behavior in response to education. However there are factors, beliefs and attitudes that play a role in food choice and these need to be considered when providing nutrition education for adolescent athletes.

8.2.1. **Influences on food choice**

Neumark-Sztainer et al (1999) developed a model which describes the levels of influences on food choice in the adolescent. They define the most important factors to be hunger, cravings, taste, appearance, time and convenience in food choice. The ANKAA study clearly shows that this is the case for the 100 subjects involved in this research. Taste was the most popular choice as the most important influence on food choice for subjects from netball (36.84%), football (35.7%) and basketball (44.1%). It was the second choice of influence for the rugby players only 3.62% behind their first choice of cravings. This may indicate a positive approach to nutrition education for adolescents in that focusing on promoting tasty foods may influence them to try, and continue to choose those foods.

Rugby players rated cravings (38.46%) slightly more important than taste (34.62%). Underwater hockey players rated the healthiness of a food as the most important influence on food choice, even though the healthiness of a food was not given as an answer option on the questionnaire. 2.84% of basketball athletes and 14.3% of football players also ranked how healthy a food was as the most important factor on food choice. Neumark-Sztainer et al (1999) rates the beneficial effects of a food at the secondary level of factors influencing food choice but it is positive that a number of subjects rated this as the main factor in their decision on food choice. It may possibly indicate that adolescents are aware of the effects of food on health and performance. When the subjects were questioned on how important nutrition was in their sporting plans overall 79% answered that it was very important (100% of the underwater hockey players gave this response) and 88% overall indicated that they believed that sports nutrition would definitely improve their performance so they may be aware of choosing healthy foods affects performance.

Interestingly 7.14% of football athletes also mentioned that their nutritionist was the most important influence on food choice and 5.26% stated that activity was the most important influence for them. No athletes rated the coach as the most important factor on food choice, and only 3.85% of the rugby athletes rated advertising as the most important factor – no other subjects indicated advertising as important. Although it has been proposed that cost has a significant impact on food choice in adolescents at a personal level (Story et al, 2002), only 7.14% of the football subjects indicated that cost was the main factor in food choice. No other subjects rated it as the number one factor. The reason for this is unknown but it could be possible that the adolescents rate factors such as taste more important than the overall cost of a food and are prepared to pay more for a food that taste better. Cultural aspects were also rated as a minor influence; only 8.82% of basketball subjects and 3.85% of rugby subjects rated this as the most important influence on their choice of food. In hindsight the option of hunger should have been included in question B.7., as well as the option of how healthy the food was. An indication of ethnic group may have provided more information on why cultural aspects were not important in food choice for majority of athletes.

8.2.2. Food skills

The food skills that the athletes possess may play a role in food choice, for example if they have a higher cooking ability they may consume better quality and more balanced meals. The subjects were asked to rate their cooking skills to give an indication of food skills on a scale of 1 to 10, with 1 being non-existent and 10 being excellent. A relationship between cooking skill rating and if the athlete played a role in food preparation seems to be apparent although it was not significant (p=0.131). Rugby players rated their cooking skills at 6.44 and they also had higher percentage of responses that said they prepared food (74%). Underwater hockey players rated their cooking skills at 7.67 and 66.7% of the group prepared food; however this group is very small so the results cannot be deemed conclusive. 57.1% of the Basketball subjects prepared food and gave themselves a rating of 5.43 for cooking skill level. Netball had a lower cooking skill rating of 4.85, only 50% of them said they prepared food and 100% of them lived at home (indicating that they may not play the role of food provision). The majority of the basketball players also still lived at home (94.1%). In contrast all of the rugby players lived away from home which indicates that they may have to take responsibility for their food intake as opposed to those who live at home where parents or caregivers may have responsibility for cooking. The rugby players were also older than the other sports groups.

It could therefore be assumed that those athletes who are living away from home are preparing meals for themselves and this is possibly a group which needs extra information immediately on how to prepare food. The rugby players who attended the focus group had a very strong focus on that they would like to have recipe ideas that would give suggestions of different ways to use a particular food, for example ways to use pasta instead of conventional recipe books which they stated “looked too flash” and they assumed the recipes contained in it would be too hard to make and need many ingredients. They also stated that having ideas on cooking healthily on a budget would be welcomed and used, and especially a breakdown of the cost of homemade meals as compared to takeaways.

It is interesting that a greater number of basketball athletes (22.86%) had attended a cooking session but that they still rated their cooking skills lower than the average for all sports. This may indicate that they did not build enough confidence (self efficacy) from this activity or as most of them lived at home they had not practiced the skill as much as they could have. This may be an area of potential research. Seventeen point nine percent of the rugby athletes had also attended a cooking session and they rated their cooking skills at 6.43, possibly indicating that have had more practice at cooking (74% of them prepare food, as opposed to only 57.1% of the basketball athletes).

This is an area that should be addressed in an educational program for this group as having the skills to make healthy, balanced meals is important in ensuring an optimal intake. If the athlete is unable, or has little confidence in their cooking ability they may be more likely to resort to unbalanced or take away type meals.

8.3. Sports Nutrition Knowledge

As well as looking at the level of basic nutrition knowledge, subjects were asked specific sports nutrition knowledge questions to assess their knowledge of this topic.

Question C.3. asked subjects to rate their sports nutrition knowledge on a scale of 1 to 10 with 1 being non-existent and 10 being excellent. The scores varied by sport; Underwater hockey athletes had a rating of 7.0, however this sample size was statistically underpowered. Football players had the next highest rating of 6.50, followed by basketball and netball both with 5.76. Rugby players rated their knowledge the lowest with a score of 5.64. When the overall scores were totaled for each sport the underwater hockey players had the highest percentage of correct answers with 47.33%, however this is the small sample size so it cannot be deemed significant. The next highest percentage of correct answers was from the netball subjects with 43.86% correct, followed by rugby with 42.26%. Basketball then had the next highest rating of correct answers with 38.73% just marginally higher than football who had the lowest overall percentage of correct answers (37.1%). It was interesting that football players had a high self rating of knowledge (6.50) but the lowest percentage of correct answers. It is possible that the football players have had nutrition education on other sports nutrition topics; however the questions were chosen for the ANKAA study as they encompassed a wide range of basic sports nutrition topics. Football subjects had the highest percentage of having had an individual session with a sports nutritionist/dietitian (30.77%) so they may have felt that their knowledge was of a good level. When questioned on basic sports nutrition, football subjects had the highest percentage of correct answers (68.32%) (behind the very small sample of underwater hockey).

Netball subjects rated themselves relatively low for self knowledge (5.76) but they had the second highest percentage of correct responses for specific sports nutrition knowledge. 26.32% of the Netball subjects have had an individual session with a nutritionist, 36.84% had attended a group session, and 57.89% have had menu plans developed for them. This could indicate that the subjects are not confident in their nutrition knowledge and this possibly due to the fact that there is so much information on nutrition and sports nutrition available, although not all correct, and this may confuse the adolescent athlete. It was noted earlier that they are confused over the role of carbohydrates in the body as well as the role of protein in muscle growth and recovery so it is possible that this is the case with other sports nutrition topics.

Overall in terms of pre event, during event and recovery knowledge athletes from underwater hockey had a slightly higher level of knowledge, followed by basketball, netball, rugby and then football. There was no significant difference in sports nutrition knowledge between the genders.

Subjects were also questioned on the roles of carbohydrate, protein, hydration and sports drinks in sports nutrition. These are discussed in further depth in the following sections.

8.3.1. Carbohydrate

When questioned on the role of carbohydrate 90% of the participants knew that carbohydrate is a main fuel source for the body, and 42% knew that carbohydrates were stored as glycogen. 88.9% knew that eating carbohydrates 2 – 4 hours before an event could help improve sporting performance and 63.3% thought that consuming carbohydrates during an event could help performance. Participants were unsure how much carbohydrate was in a banana with 69.1% 'unsure' and 21.6% incorrectly agreeing that there was 50 grams of carbohydrate in a banana.

When the athlete's scores were tallied and analysed, there were very low scores for pre event nutrition knowledge. None of the football players, and the rugby players knew the correct answer to question C.13 (how much carbohydrate should an athlete eat before a competition?). Underwater hockey and rugby players had the highest correct responses to recommendations of during event food (question C.16) with 33.33%, and 17.86% correct respectively. Netball players were well above the other sports in knowing the recommendations for amount of recovery food with 42.10% correct, with the next closest being basketball with 17.65% correct, although this was not a significant difference (p=0.241). Although the participants had low levels of knowledge about these recommendations, a large number of participants knew the recommendation in terms of timing for the recovery snack: 100% of the underwater hockey athletes, and 91.18% of the basketball athletes, 71.43% of the rugby players, 64.29% of football players were correct in answering that the best time to have a recovery snack was immediately after finishing the event. The lowest correct score for this question was netball with 42.10% correct. So although the participants did not have very high knowledge in terms of recommendations of amount of carbohydrate before, during and after events, they did have a high knowledge of carbohydrate timing for recovery. It is possible that previous education has concentrated on the timing of the recovery snack as opposed to the actual amounts that are needed and adolescents have taken this information on board to use.

As the subjects have shown a lack of knowledge in regards to the actual recommendations this is an area which should be investigated further and implemented in an educational program.

8.3.2. Protein

As discussed in section 8.1.2. athletes possessed a large amount of incorrect knowledge on the role of protein and its role in muscle growth. This is consistent with other research (Rosenbloom et al, 2002, Harrison et al, 1991). This indicates that protein, both in terms of general health and wellbeing, and in terms of sporting performance, is a potential area for resource and educational development. Fifty two percent of athletes in this study thought that eating protein 2 – 4hours before an event would improve sporting performance, and 21.4% thought that eating protein during the event would improve performance.

8.3.3. Hydration

Subjects were questioned on hydration and sports drinks. Athletes in this study correctly acknowledged that dehydration can affect sporting performance (96.9%), which is very similar to that seen in Nichols et al (2005) where 91.4% of the athletes surveyed correctly answered that dehydration decreases athletic performance. Nichols et al (2005) found that 68.3% of athletes agreed that “sports drinks are better than water because they restore glycogen in muscles” (pg. 522) while this study found 87.8% of athletes thought that drinking a sports drink during the event improves performance. Harrison et al (1991) found that 79% of elite athletes and 65% of non elite athletes knew that "endurance athletes (who exercise for more than 60 mins at a time) should try to drink fluids during exercise" (pg. 125), although they did not ask what these fluids should be (sports drink or water). Ninety four point two percent of Nichols et al (2005) participants knew that monitoring the colour of urine is a way an athlete can judge if he or she is hydrated, and 67.6% of participants stated that thirst is the best indicator of dehydration. 89.9% identified that excessive sweating, thirst and cramping were signs of dehydration. The ANKAA study found that 93% of subjects knew that the colour or urine indicates hydration status, and 83% also knew that if you are already thirsty you are dehydrated. Seventy five point eight percent thought that blury vision was a sign of dehydration, and 27.1% also believed that the stitch was a symptom of dehydration.

The subjects were unsure of the recommendations for the amount of fluid that should be consumed per hour of exercise in a moderate environment with none of the underwater hockey players knowing the correct answer despite the fact that they had all been exposed to hydration workshops. This could indicate that the adolescents either did not remember the information they had learnt at the workshop or that they had not been provided with this information at the workshops. It is also possible that there could be confusion over the guidelines as they have changed substantially over previous years. The highest score for correct answers to this question was from Netball players with a score of 26.32%. This was not a significant difference (p=0.220). Previous research suggests that females may be more conscious of hydration needs (Mullinix et al, 2003); however there was no significant difference between sports nutrition or general nutrition knowledge in males and females in the ANKAA study.

As hydration is vital important to performance and the use of sports drinks is now popular, a number of questions were used in the ANKAA questionnaire to look at the subjects knowledge and use of these drinks.

8.3.4. Sports Drinks

It is known that through the addition of 30 – 60g of rapidly digested and absorbed carbohydrate to a consumed fluid, fatigue can be reduced (Coyle, 2004). This therefore illustrates that sports performance may be enhanced if fatigue is prevented or delayed. Performance may also be enhanced through better hydration. Sports drinks contain sodium in order to maintain more appropriate levels of hydration in the athlete. It is unequivocally understood that sports drink can play a role in enhancing performance in adult athletes (Maughan, 1998, Coyle, 2004) but there is little research to suggest that they may enhance performance as much in young athletes. Sports drinks function by reducing the physiological processes which may cause fatigue and impaired mental function, namely skill performance through concentration and reaction time (Maughan, 1998). These factors are deemed to be the beginning of fatigue through use and depletion of the bodies carbohydrate stores, and through water and electrolyte loss in sweat (Maughan, 1998). Sports drinks contain carbohydrates, water and electrolytes. Carbohydrates function to replace muscle and liver carbohydrate, which are otherwise limited stores of this muscle fuel. Water in sports drinks functions to replace water lost through sweating. The addition of carbohydrates to water increases the absorption of water in the digestive system (namely the small intestine), provided it is at the correct concentration (Maughan, 1998). Sodium (Na), (usually in the form of NaCl – sodium chloride), is the only electrolyte that should be added to sports drink based on scientific evidence (Maughan, 1998)

Exact levels of dehydration and how they compromise performance in the younger athlete are not well defined (Petrie et al, 2004), however it is known that dehydration in young athletes is more detrimental to performance, than dehydration as seen in adults, because of the higher thermoregulatory strain seen with young athletes (Bar-Or, 2001). Young athletes generally have a lower sweat rate than seen in adults (Bar-Or, 2001, Petrie et al, 2004), and the composition of the young athletes sweat is different to that seen in adults (Bar-Or, 2001). Younger athletes exhibit lower levels of sodium and chloride in their sweat (Bar-Or, 2001, ADA, 1996), and consequently recommendations for fluid intake in adults may not be suitable for younger athletes.

Whilst it is clear that sports drinks, that contain carbohydrates and sodium can enhance performance in adults by delaying dehydration and carbohydrate (muscle and liver glycogen) depletion (Maughan, 1998), the fact that younger athletes exhibit differences in sweat rate (Bar-Or, 2001, Petrie et al, 2004), composition (Bar-Or, 2001) and the fact that they seem to exhibit a lower capacity for carbohydrate oxidation (Bar-Or, 2001, Petrie et al, 2004), sports drinks that are formulated for adults may not be ideally suited to these younger athletes. There is a need for further research in this area as it has been shown that sports drinks are a popular ergogenic aid for younger athletes (O'Dea, 2003).

O'Dea (2003) found that although adolescent athletes identified that sports drinks could enhance performance they did not relate this to being a tool for rehydration. Many of the athletes (87.8%) in this research identified sports drinks as being performance enhancing when they were consumed during an event. When asked about the functions of sports drinks 58.8% of the athletes agreed that "it replaces carbohydrates". Fifty two point six percent agreed that "it makes the body retain fluid", while 50.5% agreed that "it replaces sweat". Only 37.1% agreed that a function of a sports drink was to "replace sodium" and worryingly, 8.2% of the athletes thought that a function was "it helps to burn body fat" and 12.4% said "it replaces protein".

The athletes in this study mirrored findings of both Pratt and Walberg (1988), and Chapman and Toma (1997) by showing that many of them believed that a sports drink was more effective for rehydration as compared to water. Harrison et al (1991) also found that 79% of elite and 65% of non elite athletes agreed that athletes who are competing for over an hour should consume fluid, although it was unclear whether the subjects were referring to using a sports drink or using water. Rosenbloom et al (2002) found that many athletes thought that sports drinks were better than water but they also mentioned "it depends on the activity" (pg. 420) and this relates to the guidelines of using sports drinks in sessions that are over an hour in duration. Rosenbloom et al (2002) recommends in their discussion that they should change the wording of their question. Eighty seven point eight percent of participants in this research agreed that drinking a sports drink during an event improved performance but this question should also possibly be reworded to 'does drinking sports drinks in exercise sessions more than (or less than for an alternate question) one hour in duration improve performance?' Although most research suggests that athletes know that a sports drink is better than water for rehydration, Mullinix et al (2003) found that only 11% of their subjects agreed to a statement that sports drinks are better at replacing fluids than water.

8.3.5. Use of sports drinks

Sports drinks have become common throughout New Zealand and some are widely advertised. Eighty five point seven percent of the athletes in this research reported using a sports drink. Fourteen point three percent did not use sports drinks. Of the athletes who used sports drinks 26.8% reported using more than one sports drink. Eighty two point nine percent reported using PowerAde as a sports drink, which was much higher than the next ranked sports drink Horleys Replace used by 23.2% of the athletes using sports drinks. There is no other research to compare these statistics with in New Zealand.

While products like Horleys Replace are available in most New Zealand supermarkets, some chemists and specialist sporting shops, PowerAde is widely available in local dairies, shops, takeaway outlets as well as supermarkets. This may be part of the reasoning behind why such a high percentage of the adolescent athletes surveyed reported using PowerAde. As well as the easy availability of PowerAde, adolescents are known to be impressionable (Croll et al, 2006) and this may be a potential reason for the high usage of this sports drink in this research. Many adolescents are swayed by advertising. In New Zealand the national rugby team The All Blacks are vigorously sponsored by PowerAde and this is advertised widely. Observational learning is one of the concepts of the social cognitive theory (SCT) that is used in behavioural change (Owen, 1999) and it is known that using a high profile athlete as a role model is a successful influencing strategy with adolescent athletes (Hackman et al, 1992).

The reasons for the ANKAA subject's usage of sports drinks are similar to findings from other research. Kristiansen et al (2005) found that 86.7% of male, and 63.6% of female university athletes used sports drinks and reasons behind the use of these were similar to the ANKAA results. Kristiansen et al (2005) grouped carbohydrate supplements together (sports drinks, gels, and bars) and although the reasons for using sports drinks were not solely identified, they reported that the reasons for using the carbohydrate supplements included "provide more energy, enhanced performance, just like the taste, don't know, counteracts tiredness, greater muscle strength, no positive effect, enhanced recovery, to meet nutrient needs" (pg 202). The participants in this study also alluded to the taste of sports drinks being a reason for using them; "cos nice", "because its nice, "taste/recommended", "nice, think your doing something good", "thirst quenching and tastes nice" and "it tastes good" were all responses given.

It was interesting that one athlete stated that they used a V drink as a sports drink. V is high in carbohydrate but contains virtually no electrolytes. This answer may indicate that some adolescent athletes are unsure of what a sports drink actually is. O'Dea (2003) found that adolescent athletes often discussed energy drinks when they were asked about fluids and hydration. They used them as they perceived that they may give them a source of energy. It is possible that the subject in the ANKAA study also thought that a V energy drink may give them a source of energy as they stated "it helps me personally" as the reason for using this drink. Adolescent athletes need education about energy drinks and what these can do to performance.

Many coaches were sighted as having recommended that the athlete use a sports drink, and although 64.3% of the athletes noted that the coach should be involved in their nutrition education, recent research (Jacobsen et al, 2001, Zinn et al, 2006) suggests that often they do not have high levels of nutritional knowledge themselves. The role of the coach in nutrition education is discussed further in section 8.5.1.

As sports drinks are clearly popular with adolescent athletes this is another factor which should be taken into account when designing nutritional programs for adolescent athletes. Adolescents need to be educated on hydration, what a sports drink is and why they are effective for rehydration.

8.3.6. Sports related supplements

The only reported use of creatine in this study was from rugby players. Swirnzinski et al (2000) found that 90% of the players in their research that were taking supplements were taking creatine. Swirnzinski et al's (2000) research only used collegiate football players so there is a similarity between these sports, it is an advantage for players to have a high muscle mass due to rugby being a high impact game with tackling and scrums.

Twelve percent of the ANKAA subjects reported using other supplements. Another 4% reported using them sometimes. This included; 3% creatine, 5% protein, 2% iron, 1% echinacea, 1% BCAA's, 1% berocca performance, 1% iso stack, and 1% H blocker. Trainers were those who most recommended these supplements, recommending 5% of these cases, a nutritionist recommended 1%, and mother recommended 1% of the cases. Two percent of the subjects were unsure of who had recommended that they take these supplements and the rest did not give an answer to this question. Four of the rugby athletes were advised to take supplements by their fitness trainer. These supplements were protein, creatine, iso stack, H blocker, and mutant mass. One Rugby athlete stated that his fitness trainer and nutritionist had advised him to take protein as a supplement. Two other rugby athletes noted that they took protein, BCAA's, creatine and protein but did not give details of who had recommended these supplements.

The males who took part in the focus group had a large number of questions related to nutrition education and resources regarding supplements. Kristiansen et al (2005) found that supplements were very popular in terms of questions that respondents had. Thirty participants in Kristiansen's research (2005) provided comments on general supplement usage including the following "do we need supplements – are they healthy?", "is it possible to live healthy without taking supplements?" "which products are legal and which are not", "what products truly work and their effects", "effectiveness of supplements for muscle building" (pg 204). Thirty five participants commented on creatine with the common questions being "effects on performance/side effects", do I get stronger or just bigger", "ethics in use – restrictions by league", "long term effects", "has it been proven to work in clinical trials" (pg 204). For protein they asked "positive/negative effects", "usefulness in gaining lean body mass and losing weight",

“ whey vs. soy – which is best”, “is it bad for the kidneys”, “benefits for women”, “how much should/can an athlete consume a day” (pg. 204). Twenty two respondents had questions on protein. The participants in ANKAA study who took part in the focus group had similar questions. They stated that they wanted more information on sports drinks and whether they actually worked, and put a large focus on education for muscle mass, wanting to know if protein powders and supplements did work. They mentioned that they are often asked by their coaches to increase their muscle mass but are unsure how to do this healthily and what supplements, if any, they should be using. This clearly needs to be taken into consideration for future education of this group.

8.4. Belief in sports nutrition and attitudes towards sports nutrition

When questioned on the role and their belief in sports nutrition to work, 79% of the athletes overall believed that sports nutrition is very important in their sporting plans. One hundred percent of the underwater hockey players believed that it was very important, followed next by basketball players where 83.3% stated it was very important, and were followed by football and rugby players with 78.6%. Netball was the lowest in responding to this question with 68.4% believing that sports nutrition was very important in their sporting plans. There was no significant difference in these results (p=0.241). Netball players (10.5% of them) were the also the only athletes who stated that sports nutrition was not important in their sporting plans. No other sports stated that sports nutrition was not important. It was interesting to see that the netball players though had the second highest percentage when asked if they believed sports nutrition could improve their sporting performance with 94.7% agreeing that it would. Only 5.3% stated that it maybe would help. This indicates a discrepancy that should be further investigated. Underwater hockey players had a higher belief in that sports nutrition could improve their performance and rated its importance high. They also rated their knowledge highest of all of the sports. However, there were only three respondents from this sport so these results cannot be guaranteed to be representative of adolescent athletes who play underwater hockey. No other research is available to discuss in relation to these results.

Athletes from basketball, football and rugby rated the importance of sports nutrition to be high but the rugby players agreed more that sports nutrition could improve performance, whilst the football players rated their knowledge higher than basketball or rugby players. Netball players were the only group who had participants that stated that sports nutrition was not important, although 94.7% of the netball players did agree that sports nutrition could improve performance and rated their knowledge at the same level as the basketball players, and slightly higher than the rugby players. The two sports which had higher percentages of athletes stating that sports nutrition was ‘slightly important’ in their sporting plans, also had lower ratings of knowledge (Netball 21.1%/5.76 and Rugby 21.4%/5.64). There was no significant difference in these results (p= 0.220). This potentially shows that there could be an association between how adolescents perceive the importance of sports nutrition based on their perceived lack of knowledge, or it could be that as they do not have confidence in their sports nutrition knowledge they do not know the benefits of sports nutrition. This shows that from these results a clear conclusion cannot be drawn that there is a clear association between an athletes perception of the benefits of sports nutrition, their belief in that sports nutrition can improve performance and their ratings of their own knowledge in this study. The size of the study however may be a cause of this result, and with more participants a clear result may be seen. This interrelates with the idea of ‘does knowledge translate into behaviour?’ Research is inconclusive on whether knowledge does cause particular behaviours, with Wardle et al (2000), Pirouznia (2001), Read et al (1988), Saegert and Young (1983), and Cho and Fryer (1974) showing that there is a positive relationship between knowledge and nutritional practice. There is contradictory research which has shown that knowledge is not related to behaviour (Stafleu et al (1996), Schlicker, Borra and Regan (1994), Contento, Manning and Shannon (1992), Shepherd and Towler (1992), Potter and Wood (1991), Halverson (1987), Shepherd and Stockley (1987), Story and Resnick (1986), Axelson et al (1985). Although nutritional knowledge may play a role in nutritional practice, with the adolescent population there are also other clear influences on eating behaviour that has an impact on food choice in this group.

8.5. Nutrition Education

When asked what future sports nutrition education they would like the majority of the athletes (73.68%) wanted an individual session with a sports nutritionist/dietitian with the next favoured method of education being the use of an athlete as a guest speaker (52.63%). The least wanted methods of education were lectures and hydration workshops (15.79% each) and nutrition quiz sessions with only 15.91% of the athletes requesting these.

The overall results of what methods the athletes would like should be taken with caution as some sports have clearly ‘bucked’ the trend of the overall responses. For example overall only 21.05% of athletes wanted an interactive website, but basketball, football and underwater hockey had a high response to this question, whereas netball and rugby did not. Netball had a high response for group workshops, whereas football and underwater hockey had zero responses to this method. Netball and football clearly wanted written resources, whereas the remaining sports were not interested in this option. This indicates that sports nutrition education programs may need be tailored to the sport and their needs. A larger sample size is needed before a definitive conclusion is reached.

For supermarket tours, basketball, rugby and netball all had a much higher response. Interestingly, when asked about group cooking sessions, rugby, football and underwater hockey all clearly wanted these, but Netball and Basketball were not interested. The reasoning behind this is not known as the participants were not asked about why they preferred each type but the netball and basketball groups made up a large proportion of the female participants, so potentially the females believe that their cooking skills are adequate, or maybe the males think that their cooking skills are not adequate and are more interested in improving this. However when the subjects were asked to rate their cooking skills netball players had the lowest rating (4.85).

These results show that it is important to give a range of educational methods for adolescent athletes as one programme is unlikely to meet the requirements of athletes from a variety of sports, especially if that potentially is including individual athletes. It is expected that athletes are more likely to take notice when the education is delivered in a way that they want. In hindsight questions on why each of these services were wanted or not would have added extra information to the study that may have helped further in resource development.

8.6. Limiting factors in the ANKAA study

There are a number of limiting factors which need to be considered in the ANKAA study. The questionnaire used in the study was not validated due to time constraints. Although the questionnaire was pre tested on a group matched to the subjects this limits the reliability of the results.

The athletes were posted the questionnaires and therefore the researcher did not have control of the situation in which they did the questionnaire. Subjects were asked to complete the questionnaires by themselves but it is not known if any of the respondents were given help by parents, caregivers or coaches. Respondents may have been more inclined to participate if they had more of an interest in nutrition as the questionnaire was distributed and noted to be voluntary to all participants. If the parents were more interested in nutrition this may have influenced who sent back completed questionnaires. Some athletes may have been encouraged more by their NSO than others and this may have influenced who responded to the questionnaires.

The focus groups were a part of this research which did not perform as well as expected. Two series of focus groups were organised and the participants were invited by letter to these. It has been suggested that more individuals are likely to attend a group meeting if they are already part if an organized group which uses an established venue and time (Bloor, 2001) and that the job of recruiting attendees for the focus group can be done more effectively if the researcher can use an intermediary person for the job, who has contact with a pre existing group (Bloor, 2001). This method was successful with the focus group which was run with the Manawatu Rugby Academy. In future this would be a better method of recruitment for adolescent athletes for focus groups, instead of directly contacting the individual athletes and asking them to attend.

The study needs a larger sample size to give a clear indication of results. The current study had a small sample size so to confirm the results seen, more participants are needed. The study also only used subjects from five sports which were all team sports. To get a clearer indication of adolescent nutrition knowledge and methods of education it is important to widen the types of sports that athletes are selected from, and include individual sports.

Conclusion

In conclusion it is recommended that resources and educational programmes are designed for adolescent athletes. However, there are a number of points that are needed to be taken into consideration. The programs must be developmentally appropriate and have a performance based focus. They should also be positive and it is possible that they could be more successful if they involve a top sportsperson or sports team as a role model(s).

There are other factors, which have been seen in both previous research and the ANKAA study which need to be considered in the development of a nutrition education program. These are that females may need information on iron status and in particular a weight based focus. Resources that are specifically targeted at adolescents need to be developed and made available through as many avenues as possible to adolescent athletes and their parents to be more successful. A programme which has more than one nutrition session is likely to be more successful in educating athletes about sports nutrition and changing behaviour. Coaches (especially) and parents need to be educated in sports nutrition so that they can provide correct, and relevant advice to adolescent athletes. Trainers and other members of the support team need to be educated to provide sound advice or refer the athlete to a specialist. Information needs to be shared within nutritionists and as there are not enough sports nutritionists to work with all teams and often team funds do not cover for a nutritionist, trainers and coaches must improve their nutrition knowledge if they are going to be providing nutrition advice. More research needs to be conducted on the levels of knowledge in New Zealand adolescent athletes, and the ways of educating this group so that programs can continue to provide optimal dietary education for this group.

Practical applications

9.0. What methods of nutritional education should be used and who else needs to be involved?

When designing interventions and nutrition education it has been shown that the social cognitive theory (SCT) is beneficial in addressing all of the needs of a successful intervention. Results of the ANKAA study can be addressed in terms of the components of the SCT. One of the important components of the SCT is self efficacy which is an individual's confidence to be able to perform an actual behaviour (Owen et al, 1999). This can be broken down into two beliefs which are 1; the individuals belief that they can perform the behaviour, and, 2; beliefs which arise about the final outcome of the behaviour (Owen et al, 1999). Hackman et al (1992) describes four important points that Bandura (1986) has put forward in terms of self efficacy. They list guided practice as being a vital component of behavioural change. Firstly, the adolescent needs guided practice of the behaviour. The adolescent also needs vivid experiences of success, possibly including "modeling of peers, athletic trainers and significant others, and reflecting on past successes" (pg. 263). Thirdly, they discuss the concept of social persuasion through the use of posters on bulletin boards, involvement of important figures including coaches, parents and the athlete's social network, and sharing of ideas including recipes, menus, information and potentially rewards. The final component that Hackman et al (1992) discusses is that of having the "ability to monitor physiological changes" (pg. 263) through goal setting, role plays and monitoring of one's own behaviour, along with decreasing negative cues, but increasing positive experiences.

When designing educational programs gender differences may need to be considered. Female athletes are more likely to be concerned with weight while male adolescents are more likely to eat to either get more muscular, taller or to lose body fat (Neumark-Sztainer et al, 1999, Hinton et al, 2004). It has also been shown that males are likely to want to maintain their current weight while in comparison females are more likely to want to lose weight (Nowak et al, 1998). One study found that 62% of the American female athletes wanted to lose at least 5lbs regardless of what sport they competed in (Hinton et al, 2004). 76% of the female adolescents in Chapman et al's research (1997) also wanted to lose weight. Knudsen et al (1988) also found that females who participated in athletic and sporting events were not as concerned with the energy demands needed for their sport but they focused mainly on weight control. The ANKAA study did not investigate the relationship between male and female weight/image and nutrition; however this would be of interest in further research, especially in females. These are significant implications in designing interventions for adolescents and may suggest why they choose the methods of education they did in the questionnaire.

Individual sessions with a sports nutritionist was the most favoured method of education overall (73.68%) and this type of session is ideal for improving self efficacy though guided practice. A competent sports nutritionist can advise an athlete on basic nutrition, as well as sports nutrition practices, in a way that the adolescent can understand and see the benefits of particular nutritional strategies. The adolescents may feel that having the session with a sports nutritionist will be a way of gaining expert knowledge, and being guided on how to use this knowledge. An individual session allows the sports nutritionist to work with the individual athletes focus and goals and allows the education to be targeted at an area of interest (for example weight control in females). With guided practice being so vital in behaviour change it raises the issue of follow up education with the adolescent athlete as they cannot be expected to change behaviour with just one session. The rugby players who attended the focus group were clearly in favour of ongoing sessions with their nutritionist and thought that it was most beneficial as they may need ongoing help for some changes, and always had new questions that they liked answered.

From the list of education methods given to the athletes in the questionnaire the supermarket tours and cooking sessions are potentially a method for addressing the component of self confidence. Self confidence is often gained by doing practical tasks and the supermarket tour and cooking sessions allow athletes to take part and do these tasks themselves. This has the potential to improve their confidence in both selecting foods and cooking foods. For example; 31.58% of the athletes stated that they would like to receive a group cooking session, and 26.23% would like to do a supermarket tour. The rugby players who attended the focus group were enthusiastic about cooking and were eager to discuss potential resources related to cooking including recipe lists and how takeaways compare to homemade meals in terms of nutritional value and cost. They enthusiastically discussed a past experience of making sushi in a group cooking session. Incorporating a recipe list, homemade takeaway options and cooking classes together could be a successful part of an intervention with this group both improving knowledge and improving self confidence in the kitchen. It was interesting to observe that 22.86% of the basketball athletes had attended a cooking session but they still rated their cooking skills lower than the overall average. This may indicate that more than one session is needed to instill confidence or skill. 17.9% of the rugby athletes had also attended a cooking session but they rated their cooking skills at 6.43. This higher rating could possibly be attributed to the fact that because more of them live away from home (60.7%) they have had more practice at cooking, whereas as majority of the basketball players lived at home (94.1%) and may have others who are responsible for cooking. 74% of the rugby athletes said that they prepared food, whereas only 57.1% of the basketball athletes prepared food. This demonstrates how self confidence may play a major role in a successful intervention.

When addressing beliefs about final outcomes of the intended behaviour this could be an ideal situation to use elite athletes as guest speakers about how nutrition is beneficial in their sporting performance. Using a well known athlete or role model may also be beneficial in terms of addressing expectations. Expectations are the individual's beliefs about the outcome of the behaviour (Owen et al, 1999). If an athlete is able to see the desired results in a well known role model they may start to expect to be able to improve their own performance as the role model has done. 52.63% of athletes indicated that they would like to receive nutrition education in this manner (the second highest ranked method of education). One of the points that the rugby athletes who attended the focus group wanted to see on a sports nutrition website was examples of what elite rugby players ate on a daily basis, for example a meal plan. They discussed that this would be motivating and would make them consider their nutrition more. A guest speaker may be able to describe the outcomes of particular behaviours in detail from actually using this behaviour in the past in the same situations (for example in a rugby game). Although sports nutritionists are trained in the recommendations and practicalities of sports nutrition they may not have directly used the specific strategy in that situation (again for example they have not played in a rugby game) whereas another player may be better equipped to explain the outcomes to the athletes having been in the same situation. Obviously the speaker would have to be teaching the athletes correct nutrition behaviour as younger athletes are likely to mimic or copy the same behaviour.

It is evident that adolescent athletes favorably respond to a performance focused expectation than one which is based on long term health consequences (Croll et al, 2006, Litt, 2004, Chapman & Toma, 1997, Knudsen, Nowak & Schultz, 1988, Poolton, 1972). Another issue to address is that the athletes may struggle to identify expectations if they are not educated about these. This is where guest speakers may be able to be of assistance as described above. Research shows that an adolescent athlete's nutritional knowledge may be inadequate or limited (Douglas & Douglas, 1984, Benson, Gillen & Bourdet, 1986) so it is possible that they may not be able to identify the expectations of sports nutrition strategies on sports performance. 88% agreed that sports nutrition would help definitely help performance but the subject's expectations of how sports nutrition could help them and their performance was not investigated in this study. In hindsight this would have been a beneficial area to have observed, and should be investigated in the future. It is also important that coaches can identify the expectations of using sports nutrition strategies on sports performance as 64.3% of the subjects in this study believed that their coaches should be involved in their nutrition education, and coaches were given as the source of information by 62% of the subjects (the second highest method behind an individual session with a sports nutritionist).

Expectations also interrelate with the component of observational learning. It has been clearly shown that children and adolescents will mimic the behaviour of others such as parents (Ells et al, 2005, Ritchie et al, 2005). As adolescents are impressionable and mimic others behaviours this is an ideal opportunity in an intervention to impress upon adolescent athletes basic and more specific nutrition strategies. Again this may be why having a guest athlete to speak about nutrition was so appealing to the subjects, as adolescents they look to elite players as role models. Hackman et al (1992) suggests that using high profile athletes to portray nutrition information is a strategy that is likely to be successful with adolescents. Using others as role models will only be successful if the behaviours that they demonstrate for mimicking or copying are correct in the first instance. This shows that there is a real need for those who are in contact with the adolescent athlete to have correct nutrition knowledge and behaviour. Rugby athletes who attended the focus group were very particular in emphasizing that nutrition information provided to them should be written or endorsed by a sports nutritionist, and preferably the nutritionist they work with.

64.3% of athletes stated that they thought coaches should be involved in their nutrition education, whilst 81.6% of parents/caregivers should also be involved. A number of athletes noted that their parents/caregivers played a role in food availability and preparation. It is therefore vital that these parents are educated on sports nutrition and possibly general nutrition so that they can demonstrate correct behaviours to adolescent athletes. Parents play a major role in the creation of the environment that the adolescent lives in. Other individuals who should be involved in this education were given to be; team mates and team members, flatmates, partners, the nutritionist, friends (general, and in the same team), fitness trainers, and teachers.

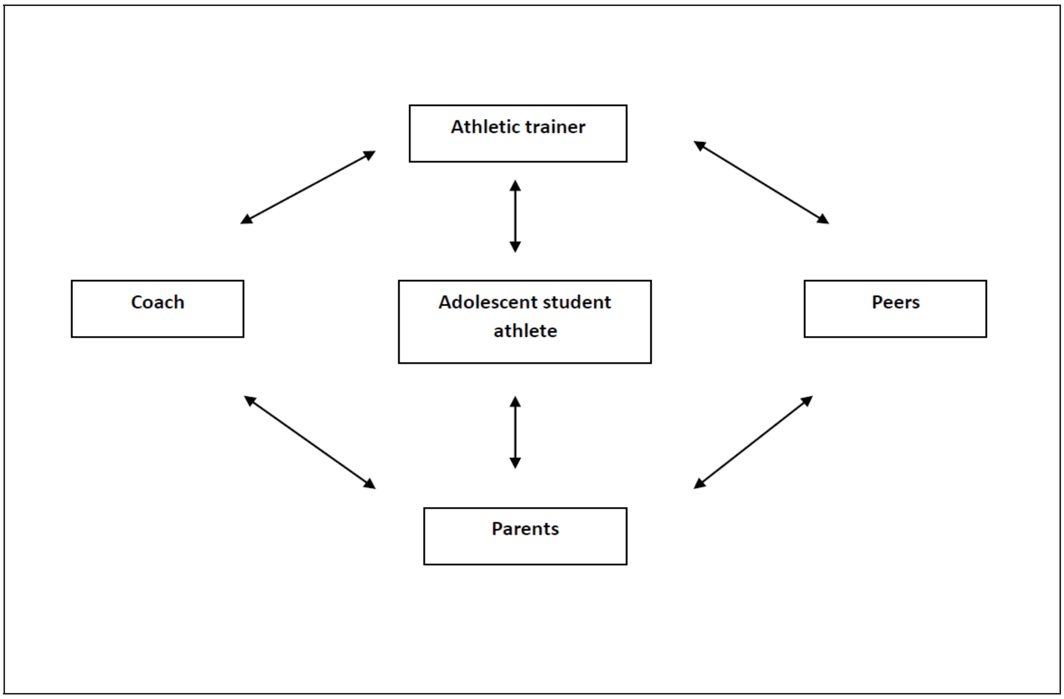
Only 25% of rugby athletes, 38.24% of basketball athletes and 33.3% of underwater hockey athletes said that their parents/caregivers should be involved in their nutrition education. Conversely 52.85% of football athletes, 84.21% of netball athletes agreed that their parents/caregivers should be involved. This may be because the rugby and underwater hockey athletes were all living away from home so did not relay as heavily on parents for support.

There were varying opinions based on sports on whether coaches should be involved with nutrition education. 94.12% of basketball athletes, 92.31% of football athletes, and 89.47% of netball athletes, said that their coaches need to be involved in their nutrition education. 66.6% of underwater hockey players and 60.7% of rugby athletes agreed that coaches should be involved. The role of the coach is important but it is also important that a coach is imparting correct knowledge to an athlete if they decide to provide nutrition advice. Previous research suggests that coaches often have incorrect perceptions of specific sports nutrition areas, in particular protein needs and building lean mass (Zinn et al, 1996, Baer et al, 1994). In the focus group the rugby players had mixed ideas about the coach's role in nutrition education. They stated that they were often asked to either increase their muscle mass, or decrease their body fat levels by the coach, but the coaches were not able to provide them with correct knowledge about how to do this. They were unsure whether it is the coach's role to provide them with nutrition advice; however they did mention that at some levels a team only had a coach, and not the services of a sports nutritionist, so in that case it would be valuable for the coach to have nutrition education and knowledge. Given that trainers were recommending supplements (particularly in rugby), it is essential to look at the nutritional knowledge of these individuals, particularly as they are encouraging to adolescents to use these supplements and previous research suggests that they may not possess substantial nutrition knowledge about them (Jacobsen et al, 2001).

The environment is a major issue in designing interventions as it is known that an intervention must target both the environment and the individual to make a successful change (Story et al, 2002). Research has shown that interventions with adolescents that involve parents are more likely to be successful (Hoelscher et al, 2002, Lytle, 1995, Parcel et al, 1988). An integrated approach is needed because of the numerous influences on behaviour on adolescents. Hackman et al (1992) has suggested the following system (figure 4) to address how a cooperative systems approach may work in adolescent nutrition education.

As well as the personal influences that are seen in the adolescent's environment, adolescents also currently live in an environment which is rapidly advancing in technology and where a significant amount of learning and communication is done via the internet and technological resources. It could be assumed that adolescent athletes would prefer website based nutrition information over written resources but 42.11% wanted written resources, as compared with 21.05% wanting website based information. With the small sample seen in this study this may be inaccurate. Another explanation for this is that active adolescents who are participating in higher level sport may not have the time to be on the internet, like adolescents who are not so active may do. The rugby athletes who attended the focus group also made it very clear that they were aware of unsuitable and potentially incorrect information on the internet so it is possible that adolescent athletes overall may be wary of using this tool because of this

Figure 4: A cooperative systems approach that can influence dietary choices of adolescent athletes (from Hackman et al, 1992, pg. 264).



Behavioural capability is the need for an individual to have the knowledge to be able to make a change (Owen et al, 1999). A potential use of resources with this component of the SCT is providing the athletes with the knowledge in forms such as written resources, recipe lists and pamphlets. Written resources were popular with 42.11% of the subjects wanting future education in this form, and recipes lists were favoured by 31.58% of the subjects. During the focus group with the rugby athletes, fact sheets and posters were by far the most popular forms of written resources. Pamphlets were not liked at all by the athletes and there was a general consensus that books would not be used by the group – the reasoning for this is that they didn’t want to sift through information, and they didn't know if the information was applicable to them. Therefore smaller, more concise forms of information could be more useful for educating these athletes. The athletes also thought that simple fact sheets would be very beneficial, especially if they contained information on takeaways, again they thought this resource should be endorsed by a nutritionist to ensure credibility. However they did state that if they were to be given a specific rugby book that was endorsed by the New Zealand Rugby Union, contained pictures and recommended by one of their nutritionists that they may read it although they were not keen on having to buy a book and thought that it would be a good idea if they were given one as part of their academy education. When asked what written information should contain it was widely agreed that not too much information should be contained on the resource. Pictures were also highly liked. One athlete stated it was best to "keep it simple but interesting".

The results given for which methods of education that the subjects wanted could be open to interpretation. The study only used athletes from team sports which may have swayed the methods wanted. For example athletes from team sports may look upon group sessions more favorably, compared to athletes who compete in individual sports. This could possibly be attributed to the fact that members of a team may see it as a situation to spend more time with their team mates, and may think that if the whole team is involved their overall performance is likely to be more successful, whereas an individual athlete may prefer one-on-one sessions as they only have to focus on their own performance, and the same team dynamics may not be present when a group of individuals are put together as opposed to a team together.

It is important to remember there is very limited information available as to whether adolescent athletes use nutrition information which is given to them. The athletes need to be ready to take on new information and use this (Hackman et al, 1992). Douglas and Douglas (1984) found that females in particular were susceptible to not using information when making food choices, however Harrison et al (1991) found that elite athletes more often met guidelines and had slightly higher levels of nutrition knowledge than non elite athletes, possibly indicating that they do use information which they are given. In the ANKAA study 43% of the subjects said they use nutrition information that they are given, whereas 46.2% said they sometimes used information, whilst 10.8% said they did not use information. Seven participants did not answer this question. This is disturbing in that so many athletes do not use, or sometimes use information, compared to how important they believe it to be. There are obviously other factors or influences which are playing a role in the adolescents' behaviour. During the focus group conducted it was clear that the athletes did use the knowledge given to them, although it is not clear why this is. It could be to do with the fact that they have team nutritionist available to answer questions or it could be that they are in an academy group means that they are more interested in improving their performance. There may also be more peer-pressure from team mates to use nutrition information, although focus groups with the other sports would have been useful to see if they gave similar answers.

9.1. An example of a successful nutrition education programme

In an example given by Burns and Dugan (1994), a nutrition programme can be highly successful if it is implemented properly and designed by a nutrition professional in consultation with other team management. The example provided by Burns and Dugan (1994) showed that the performance of team members improved by players being able to maintain weight more easily, and players having an improved endurance throughout the third quarter of a match. The nutrition programme that was designed for the National Hockey League (NHL) team was first started as a nutrition professional giving a one off lecture to the team. This was not as successful as the team did not have time to incorporate and focus on many of the topics before finals time. The programme then developed to include a nutrition session on spring minicamp. Minicamp is designed for younger players who are looking to make the senior team, and to identify talent. The player's received an introductory lecture which included an "overview of good nutrition" and "an introduction to the basics of sports nutrition" (pg. 133). A quiz was also developed and used with the younger players so that they were able to use information in a "hands on setting" (pg. 133). After the success of this education, a full nutrition education plan was developed for the team. The final nutrition program included the following as seen in table 9.

Table 8: Nutrition Agenda (*from Burns et al, 2004, pg 133).*

Time of year	Education events
Spring minicamp	Hands on lecture on sports nutrition to new players
Fall training camp	Comprehensive club lecture Individual assessments with diet records Individual counseling as needed
Winter season	Weight logs Locker room protocols (between periods and post game)

	Road trip tips
Spring playoffs	Team “nutrition tips”

The comprehensive lecture at the fall training camp included inviting player’s partners and significant others so that the message given was clear to the athlete and those who have an impact on their environment. It was also noted that one year a supermarket tour was very successful with the players, and when play off time arrived importance was placed on reinforcing the nutrition information that had already been given through flyers which focused on the topics of carbohydrate replacement and fluid balance. This shows that well planned nutrition programmes can be developed and used with athletes, however Burns et al (1994) mentions that it is vital to have the full support of coaches and other team management, as well as trainers and the medical team to make the program successful. This model has been used in the development of the resources and draft curriculum for the ANKAA study.

9.2. The author’s educational program proposal

The results of the ANKAA study show that an educational program is needed for adolescent athletes and the author has developed a proposal for a program which is described in 8.6.1.

9.2.1. The proposed program

Based on the results of the ANKAA study an education program for adolescent athletes could be designed. The following proposal by the author is based on the methods of education that the athletes have preferred in the ANKAA study and based on the theory that guided practice of a behaviour is essential to successful learning and change (Hackman et al, 1992) as well as components of the SCT. It is proposed that an adolescent should ideally have: vivid experiences of success possibly through modelling, are under the influence of social persuasion (through the involvement of coaches, parents, sports nutritionists, posters, resources and the sharing of ideas and information). To be successful the adolescent must have an ability to monitor progress and changes through goal setting, monitoring of their own behaviour, role plays and an environment where positive cues are widely used and a decrease in negative cues is seen. Table 10 shows a proposed year long education program with the reasons for particular resources and sessions being included.

Table 9: The author's proposed nutrition education program for adolescent athletes with examples of why each component is used in the program

Time of year	Educational events	What it addresses and how it improves self efficacy
Month 1 Start of year or season (depending on sport)	1. Group presentation discussing the concept of sports nutrition and how it can help performance directed by the sports nutritionist but an ideal time to include an elite athlete to speak on their experience with sports nutrition. Include coaches and parents. 2. Hand out basic nutrition fact sheets which accompany the material included in the presentation	Awareness of the outcomes of using sports nutrition strategies. Modelling and observational learning – through elite athlete involvement Social persuasion
Month 2	3. Individual consultation with athletes to look at basic nutrition.	Guided practice, ability to monitor changes
Month 3	4. Follow up individual consultation with athlete and sports nutritionist. 5. Nutrition quiz evening based on basic nutrition knowledge	Guided practice, ability to monitor changes Vivid experience of success, increase positive experiences
Month 4	8. Follow up individual consultation with athlete and sports nutritionist. 9. Supermarket tour	Guided practice, ability to monitor changes Guided practice, vivid experience of success, increase positive experiences and self confidence, observational

		learning and modelling
	10. Handouts specifically related to shopping for adolescents (e.g. snack options)	Social persuasion
Month 5	11. Follow up individual consultation with athlete and sports nutritionist.	Guided practice, ability to monitor changes
	12. Parents, coaches, managers and trainers education evening	Improve the knowledge and expectations of those who have an immediate effect on the adolescents environment, social persuasion
Month 6	13. Follow up individual consultation with athlete and sports nutritionist.	Guided practice, ability to monitor changes
	14. Cooking session 1 (quick, easy recipes)	Guided practice, vivid experience of success, increase positive experiences and self confidence, observational learning and modelling
Month 7	15. Follow up individual consultation with athlete and sports nutritionist.	Guided practice, ability to monitor changes
	16. Cooking session 2	Guided practice, vivid experience of success, increase

		positive experiences and self confidence, observational learning and modelling.
	17. Handouts for homemade takeaways (compare nutritional value and cost with brought versions)	Social persuasion
Month 8	18. Follow up individual consultation with athlete and sports nutritionist.	Guided practice, ability to monitor changes
	19. Cook Off session	Vivid experience of success, increase positive experiences and self confidence
Month 9	20. Follow up individual consultation with athlete and sports nutritionist.	Guided practice, ability to monitor changes
	21. Sports Nutrition Quiz	Vivid experience of success, increase positive experiences and self confidence
	22. Give out recipe list resource (based on recipes made in cook off and previous sessions)	Social persuasion
Month 10	23. Follow up individual consultation with athlete and sports nutritionist.	Guided practice, ability to monitor changes

	24. Hydration workshop (again a good time to allow guest athlete to discuss their nutritional habits)	Vivid experience of success, modelling, increase positive experiences and self confidence, observational learning and modelling
Month 11	25. Follow up individual consultation with athlete and sports nutritionist. 26. Sports drink tasting and education workshop including fact sheets and posters on how to choose sports drinks and when to use them	Guided practice, ability to monitor changes Vivid experience of success, social persuasion, increase positive experiences and self confidence, observational learning and modelling
Month 12	27. Follow up individual consultation with athlete and sports nutritionist. 28. Group presentation on supplements including handout fact sheets	Guided practice, ability to monitor changes Social persuasion
Throughout the entire year	Interactive website that builds on the information that the athletes have been learning. Include: - a function that athletes can search uses for a particular food, for example typing in pasta would bring a number of recipes that use pasta as the main ingredient, - notes and quotes from the elite athlete(s) that has spoken to the	Social persuasion, observational learning, modelling (role models information on website e.g. meal plans or favourite recipes)

	group possibly including their menu plan or food diary, Posters are placed in clubrooms that emphasise the areas of nutrition that the group is focusing on.	Influencing the immediate environment, social persuasion

9.2.2. Feedback on the authors proposed educational program

The author's proposed educational program was discussed with a registered dietitian who is also a high performance sports nutritionist for a NSO to obtain feedback and comments on perceived effectiveness and any other factors which should be taken into account with the plan. The overall program was well received and the sports nutritionist thought that it was a comprehensive educational tool that could successfully be used with young athletes. He did comment that it would be good to get feedback on the website design and whether it would need to changed from such bright colours to suit an older audience (those who are 16 onwards). He also suggested that older adolescent athletes may not associate themselves with being called a young athlete so another name for this group may be helpful.

The feedback on group sessions was pleasing and the only suggestion to change these is to investigate the number of athletes that is optimal to have together for education sessions. The sports nutritionist had found from previous experience that between 4 and 6 athletes worked best together. It had also been observed that groups larger than this sometimes developed a "pack mentality" and occasionally bad behaviour resulted from small groups within the larger group, but when an athlete was on his or her own they sometimes "clammed up" and were not always easy to talk to and get honest answers from. Sigman-Grant (2002) has suggested that a combination of individual and group sessions is preferred when working with adolescents. This factor which could be decided depending on the group of athletes.

Making events competitive was a strategy that was discussed and the sports nutritionist providing feedback felt that this was a good tool to use, especially with males. The sports nutritionist had also found through experience that having a competitive element made the athletes become more involved in the task and they tended to feel prouder of their final output (or food in the case of cooking sessions).

Focusing on the environment was also a large part of the discussion and feedback. The sports nutritionist had found that simply educating the athlete was not enough, the family often played a large role in social occasions where food was available (especially in some cultures like Pacific Islanders) and it had been observed that even if the athlete had been educated on what to eat they would not necessarily do this with others around. The family needed education so that the environment could be improved. This is in accordance with previous research which has shown that the environment including parents and family does play a role in food behaviour (Story et al, 2002, O'Dea, 2003, Lytle 1995, Parcel et al, 1988, Zinn et al, 2006) as adolescents will mimic the behaviour of parents (Ells et al, 2005, Ritchie et al, 2005) and the parents play a role in molding the environment of the adolescent (Searles et al, 1986).

The resources that could be used in conjunction with the program (as seen in Appendix 3) were also well received and the sports nutritionist thought that the website layout looked effective and well presented. The idea of having food based recipes (for example ways to use pasta) as opposed to one off recipes was discussed and the sports nutritionist agreed that this was an idea that should be looked at in more depth. It had also been seen through experience that athletes (males) were more enthusiastic about learning how to use a food in different ways as opposed to being given fancier looking recipes and recipe books.

There are obvious limitations to the program. Cost is a major concern and sports may prefer to target funds at other areas instead of a full sports nutrition education program. Time is another consideration; many adolescent athletes have other commitments that may intrude on time available to take part. Individual athletes would need a program which differs in some areas. This proposed program may work better for team based sports as the athletes are in a team environment but other changes may need to be made to adapt it to individual sport athletes. Some sports do not run year round so this may limit the time available for educational sessions.

Examples of the resources that could be used with these sessions are included in appendix 3.

Appendix 1 – The Questionnaire

Massey University

INSTITUTE OF FOOD, NUTRITION & HUMAN HEALTH

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

QUESTIONNAIRE

Thank you for taking the opportunity to fill out this questionnaire, the results from this research will be used to assess the level of nutrition knowledge and sports nutrition practices of talented adolescent athletes and to help develop a curriculum and resources for working with this group.

There are four sections to the questionnaire. Please ensure that you fill out the questionnaire by yourself, and answer every question. Please only give one answer per question unless the question asks you to 'tick as many as appropriate'. This is not a test, please answer honestly. If you are unsure of an answer please tick the '*unsure*' option instead of guessing the answer. Your answers will remain anonymous and be used only for this research.

SECTION A - BASIC NUTRITION KNOWLEDGE

A.1. According to **you**, what would you define as a healthy diet?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………………

A.2. Name the FOUR food groups

______________________ ______________________

______________________ ______________________

A.3. Please answer whether these statements are true, false or if you are unsure of the answer:

	True	False	Unsure
Carbohydrates are found in breads and cereals	□	□	□
Carbohydrates are a main fuel source for the body	□	□	□
Carbohydrates play a major role in muscle recovery	□	□	□
Sugar is a not a carbohydrate	□	□	□
Eating carbohydrate can increase your body fat levels	□	□	□
Fruits and vegetables contain carbohydrates	□	□	□
Lollies are a good source of carbohydrate	□	□	□
Carbohydrates are stored as glycogen	□	□	□
Potatoes should be avoided in your diet	□	□	□
Fruits and Vegetables are a good source of protein	□	□	□
Protein plays an important role in muscle recovery	□	□	□
Vegetarians cannot eat enough protein without meat	□	□	□
Milk and dairy products do not contain protein	□	□	□
Meat only contains very small amounts of protein	□	□	□
Eating too much fat can increase your body fat levels	□	□	□
Fat is used by the body when doing low intensity exercise	□	□	□
Fat should be eaten during an event as a snack for energy	□	□	□
Most of the fat that you eat should be unsaturated fat	□	□	□
Water makes up 50% of the human body	□	□	□
Water is used as a transport system in the body	□	□	□
If you are thirsty you are already dehydrated	□	□	□
The colour of your urine is a good indication of hydration status	□	□	□
A calorie is the same as a kilojoule	□	□	□

A.4. Which of these foods are high in saturated fat? (one tick for each item)

	Yes	No	Unsure
Almonds	□	□	□
Chocolate	□	□	□
Coconut cream	□	□	□
Cream	□	□	□
Olive Oil	□	□	□
Potato chips	□	□	□
Pretzels	□	□	□

A.5. Which of these foods are high in protein? (one tick for each item)

	Yes	No	Unsure
Baked beans	□	□	□
Broccoli	□	□	□
Chicken breast	□	□	□
Low fat milk	□	□	□
Wholegrain bread	□	□	□

A.6. How many servings a day do nutritional experts recommended for each of these:

Breads & Cereals	………	Fruits & Vegetables	…………
Milk & Dairy products	………	Meat & Meat Alternatives	……….

A.7. Describe a serving size for each of these:

Bread ……………………………………………………………………………

Rice ……………………………………………………………………………

Fruit ……………………………………………………………………………

Vegetable ……………………………………………………………………………

Milk ……………………………………………………………………………

Cheese ……………………………………………………………………………...

Lean mince ……………………………………………………………………………

Chicken breast ……………………………………………………………………………

A.8. Which of these food components contains the most energy?

Alcohol	□
Protein	□
Carbohydrates	□
Fat	□

A.9. What is the function of vitamins and minerals in the human body?

To build muscle mass	□
As a source of energy	□
To catalyse biological reactions	□
To help burn fat	□
To store carbohydrates	□

A.10. Which of these are symptoms of Iron deficiency? (tick as many as appropriate)

Breathlessness □ Headaches □ Pale skin □

Tiredness/fatigue □ Decreased athletic performance □

A.11. The glycaemic index system is a ranking of:

The rate of release of fat into the bloodstream □

How quickly you feel the effects of food □

The rate of release of carbohydrate into the bloodstream □

The rate of burning body fat □

SECTION B – INFLUENCES ON FOOD CHOICE AND AVAILABILITY

B.1. Who does most of the food shopping and food preparation in your living situation?

……

……

B.2. Do **you** prepare meals for yourself or your family? Yes □ No □

If yes, what type of meals do you prepare? …………………………………………………

………

………

………

B.3. How would **you** rate **your** cooking skills on a scale of 1 to 10 ? please circle the relevant score.

1 2 3 4 5 6 7 8 9 10

non-existent average excellent

B.4. How often do **you** eat breakfast?

Everyday □

4 – 6 days a week □

1 – 3 days a week □

Never □

*If you have ticked that you **do not** have breakfast everyday, what is your main reason for missing breakfast?……………………………………………………………………………….....*

B.5. Do **you** take your lunch to school/university/work?

Everyday	□
3- 4 times a week	□
1 – 2 times a week	□
Never	□

*If **you take** your lunch to school/university/work who prepares this?*

Self □ Parents/caregivers □ Other □

*If you **do not take** your lunch every day please explain what you have for lunch on those days:*……………………………………………………………………………………………………
………

B.6. Do **you** ever skip meals?

Yes □ No □

If yes, why do you skip meals? …………………………………………………………………...

B.7. What influences **you** when you are choosing foods? *Please rank in order of importance with one (1) being the most important.*

Cravings	( )	Influence of parents	( )
Advertising	( )	Influence of friends	( )
Cultural aspects	( )	Influence of coach	( )
Appearance of the food	( )	Convenience	( )
Taste	( )	Other (specify)	( ) ……………………

B.8. Do **you** get pocket money to spend on food?

Yes □ No □

B.9. How often do **you** have takeaways (food that is brought pre-made from an outlet) ?

Less than 1x a month	□
1 – 2 times a month	□
3 times a month	□
Once a week	□
2 -3 x a week	□
More than 3x a week	□

B.10. What takeaways have **you** eaten in the last three months? *(tick as many as needed)*

Burger King	□	Burger Fuel or Wisconsin	□
Chinese	□	Fish and Chips	□
Indian	□	Italian	□
Kebab	□	KFC or fried chicken	□
Malaysian	□	McDonalds	□
Pizza	□	Subway	□
Sushi	□	Thai	□
Other	□	please state……………………….…………………………	

B. 11. Do **you** eat out at restaurants? Yes □ No □

If yes, how often? ……………………………………………………………………………

If yes, what type of restaurants? ……………………………………………………………

SECTION C – BASIC SPORTS NUTRITION KNOWLEDGE AND PRACTICE

C.1. How important do **you** consider sports nutrition to be in your sporting plans?

- Very important □
- Slightly important □
- Not very important □
- Not important at all □

C.2. Do **you** believe that specific sports nutrition strategies could improve your performance?

- Yes, definitely □
- Maybe □
- No, probably not □

C.3. How do **you** rate **your** sports nutrition knowledge on a scale of 1 to 10?

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
non-existent				*average*					*excellent*

C.4. Do you think these help improve sporting performance? (one tick for each statement)

	Yes	No	Unsure
Eating carbohydrates 2 – 4 hours before an event	□	□	□
Eating protein 2 – 4 hours before an event	□	□	□
Eating carbohydrates 1- 2 hours before an event	□	□	□
Taking a multivitamin before an event	□	□	□
Drinking water immediately before an event	□	□	□
Drinking a caffeinated energy drink before an event	□	□	□
Eating protein during the event	□	□	□
Eating carbohydrates during the event	□	□	□
Drinking a Sports Drink during the event	□	□	□
Drinking Coca Cola during an event	□	□	□
Drinking Fruit juice during the event	□	□	□
Taking iron supplements without having iron deficiency	□	□	□

C.5. Please answer whether the following statements are true, false or if you are unsure of the answer:

	True	False	Unsure
There is 50grams of carbohydrate in a banana	□	□	□
Dehydration can affect sporting performance	□	□	□
Blurry vision is symptom of dehydration	□	□	□
The 'stitch' is a symptom of dehydration	□	□	□
Sports drinks contain carbohydrates	□	□	□
Sports drinks contain salt	□	□	□
Sports drinks contain fat	□	□	□
Caffeine improves running speed	□	□	□
Caffeine can improve concentration during a sporting event	□	□	□
Having bacon and eggs for breakfast before an event is ideal	□	□	□

C.6. Are sports nutrition recommendations different for adults as compared to adolescents?

Yes □ No □ Unsure □

C.7. Where do **you** gain sports nutrition knowledge from? (tick as many as appropriate)

Sports Nutritionist	□	Doctor	□
Dietitian	□	Coach	□
Fitness Trainer	□	Fellow competitors	□
Parents	□	School Teachers	□
T.V	□	Magazines	□
Internet sites	□	Friends	□

C.8. Have **you** had any of the following in the past:

	Yes
Individual session with a sports nutritionist or dietitian,	□
Supermarket Tour	□
Group Cooking session with a sports nutritionist or dietitian	□
Group workshop or lecture	□
Menu plans developed for yourself	□
Hydration Workshops	□
Athlete as a Guest speaker talking about their nutrition strategies	□
Nutrition Quiz Sessions	□

C.9. If **you** have been given sports nutrition advice in the past do you use it?

Yes	□	No	□
Sometimes	□	I have not received advice	□

C.10. Do **you** have a nutritional plan that you use for trainings?

Yes □ No □

C.11. Do **you** have a nutritional plan that you use for competitions?

Yes □ No □

C.12. What foods do **you** have before training or a competition?……………………………………

C.13. How much carbohydrate should an athlete eat before a competition?

20grams of carbohydrate	□	50grams of carbohydrate	□
100grams of carbohydrate	□	150grams of carbohydrate	□
200grams of carbohydrate	□	250grams of carbohydrate	□
Unsure of recommendations	□		

C.14. Do **you** drink fluid while at training?

Yes ◻ No ◻ Sometimes ◻

C.15. Generally how much water should an athlete consume per hour of exercise in a moderate environment?

None ◻ 100 – 300mLs ◻
350 – 550mLs ◻ 600 – 700mLs ◻
More than 700mLs ◻ Unsure ◻

C.16. If an athlete was doing exercise lasting longer than one hour, how much carbohydrate should the athlete consume per hour?

None ◻ 1 – 10grams ◻
10 – 29grams ◻ 30 – 60 grams ◻
61 – 75grams ◻ More than 75grams ◻
Unsure ◻

C.17. Do **you** drink fluid after training sessions?

Yes ◻ No ◻ Sometimes ◻

C.18. Do **you** use a sports drink?

Yes ◻ No ◻

If yes, what sports drink? ……………………………………………………………………………

If yes, why do you use this sports drink? ………………………………………………………

C.19. What is the recommended carbohydrate guideline for the recovery snack/meal in athletes?

1kg of carbohydrate per kg of bodyweight ◻
0.5g of carbohydrate per 2kgs of bodyweight ◻
1g of carbohydrate per kg of bodyweight ◻
5g of carbohydrate per kg of bodyweight ◻
Unsure of the recommended amount ◻

C.20. When is the best time to have a recovery snack after training or a competition?

Immediately after finishing the event ◻
Within 2hours of finishing the event ◻
2 – 4 hours after the event ◻
It does not really matter ◻

C.21. When do **you** eat after trainings and competitions?

As soon as I can (but definitely within 30 minutes) ◻
I try to have something within 2 hours ◻
I have something after 2hours of finishing ◻
I don't do anything for recovery ◻

C.22. Which of these will help to increase your muscle mass? (tick as many as appropriate)

Eating a very high protein diet ◻
Eating more overall ◻
Having protein shakes after every workout ◻
Weight training ◻
Eating egg whites with every meal ◻

C.23. Which of these are functions of a sports drink? (tick as many as appropriate)

It makes the body retain fluid ◻
It helps to burn fat ◻
It replaces sweat ◻
It tastes good compared to water ◻
It replaces sodium ◻
It replaces carbohydrates ◻
It replaces protein ◻
It is a source of water ◻

C.24. Do **you** take multivitamin supplements?

Yes ◻ No ◻ Sometimes ◻

If yes or sometimes, why do you take these? …………………………………………………

If yes or sometimes, who recommended that you take these? ………………………………

C.25. Do **you** use any other supplements apart from multivitamins?

Yes ◻ No ◻ Sometimes ◻

If yes or sometimes, what supplements do you use? ………………………………………

If yes or sometimes, why do you take these? …………………………………………………

If yes or sometimes, who recommended that you use these supplements? ………………

C.26. If **you** were to be given sports nutrition advice how do you think you would prefer this to be given? (*tick as many as appropriate)*

Individual session with a sports nutritionist or dietitian	□
Cooking session with a sports nutritionist or dietitian	□
Supermarket Tour	□
Quiz night	□
Group Workshops	□
Lectures	□
Written resources (e.g. pamphlets)	□
Recipe lists or books	□
Interactive Website programmes	□
Hydration workshops	□
Athlete as a guest speaker about their nutritional strategies	□

C.27. Do you think that anyone else should be involved with your nutrition education? (*tick as many as appropriate)*

Parents/Caregivers □ Coach □

Other □ *please specify* ……………………………………

C.28. Do you have any other ideas on how you would find education about sports nutrition more beneficial?

………

………

………

………

………

………

………………………………………………

SECTION D – DEMOGRAPHIC QUESTIONS

D.1. What is your age? _______ years

D.2. What is your gender? *Please circle one* Male Female

D.3. Where do you live?

At home ◻ In a hostel ◻ Flatting ◻

Other ◻ *please specify* …………………………………………………………

D.4. What level of education do you have?

Currently at University ◻ Finished school, not at university ◻

Currently in Year 13 ◻ Currently in Year 12 ◻

Currently in Year 11 ◻ Currently in Year 10 ◻

Currently in Year 9 ◻ Currently Year 8 or below ◻

D.5. Have you had any experience in nutrition or sports nutrition through your schooling?

Yes ◻ if yes, *please describe briefly* …………………………………………………

No ◻ ……………………………………………………………………………………..

D.6. What is your main sport? ……………………………………………………………………………

D.7. Do you compete competitively in more than one sport?

Yes ◻ *how many?* ………… No ◻

D.8. What level are you currently at in terms of your main sport?

Competing at International level ◻

Competing at National level ◻

Competing at Regional level ◻

D.9. How many hours a week do you spend training for your main sport (including specific sport and gym training)?

…………… hours

D.10. Do you have a rest phase during your yearly training plan?

Yes ◻ No ◻

Thank you very much for taking the time to fill out this questionnaire, your responses are greatly appreciated.

The results of this research will help to develop sports nutrition guidelines and education resources for talented adolescent athletes.

If you have any other comments on this questionnaire please feel free to put them below.

THANK YOU !

When you have completed the questionnaire, please return it to the Human Nutrition Studies Coordinator at Massey in the envelope provided.

Appendix 2 – Focus Group Question Sheet

Massey University

INSTITUTE OF FOOD, NUTRITION & HUMAN HEALTH

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

FOCUS GROUP QUESTIONNAIRE

Thank you for taking the opportunity to attend this focus group, the results from this research will be used to assess the level of nutrition knowledge and sports nutrition practices of talented adolescent athletes and to help develop a curriculum and resources for working with this group.

Please ensure that you fill out the questionnaire by yourself, and answer every question. This is not a test, please answer honestly. Your answers will remain anonymous and be used only for this research.

RESOURCES - WEBSITES

---

1. What websites do you use for obtaining sports nutrition advice?

SPARC	□
NZ Rugby Union	□
ACC Active Smart	□
Other	□ please specify………………………………………………

2. What would attract you most to a sports nutrition website?

Colour	□
Pictures of food and drink	□
Words and Headlines	□
Photos of famous players	□

3. What information would you most like to read about on a website?
   - Basic nutrition information ◻
   - Specific sports nutrition strategies ◻
   - Cooking tips ◻
   - Recipe lists ◻
   - Recommended recipe books ◻
   - Information on sports drinks ◻
   - Information on supplements ◻
   - Information from higher level athletes ◻
   - Other – please specify…………………………………………………………………

Do you have any other comments on how a website should provide education about sports nutrition?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

RESOURCES – RECIPE LISTS AND COOKBOOKS

---

4. Are any of these cookbooks familiar to you?
   - The Eat to Compete Cookbook ◻
   - Fit Food for Winners ◻
   - Survival of the Fittest ◻
   - The Edmonds Cookbook ◻
   - None are familiar ◻

5. What meals would you like recipes for?
   - Breakfast ◻
   - Brunch ◻
   - Lunch ◻
   - Dinner ◻
   - Snacks ◻
   - Baking ◻
   - Desserts and Treats ◻
   - Homemade Takeaways ◻
   - I’m not interested in recipes ◻

RESOURCES – WRITTEN

6. What written resources would you find helpful in learning about sports nutrition?
   - Fact sheets or handouts □
   - Pamphlets □
   - Books □
   - Posters □

7. What would you like to see in written resources?
   - Not too much information □
   - Lots of information □
   - Pictures □
   - Colour □
   - Other - please specify ……………………………………………………………………

RESOURCES – PRESENTATIONS & GROUP SESSIONS

8. What is important in a sports nutrition presentation?
   - A good presenter □
   - Lots of information □
   - A small amount of information □
   - Pictures/Photos □
   - Getting handouts of the presentation □

9. What is better in a presentation?
   - To have a lecture style presentation where you listen □
   - To have a presentation where you can ask questions throughout □
   - To have a presentation where you are asked questions by the presenter □
   - A combination of being able to ask questions, and being asked questions □

10. What is important in a presenter?
    - Knowledge of the topic □
    - Experience in giving presentations □
    - Enthusiasm of the presenter □

The gender of the presenter □
The age of a presenter □
The presenter doesn't matter □

11. Do you think there should be guidelines for supermarket tours so that they are all given in the same format?

    Yes □
    No □

12. Do you think there should be guidelines for cooking sessions so that they are all given in the same format?

    Yes □
    No □

Do you have any other ideas on how you would find education about sports nutrition more beneficial?

……
……
……
……
……
……
………………………………………………………………………………………………………

What resources should be produced for parents?

……
……..……
……………………………………………………………………………………………………….

What resources should be produced for coaches?

……
……
……………………………………………………………………………………………………….

What is your age? ………… years

Thank you very much for taking the time to attend this focus group, your responses are greatly appreciated.

If you have any other comments on this questionnaire please feel free to put them below.

Appendix 3 – Examples of resources to be produced

Young Athletes

SPORTS NUTRITION TIPS

Carbohydrates

Carbohydrates are an important energy source for athletes. They are used by the muscles and brain as a source of energy.

When you are training and competing you need to eat a balanced diet that provides you with carbohydrates for energy. Carbohydrate foods are also a good source of other nutrients including vitamins and minerals.

Why you need to eat carbohydrates

When you eat carbohydrate foods the carbohydrates are broken down into smaller particles called glucose in the digestive system. These smaller particles can then be passed into the bloodstream so that the blood can transport them all over the body. The muscles are able to pick up the small particles of glucose and store them in the muscle as glycogen. When the muscle requires a source of fuel so that it can perform work it uses the glycogen. For this reason you need to keep eating carbohydrates throughout the day so that you can keep re-stocking your muscles with glucose.

Where you can find carbohydrates

Two of the food groups provide good sources of carbohydrate. They are the breads and cereals group and the fruit and vegetables group.

Breads & Cereals

This food group includes pasta, rice, bread and bread products (like bread rolls, pita breads and wraps), quinoa, couscous, oats and other cereals. These foods are a good source of not only carbohydrates, but they also contain nutrients such as vitamins and minerals and fibre. When you can you should choose wholegrain breads and cereals as these contain more nutrients and fibre. You should have these foods at each meal.

Fruit & Vegetables

Fruits and vegetables also contain carbohydrate along with many nutrients and fibre. Each colour has different nutrients so you should try and eat a variety of coloured fruit and veggies. You should have fruit or vegetables at each meal and fruit is a great snack. Aim to have at least 5+ a day.

Other foods which contain carbohydrate

Other foods can also contain small amounts of carbohydrates. Some sweetened dairy products for example yoghurts and flavoured milks also contain carbohydrates.

As sugar is a carbohydrate, treat foods like lollies and sweets contain carbohydrates. Although they contain carbohydrates it is important to remember that they contain very little other nutrients (like vitamins and minerals) they should only be used as a treat and in specific sports situations. Soft drinks also contain a lot of sugar but they also have no other nutrients. Having sugary foods like soft drinks and lollies can also damage your teeth so you should only eat very small amounts of these. Sports drinks contain carbohydrates to help improve performance. They should only be used in events where you exercise for longer than 1 hour. Check with your nutritionist on when and how to use them correctly.





Top Tips

Carbohydrates are essential for sports performance. Carbohydrates are used as source of energy for the body so you need to make sure you eat these each day. Carbohydrates are found in breads and cereals and in fruits and vegetables. Try and include them at each main meal.

GUIDELINES

Group Cooking Sessions

Group cooking sessions are a fun and interactive method for providing nutrition education.

They are a great opportunity for the athlete to use their current skills and develop new skills in a relaxed, hands on environment.

Preparation and planning

- Aim to provide recipes to prepare a snack (or entrée), main meal and dessert
- Use recipes which each take no longer than 40 minutes to prepare from start to finish so that time is available to consume the finished product
- Use foods that are likely to be found in the adolescents home
- Use recipes that are easy to follow and that are given in a step by step format
- Choose interactive recipes that use different methods of preparation, such as sushi
- Make sure that any special dietary concerns are known when preparing the menu (i.e. vegetarian, Coeliacs disease, lactose intolerance, nut allergy etc) and adjust the menu accordingly
- Choose a location that has all the equipment that is needed, school cooking rooms are ideal for this. Check beforehand that all equipment is provided, i.e. muffin trays, loaf tins. Also check what clean up equipment is available, i.e. tea towels, dishwashing liquid.

Procedure

- The session duration should be 2.5 – 3 hours in order to be able to give an overview of each recipe, perform the recipe and with time to enjoy the food, and then clean up
- Describe how the session will be conducted and what recipes each group will be cooking. Encourage all participants to fully read all instructions before starting the recipe
- Give a short introduction to the four food groups and show how these relate to the recipes given to participants, and how these meals are suitable for an athlete
- Place participants in groups of 3 – 4 to prepare the food and give them the recipes to follow. Aim to place athletes in groups that have a variety of previous cooking experiences
- Ask each group to have each of their meals prepared and ready to eat at a certain time (leave at least 15 minutes at the end to clean up after time to consume the foods together)
- Allow the groups to prepare their recipes whilst moving throughout the room to answer questions and check progress. This is an ideal time to discuss nutrition and cooking with the participants

Information to be given to participants

- Show how the food fits the guidelines for an adolescent athlete (for example use a grading system on the recipe with symbols to represent i.e. high carbohydrate, moderate protein, low fat)
- Give information on why each recipe is suited for an adolescent athlete or ask the athletes to tell the group why their recipe is suitable for adolescent athletes. This could be done when the participants are consuming the food, or alternately while moving throughout the room while the participants are preparing the recipes
- Relate each recipe to the healthy plate model (½ vegetables, ¼ protein, and ¼ breads and cereals (potato).

Follow on sessions

- An advanced cooking session could be held after an initial session with more complex recipes being produced.
- A Cook Off session is also an ideal opportunity to reinforce the skills learnt in an initial session for the athletes. A Cook Off could be structured in two ways; 1. The athletes are provided with set ingredients and they are asked to cook a meal from these which meets specific guidelines within a specified timeframe, or 2. The athletes are provided with a budget and asked to buy and prepare a meal which meets specific guidelines within a specified timeframe.

Top Tips

Cooking sessions are an interactive and enjoyable way of teaching food preparation skills to adolescent athletes. They should be encouraged to cook a snack, main meal and a dessert. A Cook Off competition is an ideal follow up session to reinforce the skills and knowledge acquired in the initial session.

Young Athletes

Your Menu

- Home
- Basic nutrition guidelines
- Sport specific nutrition
- Recipes
- Links
- Ask a question
- About Us
- Contact

Information for Parents & Coaches

Welcome to the Young Athletes Sports Nutrition Website!

Sports Nutrition is important to your performance! What you eat and drink affects how well you train, play and develop.

This website is specially developed for adolescent athletes. By following the links on the menu you can find information on basic nutrition guidelines, sport specific information including sections on sports drinks, supplements and more!

You can also read hot tips from your favourite athletes and find recipes for quick and easy snacks and meals.

Your parents and coaches can use the link specially designed for them that gives them ideas for helping you with your sports nutrition.

Find out when and how to use Sports Drinks

Hot tips on sports nutrition from your favourite athletes

Quick, easy meals and snacks in less than 20 minutes

Appendix 4: Summary sheet for NSO’s

Overall summary for Sports nutritionists and interested parties

Basketball specific summary

Football specific summary

Netball specific summary

Rugby specific summary

Underwater Hockey specific summary

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

SUMMARY OF RESEARCH RESULTS

There is very limited research on the nutrition knowledge and food skills of elite athletes in New Zealand. Adolescent athletes are moving through an important physiological stage of life, as well as training and competing in their chosen sports. These athletes are the future New Zealand sporting representatives and therefore need adequate nutrition knowledge for performance, as well as health and wellbeing. This research investigated the basic and sports nutrition knowledge of 100 talented adolescent athletes from five team sports using questionnaires and a focus group. While the participants had a reasonable level of basic nutrition knowledge, their sports nutrition knowledge was not as high. They struggled with the concepts of sports drinks, muscle growth and supplements. Most participants had received some nutrition education and indicated that in the future they would prefer individual sessions with a sports nutritionist, written resources, as well as group sessions including cooking sessions and group workshops, and using a high profile athlete as a role model. The participants were very clear that their coaches and parents needed to be involved in their nutrition education. More research is needed to assess the overall knowledge of New Zealand adolescent athletes and the most appropriate, and effective methods of education for this group.

Introduction

When an adolescent is also an athlete there are many important factors to consider in terms of nutrition for both growth and sports performance. Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al, 2006). Coupled with the fact that when the athlete is an adolescent they have further energy and nutrient needs due to the large period of growth that the adolescent period entails, including the adolescent growth spurt (ADA, 1996, Story et al, 2002, Hinton et al, 2004, Croll et al, 2006), this creates a significant nutritional challenge.

The specific aims of this research were:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences this subject group in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this subject group,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

This project is designed to assess the knowledge of talented New Zealand adolescent athletes and look at identifying how adolescents would prefer to be given sports nutrition advice. Currently there is also a lack of resources designed to work specifically with this group and it is anticipated that this research project will not only identify the level of nutritional knowledge of this group but also develop an educational curriculum and accompanying resources which should be produced for this group.

METHODOLOGY

Subjects

Letters were sent to ten national sporting organisations (NSO's) describing the study and asking if they would give permission for their athletes who met the entry criteria to take part in the study. The ten sports were chosen as they encompassed a range of both team and individual sports, and sports which are generally gender specific. Sporting organizations were asked to provide contact details of athletes who met the entry criteria for the project. The entry criteria was that athletes needed to be between the ages of 13 and 20 years old as at the 1st of January 2007, and be considered a talented or elite athlete in their chosen sport by being a carded athlete, or part of a High Performance Academy Group, Regional Talent Identification Group or an equivalent Development group. Sporting organisations who agreed to participate in the study were asked to forward contact details of athletes who met the criteria to an independent third party research assistant. This preserved confidentiality of contact details.

Five sporting organizations agreed to take part in this research; Basketball New Zealand, Netball New Zealand, New Zealand Football, New Zealand Rugby Union, and New Zealand Underwater Hockey. A total of 100 athletes took part in the research.

The study was given ethical approval by the Massey University Committee of Ethics (ref 07/52).

The Questionnaire

The questionnaire was developed to address four different aims. Section A aimed to assess the basic nutritional knowledge of the subjects. Section B aimed to investigate influences on food choice and food availability in the subjects. Section C was designed to assess the basic sports nutrition knowledge and practices of the subjects and section D gathered basic demographic information about the subjects.

The questionnaire was developed using previous research questions and newly developed questions. A pilot trial of the questionnaire was conducted with athletes of the same age and who participated in the same ten sports as the targeted population and changes were made to questions which were unclear before sending to the actual subject group. Changes included rewording four questions so that they were appropriate for the age group in this study. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge, and those who did not have any knowledge the questionnaire used 'yes', 'no' and 'unsure' answers.

Procedure

The independent research assistant used the contact details from NSO's to create two sets of address labels for each contact. The first set was used to send the initial questionnaire pack which included a participant information sheet, a participant consent form, a parental information sheet, a parental consent form, a questionnaire and a return envelope.

The questionnaires were coded to identify which participants had returned their questionnaire. The independent research assistant followed up the athletes who had not returned the questionnaire phone call. When the unnamed questionnaires were received by the independent research assistant they were removed from the envelopes and passed on to the student researcher to ensure confidentiality of the subjects.

The second set of address labels were used in the organisation of focus groups. One invitation to participate in the focus groups arranged in Christchurch, Wellington, Palmerston North and Auckland in December 2008 was sent out to all participants and did not receive any responses to attend. This may have been due to being in close proximity to Christmas so another round of focus groups was planned for February 2009. Although there were very few respondents there were not enough to warrant a focus group at this time either. Instead the Manawatu Rugby Academy volunteered to run a focus group with their academy players (some of who had previously completed the questionnaire for this research). There were nine players, and their sports nutritionist present.

A number of questions were developed for use in the focus group by the researcher to prompt the athletes with the aim of initiating discussion. Several props were used including cookbooks and pamphlets/booklets.

Data analysis

Analysis of the questionnaires was carried out to provide results. The data was analysed with SPSS v14.0.

OVERALL FINDINGS

100 athletes from five sports returned questionnaires for this research project. The distribution of sports and level of competition can be seen in Table 1:

Table 1: The distribution of sports and level of competition

Level	Basketball	Football	Netball	Rugby	UWH	TOTAL
Regional	1	0	11	19	0	31
National	16	2	7	5	1	31
International	15	12	1	4	2	34

*4 responses were not given for this question

The mean age of all of the athletes was 16.64 years (std dev 1.937). 55.8% of the athletes compete in more than one sport, with athletes from Netball (68.4%) and Basketball (61.76%) more likely to partake in more than one sport. Rugby (39.2%) and UWH (33.3%) were the least likely to take part in more one sport. However, the UWH group is not large enough to get a clear result.

BASIC NUTRITION KNOWLEDGE RESULTS

The athletes were asked to complete a series of questions designed to address basic nutrition knowledge. The scores were tallied and compared for each sport. UWH athletes had the highest number of correct responses but the very small sample size of this group means that this is disputable. Football was seen to have the next highest correct response rate, followed by netball, rugby and basketball. These results are given in table 2:

Table 2: % of correct responses to questions on basic nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	60.99 % Std dev 3.35	68.32 % Std dev 2.43	63.20 % Std dev 4.43	66.36% Std dev 2.96	78.26 %* Std dev 2.00

* UWH sample size much smaller

There was no significant difference between genders when investigating basic nutrition knowledge.

SPORTS NUTRITION KNOWLEDGE RESULTS

The athletes were also questioned on their attitudes toward sports nutrition and sports nutrition knowledge using a series of questions. Athletes ranked the importance of sports nutrition highly and had a positive belief in sports nutrition improving performance. The full results of these questions are shown in table 3.

Table 3: Overall results of attitudes to sports nutrition

Attitudes towards Sports Nutrition	**Percentage of athletes**
Importance of Sports Nutrition question: "How important do you consider sports nutrition to be in your sporting plans?"	
Very important Slightly important Not Very/slightly important Not important	79% 16% 2% 2%
Belief in Sports Nutrition to improve performance question: "Do you believe that specific sports nutrition strategies could improve your performance?"	
Yes definitely Maybe No	88% 12% -
Average rating of sports nutrition knowledge Question:	

"How would you rate your sports nutrition knowledge on a scale of 1 (non-existent) to 10 (excellent)?"	
Rating	5.87
Standard deviation	1.584
Variance	2.508

The answers to these questions were also divided into sporting code. Netball athletes rated the importance of sports nutrition the lowest out of the sports with 68.4% rating it as very important. 10.5% of the netball athletes also answered that it was not important, the only sport to do so. However a higher number (94.7%) of the Netball athletes believed that sports nutrition could improve performance. Netball athletes had a low self rating of nutrition knowledge with 5.76 out of a possible 10 which was near the lower end of the sports. The Netball athletes did however have the second highest amount of correct answers (43.86%) to the sports nutrition knowledge questions behind UWH (47.33%).
Football athletes rated the importance of sports nutrition highly with 78.6% of the athletes stating that it was very important, 14.3% stated it was slightly important and the remaining 7.1% stated that it was not very/slightly important. 85.7% of the football athletes believed that sports nutrition could improve performance and 14.3% thought that it may help. Football athletes rated their sports nutrition knowledge the second highest of all the sports, behind UWH with a rating of 6.50 out of a possible 10. Football did however have the lowest percentage of correct answers on sports nutrition knowledge.

Basketball athletes rated the importance of sports nutrition highly with 83.3% of the athletes stating that it was very important, 11.1% stating it was slightly important and the remaining 2.8% stating it was not very/slightly important. None of the basketball athletes rated the importance of sports nutrition as not important. 82.9% of the basketball athletes believed that sports nutrition could improve performance. Although a high number it was still the lowest of all the sports. Basketball athletes also rated their sports nutrition with a rating of 5.76 out of a possible 10. This was even with Netball. Basketball athletes had an low overall percentage of correct sports nutrition knowledge of 38.73% which is slightly higher than Football, but lower than the other sports.

Rugby athletes rated the importance of sports nutrition highly with 78.6% of the athletes stating that it was very important, and the remaining 21.4% stating it was slightly important. None of the rugby athletes rated the importance of sports nutrition as not very/slightly important or not important. 96.4% of the rugby athletes believed that sports nutrition could improve performance. Rugby athletes also rated their sports nutrition the lowest of all the sports with a rating of 5.64 out of a possible 10. Interestingly when the sports nutrition knowledge was tested through questions, the rugby players had the third highest level of knowledge based on correct answers.

All UWH athletes rated sports nutrition as very important (100%). 100% of them also believed that sports nutrition can improve performance. It is important to remember that this was a very small sample and therefore the results cannot be deemed representative. UWH athletes also rated their sports nutrition the highest of all the sports with a rating of 7.0 out of a possible 10. The small sample of UWH athletes also had the highest score of correct sports nutrition knowledge questions. These results are shown in tables 4 and 5.

Table 4: Sport specific attitudes to sports nutrition

Question	**Sports**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Importance of sports nutrition					
Very important	83.3%	78.6%	68.4%	78.6%	100%
Slightly important	11.1%	14.3%	21.1%	21.4%	-
Not Very/slightly important	2.8%	7.1%	-	-	-
Not important	-	-	10.5%	-	-
Belief in sports nutrition to improve performance					
Yes definitely	82.9%	85.7%	94.7%	96.4%	100%
Maybe	17.1%	14.3%	5.3%	3.6%	-
Rating of knowledge					
Average rating	5.76	6.50	5.76	5.64	7.0
Standard deviation	1.555	1.387	1.719	1.632	1.000
Variance	2.417	1.923	2.955	2.664	1.000

Table 5: Percentage of correct responses to questions on sports nutrition knowledge by specific sports.

Sport	**Basketball**	**Football**	**Rugby**	**Netball**	**UWH**
% answers correct	38.73% Std dev 0.50	37.1% Std dev 0.54	42.26% Std dev 0.50	43.86% Std dev 0.50	47.33% Std dev 0.51

Again, there was no significant difference in the sports nutrition knowledge by gender.

There were a number of worrying results seen on the overall research, especially on the role of protein in the body. Overall the athletes were not clear on the role of protein and often had misguided knowledge in this area. When asked about the roles of a number of the food components, the subjects showed differing levels of knowledge. When asked which food component contained the most energy, 88% of the subjects incorrectly stated that carbohydrates, protein or alcohol had the most energy of the food component options given (alcohol, protein, carbohydrates and fat). Only 4 % were correct in agreeing that fat has the highest amount of energy with the remainder unsure. Table 6 shows that overall 68.2% of the athletes thought that eating a very high protein diet would increase muscle mass. Only 17.5% knew that eating more overall would help, and 63.9% also knew that weight training played a role in increasing muscle mass. These results are consistent with other research which shows that adolescents often have incorrect knowledge on the role of protein, especially in the area of muscle gain (Rosenbloom et al, 2002, Harrison et al, 1991, Jacobsen et al, 2001).

Table 6: The role of protein in increasing muscle mass

Question	**Percentage who agreed to the statement**	**Actual answer**
Eating a very high protein diet	68.2%	**False**
Eating more overall	17.5%	**True**
Having protein shakes after every workout	40.2%	**False**
Weight training	63.9%	**True**
Eating egg whites after every meal	21.6%	**False**

Sports drinks were another area that showed a lack of knowledge. 85.7% of the athletes reported that they use a sports drink. 14.3% did not use sports drinks. The sports drinks that these 85.7% of the subjects used are shown below in table 7. 26.8% of the athletes reported using more than one sports drink.

Table 7: Percentage of athletes who report using specific named sports drinks

Sports Drink	**Percentage of athletes who report using the named sports drink**
PowerAde	82.9%
Horley's Replace	23.2%
Endura	1.2%
Gatorade	8.5%

Although sports drinks can provide an advantage when used correctly, many of the athletes did not know why they used a sports drink and most could not back up usage with correct reasoning. This is also consistent with previous research (O'Dea, 2003, Pratt & Walberg, 1998, Chapman & Toma, 1997, Rosenbloom et al, 2002). Subjects were asked to identify the functions of a sports drink. Over 50% of the subjects knew that using a sports drink makes the body retain fluid and that it replaces carbohydrates. Only 37.1% knew that a function of a sports drink was to replace sodium, yet 50.5% agreed that a sports drink replaces sweat. When asked in another question 68% of the subjects stated that sports drinks contain carbohydrates, 63.3% stated that they contain salt (compared to 37.1% saying it replaces sodium), and 22.4% thought that they contained fat (in question C.23. 8.2% of the subjects thought that a function of a sports drink was to burn body fat). 24.5% were unsure whether sports drinks contained salt, whereas 16.5% were unsure if sports drinks contained carbohydrates. Just over half of the subjects knew that sports drinks did not contain fat (56.1%). Full results of this question can be seen in table 8.

Table 8: Results of questions on the functions of a sports drink

Answer	**Percentage of athletes who agreed to the statement**	**Correct response**
It makes the body retain fluid	52.6%	TRUE
It helps to burn body fat	8.2%	FALSE
It replaces sweat	50.5%	TRUE
It tastes good compared to water	40.2%	TRUE
It replaces sodium	37.1%	TRUE
It replaces carbohydrates	58.8%	TRUE
It replaces protein	12.4%	FALSE
It is a source of water	35.1%	TRUE

The reasons that subjects gave for the use of the named sports drinks are shown in table 9:

Table 9: Reasons that subjects use the named sports drinks

Sports drink	**A sample of athletes reasons for Sports Drink usage**
PowerAde®	"because it has a good reputation in sports drinks and tastes good" "told good by coach" "coach said to drink hour beforehand" "cos nice" "because its nice"

	"told to" "retain the losses of water in your body" "good source of electrolytes for faster rehydration" "taste/recommended" "nice, think your doing something good" "don't know" "thirst quenching and tastes nice" "because they tell us too" "fast rehydration and recovery"
Horley's Replace®	"because I know it helps and they tell us too" "stops cramps" "for vitamins and minerals, stops me cramping" "it tastes good" "to not get dehydrated, replace the electrolytes lost" "to 'replace' sodium etc that you lose"
Endura®	"replaces my electrolytes"
V*	"it helps me personally"

**V is not regarded to be a sports drink as it contains more than 8% carbohydrate but this answer is used in this table to demonstrate that young athletes may perceive it to be a sports drink.*

Athletes were also questioned on the recommendations for pre, during and after exercise in respect to fluid and food intake. Many of the sports also had low scores for majority of these questions. The overall results and results for each sport can be seen in table 10.

Table 10: The results of athlete's knowledge of the recommended guidelines for food and fluid before, during and after exercise.

Question	Sports					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**TOTAL**
Pre event food (Question C.13.)	8.82%	0%	15.79%	0%	33.33%	5.10%

During event fluid (Question C.15.)	17.65%	21.34%	26.32%	17.86%	0%	20.14%
During event food (Question C.16.)	14.75%	7.14%	10.53%	17.86%	33.33%	14.29%
Recovery food (amount) (Question C.19.)	17.65%	14.29%	42.10%	14.29%	0%	17.5%
Recovery food (when) (Question C.20.)	91.18%	64.29%	42.10%	71.43%	100%	77.1%

PREVIOUS SOURCES OF INFORMATION & METHODS FOR THE FUTURE

The athletes were also questioned on how they had received previous nutrition education, and what they would like to have in the future. The overall results of these two questions are shown in table 11.

Table 11: Overall Results of what methods of nutritional advice athletes have received in the past and what methods of nutritional advice they would like to receive in the future.

Session Type	**Percentage of athletes who have had this method of nutritional advice**	**Percentage of athletes who have would like to receive this method of nutritional advice**
Individual session with a sports nutritionist/dietitian	35.4%	73.68%
Supermarket Tour	16.2%	26.23%
Group cooking session	39.4%	31.58%
Group workshop	47.5%	47.37%
Menu plans developed	35.4%	N/A
Hydration workshops	17.2%	15.79%
Athlete as a guest speaker	40.4%	52.63%
Nutrition Quiz session	17.2%	15.91%
Lectures	N/A	15.79%

Written resources	N/A	42.11%
Recipe lists	N/A	31.58%
Interactive website	N/A	21.05%

The results were broken down in specific sports to show what methods the athletes had received in the past.

The results by sport are shown in table 12:

Table 12: Results of what methods of nutritional advice/education athletes have received in the past by sport.

Session Type	**Percentage of athletes by sport, who have received this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	17.14%	30.77%	26.32%	10.7%	0%
Supermarket Tour	25.71%	30.77%	10.53%	57.1%	33.3%
Group cooking session	22.86%	7.69%	5.26%	17.9%	0%
Group workshop	77.14%	15.38%	36.84%	32.1%	0%
Menu plans developed	45.71%	69.23%	57.89%	50%	33.3%
Hydration workshops	25.71%	46.15%	15.79%	21.4%	100%
Athlete as a guest speaker	8.57%	30.77%	21.05%	21.4%	33.3%
Nutrition Quiz session	51.43%	69.23%	26.23%	25%	33.3%

The athletes were also asked to comment on what nutrition education they would like in the future. These results can be seen in table 13.

Table 13: Results of what methods of nutritional advice athletes would like to receive in the future by sport.

Session Type	Percentage of athletes by sport, who have would like to receive this method of nutritional advice				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	0%	0%	73.68%	78.6%	0%
Supermarket Tour	59.24%	46.15%	26.23%	57.1%	0%
Group cooking session	41.18%	76.92%	31.58%	78.6%	100%
Group workshop	5.88%	0%	47.37%	14.3%	0%
Hydration workshops	8.82%	16.67%	15.79%	10.7%	33.3%
Athlete as a guest speaker	8.82%	15.38%	52.63%	14.3%	33.3%
Nutrition Quiz session	23.53%	30.77%	15.91%	28.6%	0%
Lectures	26.47%	23.08%	15.79%	25%	0%
Written resources	14.71%	53.85%	42.11%	17.9%	0%
Recipe lists	23.53%	84.62%	31.58%	25%	0%
Interactive website	52.94%	46.15%	21.05%	35.7%	66.7%

When questioned on whether they use information which is provided to them overall 43% of the subjects said that yes they did use nutrition information. 46.2% stated that they sometimes used information, whilst 10.8% said they did not use information. 7 responses were missing for this question. This is an important component to be addressed in working with adolescents and for further research to assess the factors which inhibit athletes from using information which they receive. If they do not use information which has been provided there are clearly barriers to the intended behaviour occurring.

The athletes were also asked to identify who else should be involved in their nutrition education. The results of this question can be seen in table 14. The results of this question clearly show that adolescents believe that both parents and coaches should be involved with their nutrition education.

Table 14: Results of question C.27.- Who else should be involved in your nutrition education?

	Parents	**Coaches**	**Other***
Overall percentage of athletes who thought others should be involved in their nutrition education	81.6%	64.3%	18%
Basketball athletes only	47.1%	94.1%	76.5%
Football athletes only	53.8%	92.3%	61.5%
Netball athletes only	84.2%	89.5%	21.1%
Rugby athletes only	25%	60.7%	39.3%
Underwater Hockey athletes only	33.3%	66.7%	66.7%

**Other responses were teammates and team members, members of the athletes flat, nutritionist, friends, in the same sport, teachers, the trainer, and partners.*

CONCLUSION & RECOMMENDATIONS

In conclusion it is recommended that resources and educational programmes are designed specifically for adolescent athletes. These should take the following points into consideration:

- They must be developmentally appropriate
- They must have a performance based focus and be positive
- It is possible that they could be more successful if they involve a top sportsperson or sports team as a role model(s)

Recommendations for future educational programmes are that:

- Females may need information on iron status and in particular a weight based focus
- Resources that are specifically targeted at adolescents need to be developed and made available through as many avenues as possible to adolescent athletes and their parents
- A programme which has more than one nutrition session is likely to more successful in educating athletes about sports nutrition and changing behaviour
- Coaches (especially) and parents need to be educated in sports nutrition so that they can provide correct, and relevant advice to adolescent athletes. Trainers and other members of the support team need to be educated to provide sound advice or refer the athlete to a specialist

- Information needs to be shared within nutritionists
- There are not enough sports nutritionists to work with all teams in New Zealand and often team funds do not cover for a nutritionist. Trainers and coaches must improve their nutrition knowledge if this is this the case with their team
- More research needs to be conducted on the levels of knowledge in New Zealand adolescent athletes, and the ways of educating this group.

LIMITING FACTORS OF THE RESEARCH

There are a number of limiting factors which need to be considered in the ANKAA study. The athletes were posted the questionnaires and therefore the researcher did not have control of the situation in which they did the questionnaire. Subjects were asked to complete the questionnaires by themselves but it is not known if any of the respondents were given help by parents, caregivers or coaches. Respondents may have been more inclined to participate if they had more of an interest in nutrition as the questionnaire was distributed and noted to be voluntary to all participants. If the parents were more interested in nutrition this may have influenced who sent back completed questionnaires. Some athletes may have been encouraged more by their NSO than others and this may have influenced who responded to the questionnaires.

The focus groups were a part of this research which did not perform as well as expected. Two series of focus groups were organised and the participants were invited by letter to these. It has been suggested that “attendance is likely to be higher if the group consist of a pre existing social group utilizing an established meeting venue and time for a formal pre existing group can also improve attendance” (Bloor, 2001, pg 36) and that the job of recruiting attendees for the focus group can be done more effectively if the researcher can use an intermediary person for the job, who has contact with a pre existing group (Bloor, 2001). This method was successful with the focus group which was run with the Manawatu Rugby Academy. In future this would be a better method of recruitment for adolescent athletes for focus groups, instead of directly contacting the individual athletes and asking them to attend.

The study needs a larger sample size to give a clear indication of results. The current study had a small sample size so to confirm the results seen, more participants are needed. The study also only used subjects from five sports which were all team sports. To get a clearer indication of adolescent nutrition knowledge and methods of education it is important to widen the types of sports that athletes are selected from, and include individual sports.

ACKNOWLEDGEMENTS

The author gratefully acknowledges:

- the athletes who so willingly participated in this study
- the National Sporting Organisations; Basketball New Zealand, Netball New Zealand, New Zealand Rugby Union, New Zealand Football and New Zealand Underwater Hockey for their support
- SPARC (Sport and Recreation New Zealand) who awarded this project a Research Grant
- Dr Jane Coad, student supervisor
- Dr Janet Weber
- Mrs. Chris Booth, who worked as the independent third party researcher on this project

For further information the author can be contacted via email: sarah@sportsnutritionist.co.nz

REFERENCES

Bloor , M. *Focus groups in social research – Introducing qualitative methods* (2001). Sage, London.

Chapman, P., Toma, R. B. (1997). Nutrition knowledge among adolescent high school female athletes. *Adolescence*, 32(126):1-8.

Croll, J. K., Neumark-Sztainer, D., Story, M., Wall, M., Perry, C., Harnack, L. (2006). Adolescents involved in weight-related and power-team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. *The Journal of the American Dietetic Association,* 106:709- 717.

Harrison, J., Hopkins, W. G., MacFarlane, D. J., Worsley, A. (1991). Nutrition knowledge and dietary habits of elite and non-elite athletes. *Australian Journal of Nutrition and Dietetics,* 48:124-127.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., Beck, N. C. (2004). Nutrient intakes and dietary behaviours of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:389-404.

Jacobson, B.H., Sobonya, C., Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research,* 15:63-68.

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Health education Research,* 18:98-107.

Position of the American Dietetic Association: child and adolescent food and nutrition programs. (1996) *The Journal of the American Dietetic Association,* 96:913-917.

Pratt, C.A., Walberg, J.L. (1988). Nutrition knowledge concerns of health and physical education teachers. *Journal of the American Dietetic Association,* 88, 840-841.

Rosenbloom, C.A., Jonnalagardadda, S.S., Skinner, R. (2002). Nutrition Knowledge of collegiate athletes in a division 1 national athletic association institution. *Journal of the American Dietetic Association,* 102:418-420.

Story, M., Neumark-Sztainer, D., French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *The Journal of the American Dietetic Association*, 102:3, S40-S51.

Massey University

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

SUMMARY OF RESEARCH RESULTS - *BASKETBALL*

There is very limited research on the nutrition knowledge and food skills of elite athletes in New Zealand. Adolescent athletes are moving through an important physiological stage of life, as well as training and competing in their chosen sports. These athletes are the future New Zealand sporting representatives and therefore need adequate nutrition knowledge for performance, as well as health and wellbeing. This research investigated the basic and sports nutrition knowledge of 100 talented adolescent athletes from five team sports using questionnaires and a focus group. While the participants had a reasonable level of basic nutrition knowledge, their sports nutrition knowledge was not as high. They struggled with the concepts of sports drinks, muscle growth and supplements. Most participants had received some nutrition education and indicated that in the future they would prefer individual sessions with a sports nutritionist, written resources, as well as group sessions including cooking sessions and group workshops, and using a high profile athlete as a role model. The participants were very clear that their coaches and parents needed to be involved in their nutrition education. More research is needed to assess the overall knowledge of New Zealand adolescent athletes and the most appropriate, and effective methods of education for this group.

Introduction

When an adolescent is also an athlete there are many important factors to consider in terms of nutrition for both growth and sports performance. Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al, 2006). Coupled with the fact that when the athlete is an adolescent they have further energy and nutrient needs due to the large period of growth that the adolescent period entails, including the adolescent growth spurt (ADA, 1996, Story et al, 2002, Hinton et al, 2004, Croll et al, 2006), this creates a significant nutritional challenge.

The specific aims of this research were:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences this subject group in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this subject group,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

This project is designed to assess the knowledge of talented New Zealand adolescent athletes and look at identifying how adolescents would prefer to be given sports nutrition advice. Currently there is also a lack of resources designed to work specifically with this group and it is anticipated that this research project will not only identify the level of nutritional knowledge of this group but also develop an educational curriculum and accompanying resources which should be produced for this group.

METHODOLOGY

Subjects

Letters were sent to ten national sporting organisations (NSO's) describing the study and asking if they would give permission for their athletes who met the entry criteria to take part in the study. The ten sports were chosen as they encompassed a range of both team and individual sports, and sports which are generally gender specific. Sporting organizations were asked to provide contact details of athletes who met the entry criteria for the project. The entry criteria was that athletes needed to be between the ages of 13 and 20 years old as at the 1st of January 2007, and be considered a talented or elite athlete in their chosen sport by being a carded athlete, or part of a High Performance Academy Group, Regional Talent Identification Group or an equivalent Development group. Sporting organisations who agreed to participate in the study were asked to forward contact details of athletes who met the criteria to an independent third party research assistant. This preserved confidentiality of contact details.

Five sporting organizations agreed to take part in this research; Basketball New Zealand, Netball New Zealand, New Zealand Football, New Zealand Rugby Union, and New Zealand Underwater Hockey. A total of 100 athletes took part in the research.

The study was given ethical approval by the Massey University Committee of Ethics (ref 07/52).

The Questionnaire

The questionnaire was developed to address four different aims. Section A aimed to assess the basic nutritional knowledge of the subjects. Section B aimed to investigate influences on food choice and food availability in the subjects. Section C was designed to assess the basic sports nutrition knowledge and practices of the subjects and section D gathered basic demographic information about the subjects.

The questionnaire was developed using previous research questions and newly developed questions. A pilot trial of the questionnaire was conducted with athletes of the same age and who participated in the same ten sports as the targeted population and changes were made to questions which were unclear before sending to the actual subject group. Changes included rewording four questions so that they were appropriate for the age group in this study. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge, and those who did not have any knowledge the questionnaire used 'yes', 'no' and 'unsure' answers.

Procedure

The independent research assistant used the contact details from NSO's to create two sets of address labels for each contact. The first set was used to send the initial questionnaire pack which included a participant information sheet, a participant consent form, a parental information sheet, a parental consent form, a questionnaire and a return envelope.

The questionnaires were coded to identify which participants had returned their questionnaire. The independent research assistant followed up the athletes who had not returned the questionnaire phone call. When the unnamed questionnaires were received by the independent research assistant they were removed from the envelopes and passed on to the student researcher to ensure confidentiality of the subjects.

The second set of address labels were used in the organisation of focus groups. One invitation to participate in the focus groups arranged in Christchurch, Wellington, Palmerston North and Auckland in December 2008 was sent out to all participants and did not receive any responses to attend. This may have been due to being in close proximity to Christmas so another round of focus groups was planned for February 2009. Although there were very few respondents there were not enough to warrant a focus group at this time either. Instead the Manawatu Rugby Academy volunteered to run a focus group with their academy players (some of who had previously completed the questionnaire for this research). There were nine players, and their sports nutritionist present.

A number of questions were developed for use in the focus group by the researcher to prompt the athletes with the aim of initiating discussion. Several props were used including cookbooks and pamphlets/booklets.

Data analysis

Analysis of the questionnaires was carried out to provide results. The data was analysed with SPSS v14.0.

OVERALL FINDINGS

100 athletes from five sports returned questionnaires for this research project. The distribution of sports and level of competition can be seen in Table 1:

Table 1: The distribution of sports and level of competition

Level	Basketball	Football	Netball	Rugby	UWH	TOTAL
Regional	1	0	11	19	0	31
National	16	2	7	5	1	31
International	15	12	1	4	2	34

**4 responses were missing*

The mean age of all of the athletes was 16.64 years (std dev 1.937). 55.8% of the athletes compete in more than one sport, with athletes from Netball (68.4%) and Basketball (61.76%) more likely to partake in more than one sport. Rugby (39.2%) and UWH (33.3%) were the least likely to take part in more one sport. However, the UWH group is not large enough to get a clear result.

BASIC NUTRITION KNOWLEDGE RESULTS

The athletes were asked to complete a series of questions designed to address basic nutrition knowledge. The scores were tallied and compared for each sport. UWH athletes had the highest number of correct responses but the very small sample size of this group means that this is disputable. Football was seen to have the next highest correct response rate, followed by netball and then rugby and Basketball. These results are given in table 2:

Table 2: % of correct responses to questions on basic nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	60.99 % Std dev 3.35	68.32 % Std dev 2.43	63.20 % Std dev 4.43	66.36% Std dev 2.96	78.26 %* Std dev 2.00

* UWH sample size much smaller

There was no significant difference between gender and basic nutrition knowledge.

SPORTS NUTRITION KNOWLEDGE RESULTS

The athletes were also questioned on sports nutrition knowledge using a series of questions. Athletes ranked the importance of sports nutrition highly and had a positive belief in sports nutrition improving performance. The full results of these questions are shown in table 3.

Table 3: Overall results of attitudes to sports nutrition

Attitudes towards Sports Nutrition	Percentage of athletes
Importance of Sports Nutrition question: "How important do you consider sports nutrition to be in your sporting plans?"	
Very important Slightly important Very/slightly important Not important	79% 16% 2% 2%
Belief in Sports Nutrition to improve performance question: "Do you believe that specific sports nutrition strategies could improve your performance?"	
Yes definitely Maybe No	88% 12% -
Average rating of sports nutrition knowledge Question: "How would you rate your sports nutrition knowledge on a scale of 1 (non-existent) to 10 (excellent)?"	

Rating Standard deviation Variance	5.87 1.584 2.508

The answers to these questions were also divided into sporting code. Basketball athletes rated the importance of sports nutrition highly with 83.3% of the athletes stating that it was very important, 11.1% stating it was slightly important and the remaining 2.8% stating it was not very/slightly important. None of the basketball athletes rated the importance of sports nutrition as not important. 82.9% of the basketball athletes believed that sports nutrition could improve performance. Although a high number it was still the lowest of all the sports.

Basketball athletes also rated their sports nutrition with a rating of 5.76 out of a possible 10. This was even with Netball. Basketball athletes had an overall % of correct sports nutrition knowledge of 38.73% which is slightly higher than Football, but lower than the other sports. These results are shown in tables 4 and 5

Table 4: Sport specific attitudes to sports nutrition

Question	Sports				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Importance of sports nutrition					
Very important	83.3%	78.6%	68.4%	78.6%	100%
Slightly important	11.1%	14.3%	21.1%	21.4%	-
Not Very/slightly important	2.8%	7.1%	-	-	-
Not important	-	-	10.5%	-	-
Belief in sports nutrition to improve performance					
Yes definitely	82.9%	85.7%	94.7%	96.4%	100%
Maybe	17.1%	14.3%	5.3%	3.6%	-
Rating of knowledge					
Average rating	5.76	6.50	5.76	5.64	7.0

Standard deviation	1.555	1.387	1.719	1.632	1.000
Variance	2.417	1.923	2.955	2.664	1.000

Table 5: Percentage of correct responses to questions on sports nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	38.73% Std dev 0.50	37.1% Std dev 0.54	42.26% Std dev 0.50	43.86% Std dev 0.50	47.33%* Std dev 0.51

* UWH sample size much smaller

Again, there was no significant difference in the sports nutrition knowledge by gender.

There were a number of worrying results seen on the overall research, especially on the role of protein in the body. Overall the athletes were not clear on the role of protein and often had misguided knowledge in this area. When asked about the roles of a number of the food components, the subjects showed differing levels of knowledge. When asked which food component contained the most energy, 88% of the subjects incorrectly stated that carbohydrates, protein or alcohol had the most energy of the food component options given (alcohol, protein, carbohydrates and fat). Only 4 % were correct in agreeing that fat has the highest amount of energy with the remainder unsure.

Table 6 shows that overall 68.2% of the athletes thought that eating a very high protein diet would increase muscle mass. Only 17.5% knew that eating more overall would help, and 63.9% also knew that weight training played a role in increasing muscle mass. These results are consistent with other research which shows that adolescents often have incorrect knowledge on the role of protein, especially in the area of muscle gain (Rosenbloom et al, 2002, Harrison et al, 1991, Jacobsen et al, 2001).

Table 6: The role of protein in increasing muscle mass

Question	Percentage who agreed to the statement	Actual answer
Eating a very high protein diet	68.2%	**False**
Eating more overall	17.5%	**True**
Having protein shakes after every workout	40.2%	**False**
Weight training	63.9%	**True**
Eating egg whites after every meal	21.6%	**False**

Sports drinks were another area that showed a lack of knowledge in these subjects. 85.7% of the athletes reported that they use a sports drink. 14.3% did not use sports drinks. The sports drinks that these 85.7% of the subjects used are shown below in table 7. 26.8% of the athletes reported using more than one sports drink.

Table 7: Percentage of athletes who report using specific named sports drinks

Sports Drink	Percentage of athletes who report using the named sports drink
PowerAde	82.9%
Horley's Replace	23.2%
Endura	1.2%
Gatorade	8.5%

Although sports drinks can provide an advantage when used correctly, many of the athletes did not know why they used a sports drink and most could not back up usage with correct reasoning. This is also consistent with previous research (O'Dea, 2003, Pratt & Walberg, 1998, Chapman & Toma, 1997, Rosenbloom et al, 2002). Subjects were asked to identify the functions of a sports drink. Over 50% of the subjects knew that using a sports drink makes the body retain fluid and that it replaces carbohydrates. Only 37.1% knew that a function of a sports drink was to replace sodium, yet 50.5% agreed that a sports drink replaces sweat. When asked in another question 68% of the subjects stated that sports drinks contain carbohydrates, 63.3% stated that they contain salt (compared to 37.1% saying it replaces sodium), and 22.4% thought that they contained fat (in question C.23. 8.2% of the subjects thought that a function of a sports drink was to burn body fat). 24.5% were unsure whether sports drinks contained salt, whereas 16.5% were unsure if sports drinks contained carbohydrates. Just over half of the subjects knew that sports drinks did not contain fat (56.1%). Full results of this question can be seen in table 8.

Table 8: Results of questions on the functions of a sports drink

Answer	Percentage of athletes who agreed to the statement	Correct response
It makes the body retain fluid	52.6%	TRUE
It helps to burn body fat	8.2%	FALSE
It replaces sweat	50.5%	TRUE
It tastes good compared to water	40.2%	TRUE
It replaces sodium	37.1%	TRUE
It replaces carbohydrates	58.8%	TRUE

It replaces protein	12.4%	FALSE
It is a source of water	35.1%	TRUE

The reasons that subjects gave for the use of the named sports drinks are shown in table 9:

Table 9: Reasons that subjects use the named sports drinks

Sports drink	**A sample of athletes reasons for Sports Drink usage**
PowerAde®	"because it has a good reputation in sports drinks and tastes good" "told good by coach" "coach said to drink hour beforehand" "cos nice" "because its nice" "told to" "retain the losses of water in your body" "good source of electrolytes for faster rehydration" "taste/recommended" "nice, think your doing something good" "don't know" "thirst quenching and tastes nice" "because they tell us too" "fast rehydration and recovery"
Horley's Replace®	"because I know it helps and they tell us too" "stops cramps" "for vitamins and minerals, stops me cramping" "it tastes good" "to not get dehydrated, replace the electrolytes lost" "to 'replace' sodium etc that you lose"
Endura®	"replaces my electrolytes"
V*	"it helps me personally"

**V is not regarded to be a sports drink as it contains more than 8% carbohydrate but this answer is used in this table to demonstrate that young athletes may perceive it to be a sports drink.*

Athletes were also questioned on the recommendations for pre, during and after exercise in respect to fluid and food intake. The Basketball athletes had a sound knowledge of recovery food timing (when) but had low scores on the rest of these questions. Many of the other sports also had low scores for majority of these questions. The overall results and results for each sport can be seen in table 10.

Table 10: The results of athlete's knowledge of the recommended guidelines for food and fluid before, during and after exercise.

Question	Sports					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**TOTAL**
Pre event food (Question C.13.)	8.82%	0%	15.79%	0%	33.33%	5.10%
During event fluid (Question C.15.)	17.65%	21.34%	26.32%	17.86%	0%	20.14%
During event food (Question C.16.)	14.75%	7.14%	10.53%	17.86%	33.33%	14.29%
Recovery food (amount) (Question C.19.)	17.65%	14.29%	42.10%	14.29%	0%	17.5%
Recovery food (when) (Question C.20.)	91.18%	64.29%	42.10%	71.43%	100%	77.1%

PREVIOUS SOURCES OF INFORMATION & METHODS FOR THE FUTURE

The athletes were also questioned on how they had received previous nutrition education, and what they would like to have in the future. The overall result s of these two questions are shown in table 11.

Table 11: Overall Results of what methods of nutritional advice athletes have received in the past and what methods of nutritional advice they would like to receive in the future.

Session Type	Percentage of athletes who have had this method of	Percentage of athletes who have would like to receive this

	nutritional advice	method of nutritional advice
Individual session with a sports nutritionist/dietitian	35.4%	73.68%
Supermarket Tour	16.2%	26.23%
Group cooking session	39.4%	31.58%
Group workshop	47.5%	47.37%
Menu plans developed	35.4%	N/A
Hydration workshops	17.2%	15.79%
Athlete as a guest speaker	40.4%	52.63%
Nutrition Quiz session	17.2%	15.91%
Lectures	N/A	15.79%
Written resources	N/A	42.11%
Recipe lists	N/A	31.58%
Interactive website	N/A	21.05%

The results were broken down in specific sports to show what methods the athletes had received in the past. A large percentage (77.14%) of the Basketball players had taken part in a group session, over half (51.43%) had taken part in a nutrition quiz session, and 45.71% had menu plans developed for them in the past. Like most of the sports only small numbers of basketball athletes had had an individual session with a sports nutritionist/dietitian. The results by sport are shown in table 12:

Table 12: Results of what methods of nutritional advice/education athletes have received in the past by sport.

Session Type	**Percentage of athletes by sport, who have received this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	17.14%	30.77%	26.32%	10.7%	0%
Supermarket Tour	25.71%	30.77%	10.53%	57.1%	33.3%
Group cooking session	22.86%	7.69%	5.26%	17.9%	0%

Group workshop	77.14%	15.38%	36.84%	32.1%	0%
Menu plans developed	45.71%	69.23%	57.89%	50%	33.3%
Hydration workshops	25.71%	46.15%	15.79%	21.4%	100%
Athlete as a guest speaker	8.57%	30.77%	21.05%	21.4%	33.3%
Nutrition Quiz session	51.43%	69.23%	26.23%	25%	33.3%

The athletes were asked to provide information on what nutrition education methods they would like in the future.

Table 13: Results of what methods of nutritional advice athletes would like to receive in the future by sport.

Session Type	**Percentage of athletes by sport, who have would like to receive this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	0%	0%	73.68%	78.6%	0%
Supermarket Tour	59.24%	46.15%	26.23%	57.1%	0%
Group cooking session	41.18%	76.92%	31.58%	78.6%	100%
Group workshop	5.88%	0%	47.37%	14.3%	0%
Hydration workshops	8.82%	16.67%	15.79%	10.7%	33.3%
Athlete as a guest speaker	8.82%	15.38%	52.63%	14.3%	33.3%
Nutrition Quiz session	23.53%	30.77%	15.91%	28.6%	0%
Lectures	26.47%	23.08%	15.79%	25%	0%
Written resources	14.71%	53.85%	42.11%	17.9%	0%

Recipe lists	23.53%	84.62%	31.58%	25%	0%
Interactive website	52.94%	46.15%	21.05%	35.7%	66.7%

When questioned on whether they use information which is provided to them overall 43% said that yes they did use nutrition information. 46.2% stated that they sometimes used information, whilst 10.8% said they did not use information. 7 responses were missing for this question.

The athletes were also asked to identify who else should be involved in their nutrition education. The results of this question can be seen in table 14.

Table 14 : Results of question C.27. - Who else should be involved in your nutrition education?

	Parents	**Coaches**	**Other***
Overall percentage of athletes who thought others should be involved in their nutrition education	81.6%	64.3%	18%
Basketball athletes only	47.1%	94.1%	76.5%
Football athletes only	53.8%	92.3%	61.5%
Netball athletes only	84.2%	89.5%	21.1%
Rugby athletes only	25%	60.7%	39.3%
Underwater Hockey athletes only	33.3%	66.7%	66.7%

**Other responses were teammates and team members, members of the athletes flat, nutritionist, friends, in the same sport, teachers, the trainer, and partners.*

CONCLUSION & RECOMMENDATIONS

In conclusion it is recommended that resources and educational programmes are designed for adolescent athletes. These should take the following points into consideration:

- They must be developmentally appropriate
- They must have a performance based focus and be positive
- It is possible that they could be more successful if they involve a top sportsperson or sports team as a role model(s)

Recommendations are:

- Females may need information on iron status and in particular a weight based focus

- Resources that are specifically targeted at adolescents need to be developed and made available through as many avenues as possible to adolescent athletes and their parents
- A programme which has more than one nutrition session is likely to more successful in educating athletes about sports nutrition and changing behaviour
- Coaches (especially) and parents need to be educated in sports nutrition so that they can provide correct, and relevant advice to adolescent athletes. Trainers and other members of the support team need to be educated to provide sound advice or refer the athlete to a specialist
- Information needs to be shared within nutritionists
- There are not enough sports nutritionists to work with all teams and often team funds do not cover for a nutritionist. Trainers and coaches must improve their nutrition knowledge if this is this is to remain as it is
- More research needs to be conducted on the levels of knowledge in New Zealand adolescent athletes, and the ways of educating this group.

LIMITING FACTORS OF THE RESEARCH

There are a number of limiting factors which need to be considered in the ANKAA study. The athletes were posted the questionnaires and therefore the researcher did not have control of the situation in which they did the questionnaire. Subjects were asked to complete the questionnaires by themselves but it is not known if any of the respondents were given help by parents, caregivers or coaches. Respondents may have been more inclined to participate if they had more of an interest in nutrition as the questionnaire was distributed and noted to be voluntary to all participants. If the parents were more interested in nutrition this may have influenced who sent back completed questionnaires. Some athletes may have been encouraged more by their NSO than others and this may have influenced who responded to the questionnaires.

The focus groups were a part of this research which did not perform as well as expected. Two series of focus groups were organised and the participants were invited by letter to these. It has been suggested that "attendance is likely to be higher if the group consist of a pre existing social group utilizing an established meeting venue and time for a formal pre existing group can also improve attendance" (Bloor, 2001, pg 36) and that the job of recruiting attendees for the focus group can be done more effectively if the researcher can use an intermediary person for the job, who has contact with a pre existing group (Bloor, 2001). This method was successful with the focus group which was run with the Manawatu Rugby

Academy. In future this would be a better method of recruitment for adolescent athletes for focus groups, instead of directly contacting the individual athletes and asking them to attend.

The study needs a larger sample size to give a clear indication of results. The current study had a small sample size so to confirm the results seen, more participants are needed. The study also only used subjects from five sports which were all team sports. To get a clearer indication of adolescent nutrition knowledge and methods of education it is important to widen the types of sports that athletes are selected from, and include individual sports.

ACKNOWLEDGEMENTS & FURTHER INFORMATION

The author gratefully acknowledges:

- the athletes who so willingly participated in this study
- the National Sporting Organisations; Basketball New Zealand, Netball New Zealand, New Zealand Rugby Union, New Zealand Football and New Zealand Underwater Hockey for their support
- SPARC (Sport and Recreation New Zealand) who awarded this project a Research Grant
- Dr Jane Coad, student supervisor
- Dr Janet Weber
- Mrs. Chris Booth, who worked as the independent third party researcher on this project

For further information the author can be contacted via email: sarah@sportsnutritionist.co.nz

---

REFERENCES

Bloor , M. *Focus groups in social research – Introducing qualitative methods* (2001). Sage, London.

Chapman, P., Toma, R. B. (1997). Nutrition knowledge among adolescent high school female athletes. *Adolescence*, 32(126):1-8.

Croll, J. K., Neumark-Sztainer, D., Story, M., Wall, M., Perry, C., Harnack, L. (2006). Adolescents involved in weight-related and power-team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. *The Journal of the American Dietetic Association,* 106:709- 717.

Harrison, J., Hopkins, W. G., MacFarlane, D. J., Worsley, A. (1991). Nutrition knowledge and dietary habits of elite and non-elite athletes. *Australian Journal of Nutrition and Dietetics,* 48:124-127.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., Beck, N. C. (2004). Nutrient intakes and dietary behaviours of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:389-404.

Jacobson, B.H., Sobonya, C., Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research,* 15:63-68.

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Health education Research,* 18:98-107.

Position of the American Dietetic Association: child and adolescent food and nutrition programs. (1996) *The Journal of the American Dietetic Association,* 96:913-917.

Pratt, C.A., Walberg, J.L. (1988). Nutrition knowledge concerns of health and physical education teachers. *Journal of the American Dietetic Association,* 88, 840-841.

Rosenbloom, C.A., Jonnalagardadda, S.S., Skinner, R. (2002). Nutrition Knowledge of collegiate athletes in a division 1 national athletic association institution. *Journal of the American Dietetic Association,* 102:418-420.

Story, M., Neumark-Sztainer, D., French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *The Journal of the American Dietetic Association*, 102:3, S40-S51.

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

SUMMARY OF RESEARCH RESULTS - *FOOTBALL*

There is very limited research on the nutrition knowledge and food skills of elite athletes in New Zealand. Adolescent athletes are moving through an important physiological stage of life, as well as training and competing in their chosen sports. These athletes are the future New Zealand sporting representatives and therefore need adequate nutrition knowledge for performance, as well as health and wellbeing. This research investigated the basic and sports nutrition knowledge of 100 talented adolescent athletes from five team sports using questionnaires and a focus group. While the participants had a reasonable level of basic nutrition knowledge, their sports nutrition knowledge was not as high. They struggled with the concepts of sports drinks, muscle growth and supplements. Most participants had received some nutrition education and indicated that in the future they would prefer individual sessions with a sports nutritionist, written resources, as well as group sessions including cooking sessions and group workshops, and using a high profile athlete as a role model. The participants were very clear that their coaches and parents needed to be involved in their nutrition education. More research is needed to assess the overall knowledge of New Zealand adolescent athletes and the most appropriate, and effective methods of education for this group.

Introduction

When an adolescent is also an athlete there are many important factors to consider in terms of nutrition for both growth and sports performance. Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al, 2006). Coupled with the fact that when the athlete is an adolescent they have further energy and nutrient needs due to the large period of growth that the adolescent period entails, including the adolescent growth spurt (ADA, 1996, Story et al, 2002, Hinton et al, 2004, Croll et al, 2006), this creates a significant nutritional challenge.

The specific aims of this research were:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences this subject group in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this subject group,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

This project is designed to assess the knowledge of talented New Zealand adolescent athletes and look at identifying how adolescents would prefer to be given sports nutrition advice. Currently there is also a lack of resources designed to work specifically with this group and it is anticipated that this research project will not only identify the level of nutritional knowledge of this group but also develop an educational curriculum and accompanying resources which should be produced for this group.

METHODOLOGY

Subjects

Letters were sent to ten national sporting organisations (NSO's) describing the study and asking if they would give permission for their athletes who met the entry criteria to take part in the study. The ten sports were chosen as they encompassed a range of both team and individual sports, and sports which are generally gender specific. Sporting organizations were asked to provide contact details of athletes who met the entry criteria for the project. The entry criteria was that athletes needed to be between the ages of 13 and 20 years old as at the 1st of January 2007, and be considered a talented or elite athlete in their chosen sport by being a carded athlete, or part of a High Performance Academy Group, Regional Talent Identification Group or an equivalent Development group. Sporting organisations who agreed to participate in the study were asked to forward contact details of athletes who met the criteria to an independent third party research assistant. This preserved confidentiality of contact details.

Five sporting organizations agreed to take part in this research; Basketball New Zealand, Netball New Zealand, New Zealand Football, New Zealand Rugby Union, and New Zealand Underwater Hockey. A total of 100 athletes took part in the research.

The study was given ethical approval by the Massey University Committee of Ethics (ref 07/52).

The Questionnaire

The questionnaire was developed to address four different aims. Section A aimed to assess the basic nutritional knowledge of the subjects. Section B aimed to investigate influences on food choice and food availability in the subjects. Section C was designed to assess the basic sports nutrition knowledge and practices of the subjects and section D gathered basic demographic information about the subjects.

The questionnaire was developed using previous research questions and newly developed questions. A pilot trial of the questionnaire was conducted with athletes of the same age and who participated in the same ten sports as the targeted population and changes were made to questions which were unclear before sending to the actual subject group. Changes included rewording four questions so that they were appropriate for the age group in this study. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge, and those who did not have any knowledge the questionnaire used ‘yes’, ‘no’ and ’unsure’ answers.

Procedure

The independent research assistant used the contact details from NSO’s to create two sets of address labels for each contact. The first set was used to send the initial questionnaire pack which included a participant information sheet, a participant consent form, a parental information sheet, a parental consent form, a questionnaire and a return envelope.

The questionnaires were coded to identify which participants had returned their questionnaire. The independent research assistant followed up the athletes who had not returned the questionnaire phone call. When the unnamed questionnaires were received by the independent research assistant they were removed from the envelopes and passed on to the student researcher to ensure confidentiality of the subjects.

The second set of address labels were used in the organisation of focus groups. One invitation to participate in the focus groups arranged in Christchurch, Wellington, Palmerston North and Auckland in December 2008 was sent out to all participants and did not receive any responses to attend. This may have been due to being in close proximity to Christmas so another round of focus groups was planned for February 2009. Although there were very few respondents there were not enough to warrant a focus group at this time either. Instead the Manawatu Rugby Academy volunteered to run a focus group with their academy players (some of who had previously completed the questionnaire for this research). There were nine players, and their sports nutritionist present.

A number of questions were developed for use in the focus group by the researcher to prompt the athletes with the aim of initiating discussion. Several props were used including cookbooks and pamphlets/booklets.

Data analysis

Analysis of the questionnaires was carried out to provide results. The data was analysed with SPSS v14.0.

OVERALL FINDINGS

100 athletes from five sports returned questionnaires for this research project. The distribution of sports and level of competition can be seen in Table 1:

Table 1: The distribution of sports and level of competition

Level	Basketball	Football	Netball	Rugby	UWH	TOTAL
Regional	1	0	11	19	0	31
National	16	2	7	5	1	31
International	15	12	1	4	2	34

**4 responses missing*

The mean age of all of the athletes was 16.64 years (std dev 1.937). 55.8% of the athletes compete in more than one sport, with athletes from Netball (68.4%) and Basketball (61.76%) more likely to partake in more than one sport. Rugby (39.2%) and UWH (33.3%) were the least likely to take part in more one sport. However, the UWH group is not large enough to get a clear result.

BASIC NUTRITION KNOWLEDGE RESULTS

The athletes were asked to complete a series of questions designed to address basic nutrition knowledge. The scores were tallied and compared for each sport. UWH athletes had the highest number of correct responses but the very small sample size of this group means that this is disputable. Football was seen to have the next highest correct response rate, followed by netball and then rugby. These results are given in table 2:

Table 2: % of correct responses to questions on basic nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	60.99 % Std dev 3.35	68.32 % Std dev 2.43	63.20 % Std dev 4.43	66.36% Std dev 2.96	78.26 %* Std dev 2.00

There was no significant difference between gender and basic nutrition knowledge.

SPORTS NUTRITION KNOWLEDGE RESULTS

The athletes were also questioned on sports nutrition knowledge using a series of questions. Athletes ranked the importance of sports nutrition highly and had a positive belief in sports nutrition improving performance. The full results of these questions are shown in table 3.

Table 3: Overall results of attitudes to sports nutrition

Attitudes towards Sports Nutrition	Percentage of athletes
Importance of Sports Nutrition question: “How important do you consider sports nutrition to be in your sporting plans?”	
Very important	79%
Slightly important	16%
Not Very/slightly important	2%
Not important	2%
Belief in Sports Nutrition to improve performance question: “Do you believe that specific sports nutrition strategies could improve your performance?”	
Yes definitely	88%
Maybe	12%
No	-
Average rating of sports nutrition knowledge Question: “How would you rate your sports nutrition knowledge on a scale of 1 (non-existent) to 10 (excellent)?”	

Rating Standard deviation Variance	5.87 1.584 2.508

The answers to these questions were also divided into sporting code. Football athletes rated the importance of sports nutrition highly with 78.6% of the athletes stating that it was very important, 14.3% stated it was slightly important and the remaining 7.1% stated that it was not very/slightly important. None of the football athletes rated the importance of sports nutrition as not very/slightly important or not important. 85.7% of the football athletes believed that sports nutrition could improve performance and 14.3% thought that it may help.

Football athletes rated their sports nutrition the second highest of all the sports, behind UWH with a rating of 6.50 out of a possible 10. Football did however have the lowest percentage of correct answers on sports nutrition knowledge. These results are shown in tables 4 and 5.

Table 4: Sport specific attitudes to sports nutrition

Question	**Sports**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Importance of sports nutrition					
Very important	83.3%	78.6%	68.4%	78.6%	100%
Slightly important	11.1%	14.3%	21.1%	21.4%	-
Not Very/slightly important	2.8%	7.1%	-	-	-
Not important	-	-	10.5%	-	-
Belief in sports nutrition to improve performance					
Yes definitely	82.9%	85.7%	94.7%	96.4%	100%
Maybe	17.1%	14.3%	5.3%	3.6%	-
Rating of knowledge					
Average rating	5.76	6.50	5.76	5.64	7.0

Standard deviation	1.555	1.387	1.719	1.632	1.000
Variance	2.417	1.923	2.955	2.664	1.000

Table 5: Percentage of correct responses to questions on sports nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	38.73% Std dev 0.50	37.1% Std dev 0.54	42.26% Std dev 0.50	43.86% Std dev 0.50	47.33%* Std dev 0.51

Again, there was no significant difference in the sports nutrition knowledge by gender.

There were a number of worrying results seen on the overall research, especially on the role of protein in the body. Overall the athletes were not clear on the role of protein and often had misguided knowledge in this area. When asked about the roles of a number of the food components, the subjects showed differing levels of knowledge. When asked which food component contained the most energy, 88% of the subjects incorrectly stated that carbohydrates, protein or alcohol had the most energy of the food component options given (alcohol, protein, carbohydrates and fat). Only 4 % were correct in agreeing that fat has the highest amount of energy with the remainder unsure. Table 6 shows that overall 68.2% of the athletes thought that eating a very high protein diet would increase muscle mass. Only 17.5% knew that eating more overall would help, and 63.9% also knew that weight training played a role in increasing muscle mass. These results are consistent with other research which shows that adolescents often have incorrect knowledge on the role of protein, especially in the area of muscle gain (Rosenbloom et al, 2002, Harrison et al, 1991, Jacobsen et al, 2001).

Table 6: The role of protein in increasing muscle mass

Question	Percentage who agreed to the statement	Actual answer
Eating a very high protein diet	68.2%	**False**
Eating more overall	17.5%	**True**
Having protein shakes after every workout	40.2%	**False**
Weight training	63.9%	**True**
Eating egg whites after every meal	21.6%	**False**

Sports drinks were another area that showed a lack of knowledge in these subjects. 85.7% of the athletes reported that they use a sports drink. 14.3% did not use sports drinks. The sports drinks that these 85.7%

of the subjects used are shown below in table 7. 26.8% of the athletes reported using more than one sports drink.

Table 7: Percentage of athletes who report using specific named sports drinks

Sports Drink	**Percentage of athletes who report using the named sports drink**
PowerAde	82.9%
Horley's Replace	23.2%
Endura	1.2%
Gatorade	8.5%

Although sports drinks can provide an advantage when used correctly, many of the athletes did not know why they used a sports drink and most could not back up usage with correct reasoning. This is also consistent with previous research (O'Dea, 2003, Pratt & Walberg, 1998, Chapman & Toma, 1997, Rosenbloom et al, 2002). Subjects were asked to identify the functions of a sports drink. Over 50% of the subjects knew that using a sports drink makes the body retain fluid and that it replaces carbohydrates. Only 37.1% knew that a function of a sports drink was to replace sodium, yet 50.5% agreed that a sports drink replaces sweat. When asked in another question 68% of the subjects stated that sports drinks contain carbohydrates, 63.3% stated that they contain salt (compared to 37.1% saying it replaces sodium), and 22.4% thought that they contained fat (in question C.23. 8.2% of the subjects thought that a function of a sports drink was to burn body fat). 24.5% were unsure whether sports drinks contained salt, whereas 16.5% were unsure if sports drinks contained carbohydrates. Just over half of the subjects knew that sports drinks did not contain fat (56.1%). Full results of this question can be seen in table 8.

Table 8: Results of questions on the functions of a sports drink

Answer	**Percentage of athletes who agreed to the statement**	**Correct response**
It makes the body retain fluid	52.6%	TRUE
It helps to burn body fat	8.2%	FALSE
It replaces sweat	50.5%	TRUE
It tastes good compared to water	40.2%	TRUE
It replaces sodium	37.1%	TRUE
It replaces carbohydrates	58.8%	TRUE
It replaces protein	12.4%	FALSE
It is a source of water	35.1%	TRUE

The reasons that subjects gave for the use of the named sports drinks are shown in table 9:

Table 9: Reasons that subjects use the named sports drinks

Sports drink	**A sample of athletes reasons for Sports Drink usage**
PowerAde®	"because it has a good reputation in sports drinks and tastes good" "told good by coach" "coach said to drink hour beforehand" "cos nice" "because its nice" "told to" "retain the losses of water in your body" "good source of electrolytes for faster rehydration" "taste/recommended" "nice, think your doing something good" "don't know" "thirst quenching and tastes nice" "because they tell us too" "fast rehydration and recovery"
Horley's Replace®	"because I know it helps and they tell us too" "stops cramps" "for vitamins and minerals, stops me cramping" "it tastes good" "to not get dehydrated, replace the electrolytes lost" "to 'replace' sodium etc that you lose"
Endura®	"replaces my electrolytes"
V*	"it helps me personally"

**V is not regarded to be a sports drink as it contains more than 8% carbohydrate but this answer is used in this table to demonstrate that young athletes may perceive it to be a sports drink.*

Athletes were also questioned on the recommendations for pre, during and after exercise in respect to fluid and food intake. The Football athletes had a reasonably sound knowledge of recovery food timing (when) but had low scores on the rest of these questions. None of the Football athletes knew the pre event food recommendations. Many of the other sports also had low scores for majority of these questions. Overall results and results for each sport can be seen in table 10.

Table 10: The results of athlete's knowledge of the recommended guidelines for food and fluid before, during and after exercise.

Question	Sports					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**TOTAL**
Pre event food (Question C.13.)	8.82%	0%	15.79%	0%	33.33%	5.10%
During event fluid (Question C.15.)	17.65%	21.34%	26.32%	17.86%	0%	20.14%
During event food (Question C.16.)	14.75%	7.14%	10.53%	17.86%	33.33%	14.29%
Recovery food (amount) (Question C.19.)	17.65%	14.29%	42.10%	14.29%	0%	17.5%
Recovery food (when) (Question C.20.)	91.18%	64.29%	42.10%	71.43%	100%	77.1%

PREVIOUS SOURCES OF INFORMATION & METHODS FOR THE FUTURE

The athletes were also questioned on how they had received previous nutrition education, and what they would like to have in the future. The overall result s of these two questions are shown in table 11.

Table 11: Overall Results of what methods of nutritional advice athletes have received in the past and what methods of nutritional advice they would like to receive in the future.

Session Type	**Percentage of athletes who have had this method of nutritional advice**	**Percentage of athletes who have would like to receive this method of nutritional advice**

Individual session with a sports nutritionist/dietitian	35.4%	73.68%
Supermarket Tour	16.2%	26.23%
Group cooking session	39.4%	31.58%
Group workshop	47.5%	47.37%
Menu plans developed	35.4%	N/A
Hydration workshops	17.2%	15.79%
Athlete as a guest speaker	40.4%	52.63%
Nutrition Quiz session	17.2%	15.91%
Lectures	N/A	15.79%
Written resources	N/A	42.11%
Recipe lists	N/A	31.58%
Interactive website	N/A	21.05%

The results were broken down in specific sports to show what methods the athletes had received in the past. A large percentage (69.23%) of the Football players had taken part in a nutrition quiz session and an equal number had also had menu plans developed for them. 30.77% had taken part in an individual session with a sports nutritionist/dietitian in the past, which is the highest of all of the sports. 46.15% had also taken part in hydration workshops. The results by sport are shown in table 12:

Table 12: Results of what methods of nutritional advice/education athletes have received in the past by sport.

Session Type	**Percentage of athletes by sport, who have received this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	17.14%	30.77%	26.32%	10.7%	0%
Supermarket Tour	25.71%	30.77%	10.53%	57.1%	33.3%
Group cooking session	22.86%	7.69%	5.26%	17.9%	0%
Group workshop	77.14%	15.38%	36.84%	32.1%	0%

Menu plans developed	45.71%	69.23%	57.89%	50%	33.3%
Hydration workshops	25.71%	46.15%	15.79%	21.4%	100%
Athlete as a guest speaker	8.57%	30.77%	21.05%	21.4%	33.3%
Nutrition Quiz session	51.43%	69.23%	26.23%	25%	33.3%

The athletes were also asked to comment on what nutrition education they would like in the future. These results can be seen in table 13.

Table 13: Results of what methods of nutritional advice athletes would like to receive in the future by sport.

Session Type	**Percentage of athletes by sport, who have would like to receive this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	0%	0%	73.68%	78.6%	0%
Supermarket Tour	59.24%	46.15%	26.23%	57.1%	0%
Group cooking session	41.18%	76.92%	31.58%	78.6%	100%
Group workshop	5.88%	0%	47.37%	14.3%	0%
Hydration workshops	8.82%	16.67%	15.79%	10.7%	33.3%
Athlete as a guest speaker	8.82%	15.38%	52.63%	14.3%	33.3%
Nutrition Quiz session	23.53%	30.77%	15.91%	28.6%	0%
Lectures	26.47%	23.08%	15.79%	25%	0%
Written resources	14.71%	53.85%	42.11%	17.9%	0%
Recipe lists	23.53%	84.62%	31.58%	25%	0%
Interactive website	52.94%	46.15%	21.05%	35.7%	66.7%

When questioned on whether they use information which is provided to them overall 43% said that yes they did use nutrition information. 46.2% stated that they sometimes used information, whilst 10.8% said they did not use information. 7 responses were missing for this question. This is an important component to be addressed in working with adolescents and for further research to assess the factors which inhibit athletes from using information which they receive. If they do not use information which has been provided there are clearly barriers to the intended behaviour occurring.

The athletes were also asked to identify who else should be involved in their nutrition education. The results of this question can be seen in table 14. The results of this question clearly show that adolescents believe that both parents and coaches should be involved with their nutrition education.

Table 14: Results of question C.27. - Who else should be involved in your nutrition education?

	Parents	**Coaches**	**Other***
Overall percentage of athletes who thought others should be involved in their nutrition education	81.6%	64.3%	18%
Basketball athletes only	47.1%	94.1%	76.5%
Football athletes only	53.8%	92.3%	61.5%
Netball athletes only	84.2%	89.5%	21.1%
Rugby athletes only	25%	60.7%	39.3%
Underwater Hockey athletes only	33.3%	66.7%	66.7%

**Other responses were teammates and team members, members of the athletes flat, nutritionist, friends, in the same sport, teachers, the trainer, and partners.*

CONCLUSION & RECOMMENDATIONS

In conclusion it is recommended that resources and educational programmes are designed for adolescent athletes. These should take the following points into consideration:

- They must be developmentally appropriate
- They must have a performance based focus and be positive
- It is possible that they could be more successful if they involve a top sportsperson or sports team as a role model(s)

Recommendations are:

- Females may need information on iron status and in particular a weight based focus

- Resources that are specifically targeted at adolescents need to be developed and made available through as many avenues as possible to adolescent athletes and their parents
- A programme which has more than one nutrition session is likely to more successful in educating athletes about sports nutrition and changing behaviour
- Coaches (especially) and parents need to be educated in sports nutrition so that they can provide correct, and relevant advice to adolescent athletes. Trainers and other members of the support team need to be educated to provide sound advice or refer the athlete to a specialist
- Information needs to be shared within nutritionists
- There are not enough sports nutritionists to work with all teams and often team funds do not cover for a nutritionist. Trainers and coaches must improve their nutrition knowledge if this is to remain the case
- More research needs to be conducted on the levels of knowledge in New Zealand adolescent athletes, and the ways of educating this group.

LIMITING FACTORS OF THE RESEARCH

There are a number of limiting factors which need to be considered in the ANKAA study. The athletes were posted the questionnaires and therefore the researcher did not have control of the situation in which they did the questionnaire. Subjects were asked to complete the questionnaires by themselves but it is not known if any of the respondents were given help by parents, caregivers or coaches. Respondents may have been more inclined to participate if they had more of an interest in nutrition as the questionnaire was distributed and noted to be voluntary to all participants. If the parents were more interested in nutrition this may have influenced who sent back completed questionnaires. Some athletes may have been encouraged more by their NSO than others and this may have influenced who responded to the questionnaires.

The focus groups were a part of this research which did not perform as well as expected. Two series of focus groups were organised and the participants were invited by letter to these. It has been suggested that "attendance is likely to be higher if the group consist of a pre existing social group utilizing an established meeting venue and time for a formal pre existing group can also improve attendance" (Bloor, 2001, pg 36) and that the job of recruiting attendees for the focus group can be done more effectively if the researcher can use an intermediary person for the job, who has contact with a pre existing group (Bloor, 2001). This method was successful with the focus group which was run with the Manawatu Rugby

Academy. In future this would be a better method of recruitment for adolescent athletes for focus groups, instead of directly contacting the individual athletes and asking them to attend.

The study needs a larger sample size to give a clear indication of results. The current study had a small sample size so to confirm the results seen, more participants are needed. The study also only used subjects from five sports which were all team sports. To get a clearer indication of adolescent nutrition knowledge and methods of education it is important to widen the types of sports that athletes are selected from, and include individual sports.

ACKNOWLEDGEMENTS

The author gratefully acknowledges:

- the athletes who so willingly participated in this study
- the National Sporting Organisations; Basketball New Zealand, Netball New Zealand, New Zealand Rugby Union, New Zealand Football and New Zealand Underwater Hockey for their support
- SPARC (Sport and Recreation New Zealand) who awarded this project a Research Grant
- Dr Jane Coad, student supervisor
- Dr Janet Weber
- Mrs. Chris Booth, who worked as the independent third party researcher on this project

For further information the author can be contacted via email: sarah@sportsnutritionist.co.nz

REFERENCES

Bloor , M. *Focus groups in social research – Introducing qualitative methods* (2001). Sage, London.

Chapman, P., Toma, R. B. (1997). Nutrition knowledge among adolescent high school female athletes. *Adolescence*, 32(126):1-8.

Croll, J. K., Neumark-Sztainer, D., Story, M., Wall, M., Perry, C., Harnack, L. (2006). Adolescents involved in weight-related and power-team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. *The Journal of the American Dietetic Association,* 106:709- 717.

Harrison, J., Hopkins, W. G., MacFarlane, D. J., Worsley, A. (1991). Nutrition knowledge and dietary habits of elite and non-elite athletes. *Australian Journal of Nutrition and Dietetics,* 48:124-127.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., Beck, N. C. (2004). Nutrient intakes and dietary behaviours of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:389-404.

Jacobson, B.H., Sobonya, C., Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research,* 15:63-68.

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Health education Research,* 18:98-107.

Position of the American Dietetic Association: child and adolescent food and nutrition programs. (1996) *The Journal of the American Dietetic Association,* 96:913-917.

Pratt, C.A., Walberg, J.L. (1988). Nutrition knowledge concerns of health and physical education teachers. *Journal of the American Dietetic Association,* 88, 840-841.

Rosenbloom, C.A., Jonnalagardadda, S.S., Skinner, R. (2002). Nutrition Knowledge of collegiate athletes in a division 1 national athletic association institution. *Journal of the American Dietetic Association,* 102:418-420.

Story, M., Neumark-Sztainer, D., French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *The Journal of the American Dietetic Association*, 102:3, S40-S51.

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

SUMMARY OF RESEARCH RESULTS - *NETBALL*

There is very limited research on the nutrition knowledge and food skills of elite athletes in New Zealand. Adolescent athletes are moving through an important physiological stage of life, as well as training and competing in their chosen sports. These athletes are the future New Zealand sporting representatives and therefore need adequate nutrition knowledge for performance, as well as health and wellbeing. This research investigated the basic and sports nutrition knowledge of 100 talented adolescent athletes from five team sports using questionnaires and a focus group. While the participants had a reasonable level of basic nutrition knowledge, their sports nutrition knowledge was not as high. They struggled with the concepts of sports drinks, muscle growth and supplements. Most participants had received some nutrition education and indicated that in the future they would prefer individual sessions with a sports nutritionist, written resources, as well as group sessions including cooking sessions and group workshops, and using a high profile athlete as a role model. The participants were very clear that their coaches and parents needed to be involved in their nutrition education. More research is needed to assess the overall knowledge of New Zealand adolescent athletes and the most appropriate, and effective methods of education for this group.

Introduction

When an adolescent is also an athlete there are many important factors to consider in terms of nutrition for both growth and sports performance. Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al, 2006). Coupled with the fact that when the athlete is an adolescent they have further energy and nutrient needs due to the large period of growth that the adolescent period entails, including the adolescent growth spurt (ADA, 1996, Story et al, 2002, Hinton et al, 2004, Croll et al, 2006), this creates a significant nutritional challenge.

The specific aims of this research were:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences this subject group in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this subject group,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

This project is designed to assess the knowledge of talented New Zealand adolescent athletes and look at identifying how adolescents would prefer to be given sports nutrition advice. Currently there is also a lack of resources designed to work specifically with this group and it is anticipated that this research project will not only identify the level of nutritional knowledge of this group but also develop an educational curriculum and accompanying resources which should be produced for this group.

METHODOLOGY

Subjects

Letters were sent to ten national sporting organisations (NSO's) describing the study and asking if they would give permission for their athletes who met the entry criteria to take part in the study. The ten sports were chosen as they encompassed a range of both team and individual sports, and sports which are generally gender specific. Sporting organizations were asked to provide contact details of athletes who met the entry criteria for the project. The entry criteria was that athletes needed to be between the ages of 13 and 20 years old as at the 1st of January 2007, and be considered a talented or elite athlete in their chosen sport by being a carded athlete, or part of a High Performance Academy Group, Regional Talent Identification Group or an equivalent Development group. Sporting organisations who agreed to participate in the study were asked to forward contact details of athletes who met the criteria to an independent third party research assistant. This preserved confidentiality of contact details.

Five sporting organizations agreed to take part in this research; Basketball New Zealand, Netball New Zealand, New Zealand Football, New Zealand Rugby Union, and New Zealand Underwater Hockey. A total of 100 athletes took part in the research.

The study was given ethical approval by the Massey University Committee of Ethics (ref 07/52).

The Questionnaire

The questionnaire was developed to address four different aims. Section A aimed to assess the basic nutritional knowledge of the subjects. Section B aimed to investigate influences on food choice and food availability in the subjects. Section C was designed to assess the basic sports nutrition knowledge and practices of the subjects and section D gathered basic demographic information about the subjects.

The questionnaire was developed using previous research questions and newly developed questions. A pilot trial of the questionnaire was conducted with athletes of the same age and who participated in the same ten sports as the targeted population and changes were made to questions which were unclear before sending to the actual subject group. Changes included rewording four questions so that they were appropriate for the age group in this study. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge, and those who did not have any knowledge the questionnaire used 'yes', 'no' and 'unsure' answers.

Procedure

The independent research assistant used the contact details from NSO's to create two sets of address labels for each contact. The first set was used to send the initial questionnaire pack which included a participant information sheet, a participant consent form, a parental information sheet, a parental consent form, a questionnaire and a return envelope.

The questionnaires were coded to identify which participants had returned their questionnaire. The independent research assistant followed up the athletes who had not returned the questionnaire phone call. When the unnamed questionnaires were received by the independent research assistant they were removed from the envelopes and passed on to the student researcher to ensure confidentiality of the subjects.

The second set of address labels were used in the organisation of focus groups. One invitation to participate in the focus groups arranged in Christchurch, Wellington, Palmerston North and Auckland in December 2008 was sent out to all participants and did not receive any responses to attend. This may have been due to being in close proximity to Christmas so another round of focus groups was planned for February 2009. Although there were very few respondents there were not enough to warrant a focus group at this time either. Instead the Manawatu Rugby Academy volunteered to run a focus group with their academy players (some of who had previously completed the questionnaire for this research). There were nine players, and their sports nutritionist present.

A number of questions were developed for use in the focus group by the researcher to prompt the athletes with the aim of initiating discussion. Several props were used including cookbooks and pamphlets/booklets.

Data analysis

Analysis of the questionnaires was carried out to provide results. The data was analysed with SPSS v14.0.

OVERALL FINDINGS

100 athletes from five sports returned questionnaires for this research project. The distribution of sports and level of competition can be seen in Table 1:

Table 1: The distribution of sports and level of competition

Level	Basketball	Football	Netball	Rugby	UWH	TOTAL
Regional	1	0	11	19	0	31
National	16	2	7	5	1	31
International	15	12	1	4	2	34

The mean age of all of the athletes was 16.64 years (std dev 1.937). 55.8% of the athletes compete in more than one sport, with athletes from Netball (68.4%) and Basketball (61.76%) more likely to partake in more than one sport. Rugby (39.2%) and UWH (33.3%) were the least likely to take part in more one sport. However, the UWH group is not large enough to get a clear result.

BASIC NUTRITION KNOWLEDGE RESULTS

The athletes were asked to complete a series of questions designed to address basic nutrition knowledge. The scores were tallied and compared for each sport. UWH athletes had the highest number of correct responses but the very small sample size of this group means that this is disputable. Football was seen to have the next highest correct response rate, followed by netball and then rugby. These results are given in table 2:

Table 2: % of correct responses to questions on basic nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	60.99 % Std dev 3.35	68.32 % Std dev 2.43	63.20 % Std dev 4.43	66.36% Std dev 2.96	78.26 %* Std dev 2.00

There was no significant difference between gender and basic nutrition knowledge.

SPORTS NUTRITION KNOWLEDGE RESULTS

The athletes were also questioned on sports nutrition knowledge using a series of questions. Athletes ranked the importance of sports nutrition highly and had a positive belief in sports nutrition improving performance. The full results of these questions are shown in table 3.

Table 3: Overall results of attitudes to sports nutrition

Attitudes towards Sports Nutrition	Percentage of athletes
Importance of Sports Nutrition question: "How important do you consider sports nutrition to be in your sporting plans?"	
Very important	79%
Slightly important	16%
Not Very/slightly important	2%
Not important	2%
Belief in Sports Nutrition to improve performance question: "Do you believe that specific sports nutrition strategies could improve your performance?"	
Yes definitely	88%
Maybe	12%
No	-
Average rating of sports nutrition knowledge Question: "How would you rate your sports nutrition knowledge on a scale of 1 (non-existent) to 10 (excellent)?"	

Rating Standard deviation Variance	5.87 1.584 2.508

The answers to these questions were also divided into sporting code. Netball athletes rated the importance lowest out of the sports with 68.4% rating it as very important. 10.5% also answered that it was not important, the only sport to do so. However a higher number (94.7%) of the Netball athletes believed that sports nutrition could improve performance. Netball athletes had a low self rating of nutrition knowledge with 5.76 out of a possible 10 which was near the lower end of the sports. The Netball athletes did however have the second highest amount of correct answers (43.86%) to the sports nutrition knowledge questions behind UWH (47.33%). These results are shown in tables 4 and 5.

Table 4: Sport specific attitudes to sports nutrition

Question	Sports				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Importance of sports nutrition					
Very important	83.3%	78.6%	68.4%	78.6%	100%
Slightly important	11.1%	14.3%	21.1%	21.4%	-
Not Very/slightly important	2.8%	7.1%	-	-	-
Not important	-	-	10.5%	-	-
Belief in sports nutrition to improve performance					
Yes definitely	82.9%	85.7%	94.7%	96.4%	100%
Maybe	17.1%	14.3%	5.3%	3.6%	-
Rating of knowledge					
Average rating	5.76	6.50	5.76	5.64	7.0
Standard deviation	1.555	1.387	1.719	1.632	1.000
Variance	2.417	1.923	2.955	2.664	1.000

Table 5: Percentage of correct responses to questions on sports nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	38.73% Std dev 0.50	37.1% Std dev 0.54	42.26% Std dev 0.50	43.86% Std dev 0.50	47.33%* Std dev 0.51

Again, there was no significant difference in the sports nutrition knowledge by gender.

There were a number of worrying results seen on the overall research, especially on the role of protein in the body. Overall the athletes were not clear on the role of protein and often had misguided knowledge in this area. When asked about the roles of a number of the food components, the subjects showed differing levels of knowledge. When asked which food component contained the most energy, 88% of the subjects incorrectly stated that carbohydrates, protein or alcohol had the most energy of the food component options given (alcohol, protein, carbohydrates and fat). Only 4 % were correct in agreeing that fat has the highest amount of energy with the remainder unsure. Table 6 shows that overall 68.2% of the athletes thought that eating a very high protein diet would increase muscle mass. Only 17.5% knew that eating more overall would help, and 63.9% also knew that weight training played a role in increasing muscle mass. These results are consistent with other research which shows that adolescents often have incorrect knowledge on the role of protein, especially in the area of muscle gain (Rosenbloom et al, 2002, Harrison et al, 1991, Jacobsen et al, 2001).

Table 6: The role of protein in increasing muscle mass

Question	Percentage who agreed to the statement	Actual answer
Eating a very high protein diet	68.2%	**False**
Eating more overall	17.5%	**True**
Having protein shakes after every workout	40.2%	**False**
Weight training	63.9%	**True**
Eating egg whites after every meal	21.6%	**False**

Sports drinks were another area that showed a lack of knowledge in these subjects. 85.7% of the athletes reported that they use a sports drink. 14.3% did not use sports drinks. The sports drinks that these 85.7% of the subjects used are shown below in table 7. 26.8% of the athletes reported using more than one sports drink.

Table 7: Percentage of athletes who report using specific named sports drinks

Sports Drink	Percentage of athletes who report using the named sports drink
PowerAde	82.9%
Horley's Replace	23.2%
Endura	1.2%
Gatorade	8.5%

* athletes often gave more than one response to this question

Although sports drinks can provide an advantage when used correctly, many of the athletes did not know why they used a sports drink and most could not back up usage with correct reasoning. This is also consistent with previous research (O'Dea, 2003, Pratt & Walberg, 1998, Chapman & Toma, 1997, Rosenbloom et al, 2002). Subjects were asked to identify the functions of a sports drink. Over 50% of the subjects knew that using a sports drink makes the body retain fluid and that it replaces carbohydrates. Only 37.1% knew that a function of a sports drink was to replace sodium, yet 50.5% agreed that a sports drink replaces sweat. When asked in another question 68% of the subjects stated that sports drinks contain carbohydrates, 63.3% stated that they contain salt (compared to 37.1% saying it replaces sodium), and 22.4% thought that they contained fat (in question C.23. 8.2% of the subjects thought that a function of a sports drink was to burn body fat). 24.5% were unsure whether sports drinks contained salt, whereas 16.5% were unsure if sports drinks contained carbohydrates. Just over half of the subjects knew that sports drinks did not contain fat (56.1%). Full results of this question can be seen in table 8.

Table 8: Results of questions on the functions of a sports drink

Answer	Percentage of athletes who agreed to the statement	Correct response
It makes the body retain fluid	52.6%	TRUE
It helps to burn body fat	8.2%	FALSE
It replaces sweat	50.5%	TRUE
It tastes good compared to water	40.2%	TRUE
It replaces sodium	37.1%	TRUE
It replaces carbohydrates	58.8%	TRUE
It replaces protein	12.4%	FALSE
It is a source of water	35.1%	TRUE

The reasons that subjects gave for the use of the named sports drinks are shown in table 9:

Table 9: Reasons that subjects use the named sports drinks

Sports drink	A sample of athletes reasons for Sports Drink usage
PowerAde®	"because it has a good reputation in sports drinks and tastes good" "told good by coach" "coach said to drink hour beforehand" "cos nice" "because its nice" "told to" "retain the losses of water in your body" "good source of electrolytes for faster rehydration" "taste/recommended" "nice, think your doing something good" "don't know" "thirst quenching and tastes nice" "because they tell us too" "fast rehydration and recovery"
Horley's Replace®	"because I know it helps and they tell us too" "stops cramps" "for vitamins and minerals, stops me cramping" "it tastes good" "to not get dehydrated, replace the electrolytes lost" "to 'replace' sodium etc that you lose"
Endura®	"replaces my electrolytes"
V*	"it helps me personally"

**V is not regarded to be a sports drink as it contains more than 8% carbohydrate but this answer is used in this table to demonstrate that young athletes may perceive it to be a sports drink.*

Athletes were also questioned on the recommendations for pre, during and after exercise in respect to fluid and food intake. The Netball athletes had scores at the lower end of the scale of knowledge of these questions, although for all bar two (C.16. and C.20.) they were higher than the mean overall total. Many of the other sports also had low scores for majority of these questions. Overall results and results for each sport can be seen in table 10.

Table 10: The results of athlete's knowledge of the recommended guidelines for food and fluid before, during and after exercise.

Question	Sports					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**TOTAL**
Pre event food (Question C.13.)	8.82%	0%	15.79%	0%	33.33%	5.10%
During event fluid (Question C.15.)	17.65%	21.34%	26.32%	17.86%	0%	20.14%
During event food (Question C.16.)	14.75%	7.14%	10.53%	17.86%	33.33%	14.29%
Recovery food (amount) (Question C.19.)	17.65%	14.29%	42.10%	14.29%	0%	17.5%
Recovery food (when) (Question C.20.)	91.18%	64.29%	42.10%	71.43%	100%	77.1%

PREVIOUS SOURCES OF INFORMATION & METHODS FOR THE FUTURE

The athletes were also questioned on how they had received previous nutrition education, and what they would like to have in the future. The overall result s of these two questions are shown in table 11.

Table 11: Overall Results of what methods of nutritional advice athletes have received in the past and what methods of nutritional advice they would like to receive in the future.

Session Type	**Percentage of athletes who have had this method of nutritional advice**	**Percentage of athletes who have would like to receive this method of nutritional advice**
Individual session with a sports nutritionist/dietitian	35.4%	73.68%

Supermarket Tour	16.2%	26.23%
Group cooking session	39.4%	31.58%
Group workshop	47.5%	47.37%
Menu plans developed	35.4%	N/A
Hydration workshops	17.2%	15.79%
Athlete as a guest speaker	40.4%	52.63%
Nutrition Quiz session	17.2%	15.91%
Lectures	N/A	15.79%
Written resources	N/A	42.11%
Recipe lists	N/A	31.58%
Interactive website	N/A	21.05%

The results were broken down in specific sports to show what methods the athletes had received in the past. A large percentage (57.89%) had received menu plans that had been developed for them, and 26.32% had taken part in an individual session with a sports nutritionist/dietitian. The results by sport are shown in table 12:

Table 12: Results of what methods of nutritional advice/education athletes have received in the past by sport.

Session Type	**Percentage of athletes by sport, who have received this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	17.14%	30.77%	26.32%	10.7%	0%
Supermarket Tour	25.71%	30.77%	10.53%	57.1%	33.3%
Group cooking session	22.86%	7.69	5.26%	17.9%	0%
Group workshop	77.14%	15.38	36.84%	32.1%	0%
Menu plans developed	45.71%	69.23	57.89%	50%	33.3%

Hydration workshops	25.71%	46.15	15.79%	21.4%	100%
Athlete as a guest speaker	8.57%	30.77	21.05%	21.4%	33.3%
Nutrition Quiz session	51.43%	69.23	26.23%	25%	33.3%

The athletes were also asked to comment on what nutrition education they would like in the future. These results can be seen in table 13.

Table 13: Results of what methods of nutritional advice athletes would like to receive in the future by sport.

Session Type	**Percentage of athletes by sport, who have would like to receive this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	0%	0%	73.68%	78.6%	0%
Supermarket Tour	59.24%	46.15%	26.23%	57.1%	0%
Group cooking session	41.18%	76.92%	31.58%	78.6%	100%
Group workshop	5.88%	0%	47.37%	14.3%	0%
Hydration workshops	8.82%	16.67%	15.79%	10.7%	33.3%
Athlete as a guest speaker	8.82%	15.38%	52.63%	14.3%	33.3%
Nutrition Quiz session	23.53%	30.77%	15.91%	28.6%	0%
Lectures	26.47%	23.08%	15.79%	25%	0%
Written resources	14.71%	53.85%	42.11%	17.9%	0%
Recipe lists	23.53%	84.62%	31.58%	25%	0%
Interactive website	52.94%	46.15%	21.05%	35.7%	66.7%

When questioned on whether they use information which is provided to them overall 43% said that yes they did use nutrition information. 46.2% stated that they sometimes used information, whilst 10.8% said they did not use information. 7 responses were missing for this question. This is an important component to be addressed in working with adolescents and for further research to assess the factors which inhibit athletes from using information which they receive. If they do not use information which has been provided there are clearly barriers to the intended behaviour occurring.

The athletes were also asked to identify who else should be involved in their nutrition education. The results of this question can be seen in table 14. The results of this question clearly show that adolescents believe that both parents and coaches should be involved with their nutrition education.

Table 14: Results of question C.27.- Who else should be involved in your nutrition education?

	Parents	**Coaches**	**Other***
Overall percentage of athletes who thought others should be involved in their nutrition education	81.6%	64.3%	18%
Basketball athletes only	47.1%	94.1%	76.5%
Football athletes only	53.8%	92.3%	61.5%
Netball athletes only	84.2%	89.5%	21.1%
Rugby athletes only	25%	60.7%	39.3%
Underwater Hockey athletes only	33.3%	66.7%	66.7%

**Other responses were teammates and team members, members of the athletes flat, nutritionist, friends, in the same sport, teachers, the trainer, and partners.*

CONCLUSION & RECOMMENDATIONS

In conclusion it is recommended that resources and educational programmes are designed for adolescent athletes. These should take the following points into consideration:

- They must be developmentally appropriate
- They must have a performance based focus and be positive
- It is possible that they could be more successful if they involve a top sportsperson or sports team as a role model(s)

Recommendations are:

- Females may need information on iron status and in particular a weight based focus
- Resources that are specifically targeted at adolescents need to be developed and made available through as many avenues as possible to adolescent athletes and their parents

- A programme which has more than one nutrition session is likely to more successful in educating athletes about sports nutrition and changing behaviour
- Coaches (especially) and parents need to be educated in sports nutrition so that they can provide correct, and relevant advice to adolescent athletes. Trainers and other members of the support team need to be educated to provide sound advice or refer the athlete to a specialist
- Information needs to be shared within nutritionists
- There are not enough sports nutritionists to work with all teams and often team funds do not cover for a nutritionist. Trainers and coaches must improve their nutrition knowledge if this is this is to remain as it is
- More research needs to be conducted on the levels of knowledge in New Zealand adolescent athletes, and the ways of educating this group.

LIMITING FACTORS OF THE RESEARCH

There are a number of limiting factors which need to be considered in the ANKAA study. The athletes were posted the questionnaires and therefore the researcher did not have control of the situation in which they did the questionnaire. Subjects were asked to complete the questionnaires by themselves but it is not known if any of the respondents were given help by parents, caregivers or coaches. Respondents may have been more inclined to participate if they had more of an interest in nutrition as the questionnaire was distributed and noted to be voluntary to all participants. If the parents were more interested in nutrition this may have influenced who sent back completed questionnaires. Some athletes may have been encouraged more by their NSO than others and this may have influenced who responded to the questionnaires.

The focus groups were a part of this research which did not perform as well as expected. Two series of focus groups were organised and the participants were invited by letter to these. It has been suggested that "attendance is likely to be higher if the group consist of a pre existing social group utilizing an established meeting venue and time for a formal pre existing group can also improve attendance" (Bloor, 2001,pg 36) and that the job of recruiting attendees for the focus group can be done more effectively if the researcher can use an intermediary person for the job, who has contact with a pre existing group (Bloor, 2001). This method was successful with the focus group which was run with the Manawatu Rugby Academy. In future this would be a better method of recruitment for adolescent athletes for focus groups, instead of directly contacting the individual athletes and asking them to attend.

The study needs a larger sample size to give a clear indication of results. The current study had a small sample size so to confirm the results seen, more participants are needed. The study also only used subjects from five sports which were all team sports. To get a clearer indication of adolescent nutrition knowledge and methods of education it is important to widen the types of sports that athletes are selected from, and include individual sports.

ACKNOWLEDGEMENTS

The author gratefully acknowledges:

- the athletes who so willingly participated in this study
- the National Sporting Organisations; Basketball New Zealand, Netball New Zealand, New Zealand Rugby Union, New Zealand Football and New Zealand Underwater Hockey for their support
- SPARC (Sport and Recreation New Zealand) who awarded this project a Research Grant
- Dr Jane Coad, student supervisor
- Dr Janet Weber
- Mrs. Chris Booth, who worked as the independent third party researcher on this project

For further information the author can be contacted via email: sarah@sportsnutritionist.co.nz

REFERENCES

Bloor , M. *Focus groups in social research – Introducing qualitative methods* (2001). Sage, London.

Chapman, P., Toma, R. B. (1997). Nutrition knowledge among adolescent high school female athletes. *Adolescence*, 32(126):1-8.

Croll, J. K., Neumark-Sztainer, D., Story, M., Wall, M., Perry, C., Harnack, L. (2006). Adolescents involved in weight-related and power-team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. *The Journal of the American Dietetic Association,* 106:709- 717.

Harrison, J., Hopkins, W. G., MacFarlane, D. J., Worsley, A. (1991). Nutrition knowledge and dietary habits of elite and non-elite athletes. *Australian Journal of Nutrition and Dietetics,* 48:124-127.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., Beck, N. C. (2004). Nutrient intakes and dietary behaviours of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:389-404.

Jacobson, B.H., Sobonya, C., Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research,* 15:63-68.

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Health education Research,* 18:98-107.

Position of the American Dietetic Association: child and adolescent food and nutrition programs. (1996) *The Journal of the American Dietetic Association,* 96:913-917.

Pratt, C.A., Walberg, J.L. (1988). Nutrition knowledge concerns of health and physical education teachers. *Journal of the American Dietetic Association,* 88, 840-841.

Rosenbloom, C.A., Jonnalagardadda, S.S., Skinner, R. (2002). Nutrition Knowledge of collegiate athletes in a division 1 national athletic association institution. *Journal of the American Dietetic Association,* 102:418-420.

Story, M., Neumark-Sztainer, D., French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *The Journal of the American Dietetic Association*, 102:3, S40-S51.

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

SUMMARY OF RESEARCH RESULTS - RUGBY

There is very limited research on the nutrition knowledge and food skills of elite athletes in New Zealand. Adolescent athletes are moving through an important physiological stage of life, as well as training and competing in their chosen sports. These athletes are the future New Zealand sporting representatives and therefore need adequate nutrition knowledge for performance, as well as health and wellbeing. This research investigated the basic and sports nutrition knowledge of 100 talented adolescent athletes from five team sports using questionnaires and a focus group. While the participants had a reasonable level of basic nutrition knowledge, their sports nutrition knowledge was not as high. They struggled with the concepts of sports drinks, muscle growth and supplements. Most participants had received some nutrition education and indicated that in the future they would prefer individual sessions with a sports nutritionist, written resources, as well as group sessions including cooking sessions and group workshops, and using a high profile athlete as a role model. The participants were very clear that their coaches and parents needed to be involved in their nutrition education. More research is needed to assess the overall knowledge of New Zealand adolescent athletes and the most appropriate, and effective methods of education for this group.

Introduction

When an adolescent is also an athlete there are many important factors to consider in terms of nutrition for both growth and sports performance. Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al, 2006). Coupled with the fact that when the athlete is an adolescent they have further energy and nutrient needs due to the large period of growth that the adolescent period entails, including the adolescent growth spurt (ADA, 1996, Story et al, 2002, Hinton et al, 2004, Croll et al, 2006), this creates a significant nutritional challenge.

The specific aims of this research were:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences this subject group in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this subject group,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

This project is designed to assess the knowledge of talented New Zealand adolescent athletes and look at identifying how adolescents would prefer to be given sports nutrition advice. Currently there is also a lack of resources designed to work specifically with this group and it is anticipated that this research project will not only identify the level of nutritional knowledge of this group but also develop an educational curriculum and accompanying resources which should be produced for this group.

METHODOLOGY

Subjects

Letters were sent to ten national sporting organisations (NSO's) describing the study and asking if they would give permission for their athletes who met the entry criteria to take part in the study. The ten sports were chosen as they encompassed a range of both team and individual sports, and sports which are generally gender specific. Sporting organizations were asked to provide contact details of athletes who met the entry criteria for the project. The entry criteria was that athletes needed to be between the ages of 13 and 20 years old as at the 1st of January 2007, and be considered a talented or elite athlete in their chosen sport by being a carded athlete, or part of a High Performance Academy Group, Regional Talent Identification Group or an equivalent Development group. Sporting organisations who agreed to participate in the study were asked to forward contact details of athletes who met the criteria to an independent third party research assistant. This preserved confidentiality of contact details.

Five sporting organizations agreed to take part in this research; Basketball New Zealand, Netball New Zealand, New Zealand Football, New Zealand Rugby Union, and New Zealand Underwater Hockey. A total of 100 athletes took part in the research.

The study was given ethical approval by the Massey University Committee of Ethics (ref 07/52).

The Questionnaire

The questionnaire was developed to address four different aims. Section A aimed to assess the basic nutritional knowledge of the subjects. Section B aimed to investigate influences on food choice and food availability in the subjects. Section C was designed to assess the basic sports nutrition knowledge and practices of the subjects and section D gathered basic demographic information about the subjects.

The questionnaire was developed using previous research questions and newly developed questions. A pilot trial of the questionnaire was conducted with athletes of the same age and who participated in the same ten sports as the targeted population and changes were made to questions which were unclear before sending to the actual subject group. Changes included rewording four questions so that they were appropriate for the age group in this study. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge, and those who did not have any knowledge the questionnaire used 'yes', 'no' and 'unsure' answers.

Procedure

The independent research assistant used the contact details from NSO's to create two sets of address labels for each contact. The first set was used to send the initial questionnaire pack which included a participant information sheet, a participant consent form, a parental information sheet, a parental consent form, a questionnaire and a return envelope.

The questionnaires were coded to identify which participants had returned their questionnaire. The independent research assistant followed up the athletes who had not returned the questionnaire phone call. When the unnamed questionnaires were received by the independent research assistant they were removed from the envelopes and passed on to the student researcher to ensure confidentiality of the subjects.

The second set of address labels were used in the organisation of focus groups. One invitation to participate in the focus groups arranged in Christchurch, Wellington, Palmerston North and Auckland in December 2008 was sent out to all participants and did not receive any responses to attend. This may have been due to being in close proximity to Christmas so another round of focus groups was planned for February 2009. Although there were very few respondents there were not enough to warrant a focus group at this time either. Instead the Manawatu Rugby Academy volunteered to run a focus group with their academy players (some of who had previously completed the questionnaire for this research). There were nine players, and their sports nutritionist present.

A number of questions were developed for use in the focus group by the researcher to prompt the athletes with the aim of initiating discussion. Several props were used including cookbooks and pamphlets/booklets.

Data analysis

Analysis of the questionnaires was carried out to provide results. The data was analysed with SPSS v14.0.

OVERALL FINDINGS

100 athletes from five sports returned questionnaires for this research project. The distribution of sports and level of competition can be seen in Table 1:

Table 1: The distribution of sports and level of competition

Level	Basketball	Football	Netball	Rugby	UWH	TOTAL
Regional	1	0	11	19	0	31
National	16	2	7	5	1	31
International	15	12	1	4	2	34

The mean age of all of the athletes was 16.64 years (std dev 1.937). 55.8% of the athletes compete in more than one sport, with athletes from Netball (68.4%) and Basketball (61.76%) more likely to partake in more than one sport. Rugby (39.2%) and UWH (33.3%) were the least likely to take part in more one sport. However, the UWH group is not large enough to get a clear result.

BASIC NUTRITION KNOWLEDGE RESULTS

The athletes were asked to complete a series of questions designed to address basic nutrition knowledge. The scores were tallied and compared for each sport. UWH athletes had the highest number of correct responses but the very small sample size of this group means that this is disputable. Football was seen to have the next highest correct response rate, followed by netball and then rugby. These results are given in table 2:

Table 2: % of correct responses to questions on basic nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	60.99 % Std dev 3.35	68.32 % Std dev 2.43	63.20 % Std dev 4.43	66.36% Std dev 2.96	78.26 %* Std dev 2.00

There was no significant difference between gender and basic nutrition knowledge.

SPORTS NUTRITION KNOWLEDGE RESULTS

The athletes were also questioned on sports nutrition knowledge using a series of questions. Athletes ranked the importance of sports nutrition highly and had a positive belief in sports nutrition improving performance. The full results of these questions are shown in table 3.

Table 3: Overall results of attitudes to sports nutrition

Attitudes towards Sports Nutrition	**Percentage of athletes**
Importance of Sports Nutrition question: “How important do you consider sports nutrition to be in your sporting plans?”	
Very important Slightly important Very/slightly important Not important	79% 16% 2% 2%
Belief in Sports Nutrition to improve performance question: “Do you believe that specific sports nutrition strategies could improve your performance?”	
Yes definitely Maybe No	88% 12% -
Average rating of sports nutrition knowledge Question: “How would you rate your sports nutrition knowledge on a scale of 1 (non-existent) to 10 (excellent)?”	

Rating Standard deviation Variance	5.87 1.584 2.508

The answers to these questions were also divided into sporting code. Rugby athletes rated the importance of sports nutrition highly with 78.6% of the athletes stating that it was very important, and the remaining 21.4% stating it was slightly important. None of the rugby athletes rated the importance of sports nutrition as not very/slightly important or not important. 96.4% of the rugby athletes believed that sports nutrition could improve performance. Rugby athletes also rated their sports nutrition the lowest of all the sports with a rating of 5.64 out of a possible 10. Interestingly when the sports nutrition knowledge was tested through questions, the rugby players had the third highest level of knowledge based on correct answers. These results are shown in tables 4 and 5.

Table 4: Sport specific attitudes to sports nutrition

Question	**Sports**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Importance of sports nutrition					
Very important Slightly important Not Very/slightly important Not important	83.3% 11.1% 2.8% -	78.6% 14.3% 7.1% -	68.4% 21.1% - 10.5%	78.6% 21.4% - -	100% - - -
Belief in sports nutrition to improve performance					
Yes definitely Maybe	82.9% 17.1%	85.7% 14.3%	94.7% 5.3%	96.4% 3.6%	100% -
Rating of knowledge					
Average rating Standard deviation Variance	5.76 1.555 2.417	6.50 1.387 1.923	5.76 1.719 2.955	5.64 1.632 2.664	7.0 1.000 1.000

Table 5: Percentage of correct responses to questions on sports nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	38.73% Std dev 0.50	37.1% Std dev 0.54	42.26% Std dev 0.50	43.86% Std dev 0.50	47.33%* Std dev 0.51

* UWH sample size much smaller

Again, there was no significant difference in the sports nutrition knowledge by gender.

There were a number of worrying results seen on the overall research, especially on the role of protein in the body. Overall the athletes were not clear on the role of protein and often had misguided knowledge in this area. When asked about the roles of a number of the food components, the subjects showed differing levels of knowledge. When asked which food component contained the most energy, 88% of the subjects incorrectly stated that carbohydrates, protein or alcohol had the most energy of the food component options given (alcohol, protein, carbohydrates and fat). Only 4 % were correct in agreeing that fat has the highest amount of energy with the remainder unsure. Table 6 shows that overall 68.2% of the athletes thought that eating a very high protein diet would increase muscle mass. Only 17.5% knew that eating more overall would help, and 63.9% also knew that weight training played a role in increasing muscle mass. These results are consistent with other research which shows that adolescents often have incorrect knowledge on the role of protein, especially in the area of muscle gain (Rosenbloom et al, 2002, Harrison et al, 1991, Jacobsen et al, 2001).

Table 6: The role of protein in increasing muscle mass

Question	Percentage who agreed to the statement	Actual answer
Eating a very high protein diet	68.2%	**False**
Eating more overall	17.5%	**True**
Having protein shakes after every workout	40.2%	**False**
Weight training	63.9%	**True**
Eating egg whites after every meal	21.6%	**False**

Sports drinks were another area that showed a lack of knowledge in these subjects. 85.7% of the athletes reported that they use a sports drink. 14.3% did not use sports drinks. The sports drinks that these 85.7% of the subjects used are shown below in table 7. 26.8% of the athletes reported using more than one sports drink.

Table 7: Percentage of athletes who report using specific named sports drinks

Sports Drink	Percentage of athletes who report using the named sports drink
PowerAde	82.9%
Horley's Replace	23.2%
Endura	1.2%
Gatorade	8.5%

Although sports drinks can provide an advantage when used correctly, many of the athletes did not know why they used a sports drink and most could not back up usage with correct reasoning. This is also consistent with previous research (O'Dea, 2003, Pratt & Walberg, 1998, Chapman & Toma, 1997, Rosenbloom et al, 2002). Subjects were asked to identify the functions of a sports drink. Over 50% of the subjects knew that using a sports drink makes the body retain fluid and that it replaces carbohydrates. Only 37.1% knew that a function of a sports drink was to replace sodium, yet 50.5% agreed that a sports drink replaces sweat. When asked in another question 68% of the subjects stated that sports drinks contain carbohydrates, 63.3% stated that they contain salt (compared to 37.1% saying it replaces sodium), and 22.4% thought that they contained fat (in question C.23. 8.2% of the subjects thought that a function of a sports drink was to burn body fat). 24.5% were unsure whether sports drinks contained salt, whereas 16.5% were unsure if sports drinks contained carbohydrates. Just over half of the subjects knew that sports drinks did not contain fat (56.1%). Full results of this question can be seen in table 8.

Table 8: Results of questions on the functions of a sports drink

Answer	Percentage of athletes who agreed to the statement	Correct response
It makes the body retain fluid	52.6%	TRUE
It helps to burn body fat	8.2%	FALSE
It replaces sweat	50.5%	TRUE
It tastes good compared to water	40.2%	TRUE
It replaces sodium	37.1%	TRUE
It replaces carbohydrates	58.8%	TRUE
It replaces protein	12.4%	FALSE
It is a source of water	35.1%	TRUE

The reasons that subjects gave for the use of the named sports drinks are shown in table 9:

Table 9: Reasons that subjects use the named sports drinks

Sports drink	A sample of athletes reasons for Sports Drink usage
PowerAde®	"because it has a good reputation in sports drinks and tastes good" "told good by coach" "coach said to drink hour beforehand" "cos nice" "because its nice" "told to" "retain the losses of water in your body" "good source of electrolytes for faster rehydration" "taste/recommended" "nice, think your doing something good" "don't know" "thirst quenching and tastes nice" "because they tell us too" "fast rehydration and recovery"
Horley's Replace®	"because I know it helps and they tell us too" "stops cramps" "for vitamins and minerals, stops me cramping" "it tastes good" "to not get dehydrated, replace the electrolytes lost" "to 'replace' sodium etc that you lose"
Endura®	"replaces my electrolytes"
V*	"it helps me personally"

**V is not regarded to be a sports drink as it contains more than 8% carbohydrate but this answer is used in this table to demonstrate that young athletes may perceive it to be a sports drink.*

Athletes were also questioned on the recommendations for pre, during and after exercise in respect to fluid and food intake. The rugby athletes had a reasonably sound knowledge of recovery food timing (when) but had low scores on the rest of these questions. None of the rugby athletes knew the pre event food recommendations. Many of the other sports also had low scores for majority of these questions. Overall results and results for each sport can be seen in table 10.

Table 10: The results of athlete's knowledge of the recommended guidelines for food and fluid before, during and after exercise.

Question	Sports					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**TOTAL**
Pre event food (Question C.13.)	8.82%	0%	15.79%	0%	33.33%	5.10%
During event fluid (Question C.15.)	17.65%	21.34%	26.32%	17.86%	0%	20.14%
During event food (Question C.16.)	14.75%	7.14%	10.53%	17.86%	33.33%	14.29%
Recovery food (amount) (Question C.19.)	17.65%	14.29%	42.10%	14.29%	0%	17.5%
Recovery food (when) (Question C.20.)	91.18%	64.29%	42.10%	71.43%	100%	77.1%

PREVIOUS SOURCES OF INFORMATION & METHODS FOR THE FUTURE

The athletes were also questioned on how they had received previous nutrition education, and what they would like to have in the future. The overall result s of these two questions are shown in table 11.

Table 11: Overall Results of what methods of nutritional advice athletes have received in the past and what methods of nutritional advice they would like to receive in the future.

Session Type	**Percentage of athletes who have had this method of nutritional advice**	**Percentage of athletes who have would like to receive this method of nutritional advice**
Individual session with a sports nutritionist/dietitian	35.4%	73.68%

Supermarket Tour	16.2%	26.23%
Group cooking session	39.4%	31.58%
Group workshop	47.5%	47.37%
Menu plans developed	35.4%	N/A
Hydration workshops	17.2%	15.79%
Athlete as a guest speaker	40.4%	52.63%
Nutrition Quiz session	17.2%	15.91%
Lectures	N/A	15.79%
Written resources	N/A	42.11%
Recipe lists	N/A	31.58%
Interactive website	N/A	21.05%

The results were broken down in specific sports to show what methods the athletes had received in the past. A large percentage (57.2%) of the rugby players had taken part in a supermarket tour, and only 10.7% had taken part in an individual session with a sports nutritionist/dietitian in the past, although 50% had received menu plans that had been developed for them so it is unclear who provided the menu plans or if they had incorrectly answered the section on sports nutritionist/dietitian help. The results by sport are shown in table 12:

Table 12: Results of what methods of nutritional advice/education athletes have received in the past by sport.

Session Type	**Percentage of athletes by sport, who have received this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	17.14%	30.77%	26.32%	10.7%	0%
Supermarket Tour	25.71%	30.77%	10.53%	57.1%	33.3%
Group cooking session	22.86%	7.69	5.26%	17.9%	0%
Group workshop	77.14%	15.38	36.84%	32.1%	0%

Menu plans developed	45.71%	69.23	57.89%	50%	33.3%
Hydration workshops	25.71%	46.15	15.79%	21.4%	100%
Athlete as a guest speaker	8.57%	30.77	21.05%	21.4%	33.3%
Nutrition Quiz session	51.43%	69.23	26.23%	25%	33.3%

The athletes were also asked to comment on what nutrition education they would like in the future. These results can be seen in table 13.

Table 13: Results of what methods of nutritional advice athletes would like to receive in the future by sport.

Session Type	**Percentage of athletes by sport, who have would like to receive this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	0%	0%	73.68%	78.6%	0%
Supermarket Tour	59.24%	46.15%	26.23%	57.1%	0%
Group cooking session	41.18%	76.92%	31.58%	78.6%	100%
Group workshop	5.88%	0%	47.37%	14.3%	0%
Hydration workshops	8.82%	16.67%	15.79%	10.7%	33.3%
Athlete as a guest speaker	8.82%	15.38%	52.63%	14.3%	33.3%
Nutrition Quiz session	23.53%	30.77%	15.91%	28.6%	0%
Lectures	26.47%	23.08%	15.79%	25%	0%
Written resources	14.71%	53.85%	42.11%	17.9%	0%
Recipe lists	23.53%	84.62%	31.58%	25%	0%
Interactive website	52.94%	46.15%	21.05%	35.7%	66.7%

When questioned on whether they use information which is provided to them overall 43% said that yes they did use nutrition information. 46.2% stated that they sometimes used information, whilst 10.8% said they did not use information. 7 responses were missing for this question. This is an important component to be addressed in working with adolescents and for further research to assess the factors which inhibit athletes from using information which they receive. If they do not use information which has been provided there are clearly barriers to the intended behaviour occurring.

The athletes were also asked to identify who else should be involved in their nutrition education. The results of this question can be seen in table 14. The results of this question clearly show that adolescents believe that both parents and coaches should be involved with their nutrition education.

Table 14: Results of question C.27. - Who else should be involved in your nutrition education?

	Parents	**Coaches**	**Other***
Overall percentage of athletes who thought others should be involved in their nutrition education	81.6%	64.3%	18%
Basketball athletes only	47.1%	94.1%	76.5%
Football athletes only	53.8%	92.3%	61.5%
Netball athletes only	84.2%	89.5%	21.1%
Rugby athletes only	25%	60.7%	39.3%
Underwater Hockey athletes only	33.3%	66.7%	66.7%

**Other responses were teammates and team members, members of the athletes flat, nutritionist, friends, in the same sport, teachers, the trainer, and partners.*

The focus group

A focus group was conducted with nine rugby athletes from the Manawatu Rugby Academy programme. The focus group ran for 1 hour and was designed to ascertain the athlete's thoughts on nutrition resources. The sheet which was used during the focus group can be seen in appendix C.

Use of a Website

There was a very strong general agreement that a website was not something that this group of athletes was interested in. They did not think that they had the time to use a website and were vary of how accurate the information would be on the site. They also stated that they did not spend a lot of time using computers and the internet.

If they were to use a website then they would be attracted to this most by words and headlines, (so long as they are precise), and if they had pictures of famous players. Colour and pictures of food and drink rated lower in preference. One player stated that if they were player endorsed or recommended by a known nutritionist they would use it – other players agreed to this statement.

If they were to have a website to use they would mostly use information on sports specific nutrition strategies, recipe lists, information on supplements, and information from higher level athletes (for example, they would like to see a menu plan of a top players). Information on cooking tips and sports drinks was also desirable. Only one athlete commented that the website should "have different sections so you can choose what information relates to you (maybe tabs)".

They expressed concern in that they knew there was a large amount of unsuitable and incorrect nutrition knowledge, and were wary of using information off the internet.

Cookbook Resources

Most were familiar with the Edmonds Cookbook, but majority of the athletes had no association with any other cook book. When shown a NZ published cook book "Fit Food for Winners", they athletes stated that it "looked too flash" and said that they wouldn't be interested in using it as it looked like the recipe on the front needed lots of different ingredients, and would be hard and time consuming to make. The athletes were in agreement that instead of cookbooks with lists of recipes they would rather have suggestions of foods and how they could make simple meals that could be varied easily. They were also very concerned about food ideas and how they related to their budget – they suggested that they be given a number of food ideas e.g. what to do with pasta, and have corresponding shopping lists to go with them. They also would like information on how a meal compares in monetary values to fast food – for example a breakdown of how much it would cost to make a pasta meal compared to buying different fast foods. They noted that this would actually impact on their choice of having meals at home as compared to buying takeaways. The athletes were asked what meals they would like recipes for if they were to receive recipes as part of their nutrition education and they responded that lunch, dinner, and homemade takeaways were most important, but also stressed that they would like ideas for healthy baking and treat/dessert ideas. They were also really keen to have more ideas for snacks. Cultural issues were emphasized by some of the athletes who thought it was important that information was made available for all cultures.

Written resources

Fact sheets and posters were by far the most popular forms of written resources. Pamphlets were not liked at all by the athletes and there was a general consensus that books would not be used by the group – the reasoning for this is that they didn't want to sift through information, and they didn't know if the information was applicable to them. They did state that if they were to be given a specific rugby book that was endorsed by the NZRU, contained pictures and recommended by one of their nutritionists that they may read it. They were not keen on having to buy a book resource and would prefer if they were given one as part of their academy education.

Fact sheets that comparisons such as the fat content between different takeaways, for example "McDonalds compared to Burger King takeaways, and compared to what you could make at home". Fact sheets should also be endorsed by a known nutritionist and be rugby related to make the athletes more receptive to them. It was also suggested and agreed that fact sheets should be handed out in the team environment and covered with the whole team instead of the athletes being asked to read and remember the information as the athletes said that if they were expected to read the information in their own time they most probably would not take the time to read it. Resources that the athletes had found helpful was a small booklet that one had received when they had brought eggs which gave more ideas on how to use eggs, and one athlete mentioned that he looks at the weekly menu planner in a women's magazine for ideas (if the foods look simple enough).

When asked what written information should contain it was widely agreed that not too much information should be contained on the resource. Pictures were also highly liked. One athlete stated it was best to "keep it simple but interesting".

Group presentations/workshops

The athletes suggested that group presentations should be limited to 30 – 45 minutes as they thought that it was too hard to concentrate for periods longer than this. They also stressed that it was important to them that the presentation was "short and sharp to the point". They favoured a style where they were able to ask questions during the presentations, and where the presenter also asked them questions throughout the presentation. They were strongly against being lectured at, and thought that being given handouts from the presentation was very important in terms of recalling what they had learnt in the presentation. A good presenter was very important to the success of the presentation.

The athletes felt that the presenter needs to demonstrate knowledge and enthusiasm. Experience was also a quality that was important to the athletes. The athletes stated that the presenter should be in "shape", they stated that they would not take a presenter who was not "sporty and fit looking" seriously if they were giving nutrition education to them. It was important that the presenter looked like they practiced what they preached. The age of the presenter was also discussed by the athletes. They felt that age often leads to a perception that the presenter would know what they were talking about, but they also stated that sometimes those who were older may not be “in touch” with them, and they also perceived that they may speak in a more monotone way with less enthusiasm. They perceived younger presenters to potentially have more enthusiasm for the topic but thought that sometimes they may not have as much experience. The gender of the presenter was not something that mattered to the athletes.

The use of consistent guidelines for supermarket tours and cooking sessions

Having consistent guidelines and structure for performing supermarket tours and cooking sessions was discussed with the athletes. They felt that there should be general guidelines as to what an athlete should learn on through these activities, but they thought that they should not be strictly structured. One athlete summed up the groups opinion as “have guidelines but let the nutritionist put their own spin to it so that they are comfortable with what they are presenting”.

Advice for others

Although the athletes had left home, they felt that if would have been helpful if their parents had been able to access sports nutrition advice. Examples of where they thought this was absolutely necessary were information on sports drinks, for example when young athletes should use sports drinks and what was a sports drink, and they also felt that it was important that their parents knew about appropriate foods and fluids for before a rugby game, and as recovery foods. They stated that this needed to be culturally based and needed to be looked at in terms of how it fitted a budget. They also stated that their parents were “old school and had their own thoughts on what was best to eat as that’s what they had done back when they were playing, even if its not what we are told to do now”.

Athletes were undecided on whether specific sports nutrition resources should be produced for their coaches. They were confused as to whether it was the coaches responsibility to know about sound nutrition practices, or if that was the role of the manager. They did however mention that back when they were playing club or school level, where there was generally only a coach available that it would have been helpful for that coach to have sound nutrition knowledge to help them with ideas of foods to eat before, during and after a game, and to give advice on fluids.

Having a team nutritionist

The athletes felt that when they were receiving nutrition education that although it was not essential that every member of their team received information from the same nutritionist, it was more helpful if they did, as that way they were assured of all receiving consistent messages. They thought that if they were in the situation where they are receiving advice from two or more different nutritionists that these nutritionists had to be in close contact and have effective communication to ensure consistent messages.

Other points raised

The athletes felt that information on alcohol would be beneficial in their nutrition education. They stated that simply being told that they were not allowed to drink alcohol would not stop them, but if they had access to information on alcohol and tips on how drink more safely that they would use these. They would like to know how alcohol intake affects dehydration and recovery, and wanted information on what volumes of alcohol were safe to consume and how to make sensible choices to avoid hangovers. They also mentioned that information on takeaways would also be useful here as many of them found themselves having takeaways during, and after drinking alcohol.

The athletes also wanted more specific information on sports drinks, including when they should drink them, how to choose an appropriate one and what they did. Supplements were also discussed by the athletes and they would like more information on supplements, especially where they were trying to build muscle mass. They related this back to their coaches and discussed that their coaches often ask them to increase their weight through building muscle mass, or lose weight by decreasing body fat, but do not have the information to help them do this in a healthy, sustainable way. From this part of the discussion the athletes decided that coaches should have knowledge about changing an athlete's body composition, and should receive nutritional help in this area to make sure that they could provide advice around this if needed.

CONCLUSION & RECOMMENDATIONS

In conclusion it is recommended that resources and educational programmes are designed for adolescent athletes. These should take the following points into consideration:

- They must be developmentally appropriate
- They must have a performance based focus and be positive
- It is possible that they could be more successful if they involve a top sportsperson or sports team as a role model(s)

Recommendations are:

- Females may need information on iron status and in particular a weight based focus
- Resources that are specifically targeted at adolescents need to be developed and made available through as many avenues as possible to adolescent athletes and their parents

- A programme which has more than one nutrition session is likely to more successful in educating athletes about sports nutrition and changing behaviour
- Coaches (especially) and parents need to be educated in sports nutrition so that they can provide correct, and relevant advice to adolescent athletes. Trainers and other members of the support team need to be educated to provide sound advice or refer the athlete to a specialist
- Information needs to be shared within nutritionists
- There are not enough sports nutritionists to work with all teams and often team funds do not cover for a nutritionist. Trainers and coaches must improve their nutrition knowledge if this is this is to remain as it is
- More research needs to be conducted on the levels of knowledge in New Zealand adolescent athletes, and the ways of educating this group.

LIMITING FACTORS OF THE RESEARCH

There are a number of limiting factors which need to be considered in the ANKAA study. The athletes were posted the questionnaires and therefore the researcher did not have control of the situation in which they did the questionnaire. Subjects were asked to complete the questionnaires by themselves but it is not known if any of the respondents were given help by parents, caregivers or coaches. Respondents may have been more inclined to participate if they had more of an interest in nutrition as the questionnaire was distributed and noted to be voluntary to all participants. If the parents were more interested in nutrition this may have influenced who sent back completed questionnaires. Some athletes may have been encouraged more by their NSO than others and this may have influenced who responded to the questionnaires.

The focus groups were a part of this research which did not perform as well as expected. Two series of focus groups were organised and the participants were invited by letter to these. It has been suggested that “attendance is likely to be higher if the group consist of a pre existing social group utilizing an established meeting venue and time for a formal pre existing group can also improve attendance” (Bloor, 2001,pg 36) and that the job of recruiting attendees for the focus group can be done more effectively if the researcher can use an intermediary person for the job, who has contact with a pre existing group (Bloor, 2001). This method was successful with the focus group which was run with the Manawatu Rugby Academy. In future this would be a better method of recruitment for adolescent athletes for focus groups, instead of directly contacting the individual athletes and asking them to attend.

The study needs a larger sample size to give a clear indication of results. The current study had a small sample size so to confirm the results seen, more participants are needed. The study also only used subjects from five sports which were all team sports. To get a clearer indication of adolescent nutrition knowledge and methods of education it is important to widen the types of sports that athletes are selected from, and include individual sports.

ACKNOWLEDGEMENTS

The author gratefully acknowledges:

- the athletes who so willingly participated in this study
- the National Sporting Organisations; Basketball New Zealand, Netball New Zealand, New Zealand Rugby Union, New Zealand Football and New Zealand Underwater Hockey for their support
- SPARC (Sport and Recreation New Zealand) who awarded this project a Research Grant
- Dr Jane Coad, student supervisor
- Dr Janet Weber
- Mrs. Chris Booth, who worked as the independent third party researcher on this project

For further information the author can be contacted via email: sarah@sportsnutritionist.co.nz

REFERENCES

Bloor , M. *Focus groups in social research – Introducing qualitative methods* (2001). Sage, London.

Chapman, P., Toma, R. B. (1997). Nutrition knowledge among adolescent high school female athletes. *Adolescence*, 32(126):1-8.

Croll, J. K., Neumark-Sztainer, D., Story, M., Wall, M., Perry, C., Harnack, L. (2006). Adolescents involved in weight-related and power-team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. *The Journal of the American Dietetic Association,* 106:709- 717.

Harrison, J., Hopkins, W. G., MacFarlane, D. J., Worsley, A. (1991). Nutrition knowledge and dietary habits of elite and non-elite athletes. *Australian Journal of Nutrition and Dietetics,* 48:124-127.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., Beck, N. C. (2004). Nutrient intakes and dietary behaviours of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:389-404.

Jacobson, B.H., Sobonya, C., Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research,* 15:63-68.

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Health education Research,* 18:98-107.

Position of the American Dietetic Association: child and adolescent food and nutrition programs. (1996) *The Journal of the American Dietetic Association,* 96:913-917.

Pratt, C.A., Walberg, J.L. (1988). Nutrition knowledge concerns of health and physical education teachers. *Journal of the American Dietetic Association,* 88, 840-841.

Rosenbloom, C.A., Jonnalagardadda, S.S., Skinner, R. (2002). Nutrition Knowledge of collegiate athletes in a division 1 national athletic association institution. *Journal of the American Dietetic Association,* 102:418-420.

Story, M., Neumark-Sztainer, D., French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *The Journal of the American Dietetic Association*, 102:3, S40-S51.

.

Massey University

Assessment of nutrition knowledge and food skills in talented adolescent athletes

Sarah Burkhart - MSc Research Project

SUMMARY OF RESEARCH RESULTS – *UNDERWATER HOCKEY*

There is very limited research on the nutrition knowledge and food skills of elite athletes in New Zealand. Adolescent athletes are moving through an important physiological stage of life, as well as training and competing in their chosen sports. These athletes are the future New Zealand sporting representatives and therefore need adequate nutrition knowledge for performance, as well as health and wellbeing. This research investigated the basic and sports nutrition knowledge of 100 talented adolescent athletes from five team sports using questionnaires and a focus group. While the participants had a reasonable level of basic nutrition knowledge, their sports nutrition knowledge was not as high. They struggled with the concepts of sports drinks, muscle growth and supplements. Most participants had received some nutrition education and indicated that in the future they would prefer individual sessions with a sports nutritionist, written resources, as well as group sessions including cooking sessions and group workshops, and using a high profile athlete as a role model. The participants were very clear that their coaches and parents needed to be involved in their nutrition education. More research is needed to assess the overall knowledge of New Zealand adolescent athletes and the most appropriate, and effective methods of education for this group.

Introduction

When an adolescent is also an athlete there are many important factors to consider in terms of nutrition for both growth and sports performance. Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al, 2006). Coupled with the fact that when the athlete is an adolescent they have further energy and nutrient needs due to the large period of growth that the adolescent period entails, including the adolescent growth spurt (ADA, 1996, Story et al, 2002, Hinton et al, 2004, Croll et al, 2006), this creates a significant nutritional challenge.

The specific aims of this research were:

- to assess the basic nutrition knowledge of talented young adolescent athletes,
- to define what influences this subject group in their knowledge and practice of choosing foods,
- to assess the sports nutrition knowledge and sports nutrition behaviour of this subject group,
- to develop a curriculum and resources that can be used with talented adolescent athletes.

This project is designed to assess the knowledge of talented New Zealand adolescent athletes and look at identifying how adolescents would prefer to be given sports nutrition advice. Currently there is also a lack of resources designed to work specifically with this group and it is anticipated that this research project will not only identify the level of nutritional knowledge of this group but also develop an educational curriculum and accompanying resources which should be produced for this group.

METHODOLOGY

Subjects

Letters were sent to ten national sporting organisations (NSO's) describing the study and asking if they would give permission for their athletes who met the entry criteria to take part in the study. The ten sports were chosen as they encompassed a range of both team and individual sports, and sports which are generally gender specific. Sporting organizations were asked to provide contact details of athletes who met the entry criteria for the project. The entry criteria was that athletes needed to be between the ages of 13 and 20 years old as at the 1st of January 2007, and be considered a talented or elite athlete in their chosen sport by being a carded athlete, or part of a High Performance Academy Group, Regional Talent Identification Group or an equivalent Development group. Sporting organisations who agreed to participate in the study were asked to forward contact details of athletes who met the criteria to an independent third party research assistant. This preserved confidentiality of contact details.

Five sporting organizations agreed to take part in this research; Basketball New Zealand, Netball New Zealand, New Zealand Football, New Zealand Rugby Union, and New Zealand Underwater Hockey. A total of 100 athletes took part in the research.

The study was given ethical approval by the Massey University Committee of Ethics (ref 07/52).

The Questionnaire

The questionnaire was developed to address four different aims. Section A aimed to assess the basic nutritional knowledge of the subjects. Section B aimed to investigate influences on food choice and food availability in the subjects. Section C was designed to assess the basic sports nutrition knowledge and practices of the subjects and section D gathered basic demographic information about the subjects.

The questionnaire was developed using previous research questions and newly developed questions. A pilot trial of the questionnaire was conducted with athletes of the same age and who participated in the same ten sports as the targeted population and changes were made to questions which were unclear before sending to the actual subject group. Changes included rewording four questions so that they were appropriate for the age group in this study. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge, and those who did not have any knowledge the questionnaire used 'yes', 'no' and 'unsure' answers.

Procedure

The independent research assistant used the contact details from NSO's to create two sets of address labels for each contact. The first set was used to send the initial questionnaire pack which included a participant information sheet, a participant consent form, a parental information sheet, a parental consent form, a questionnaire and a return envelope.

The questionnaires were coded to identify which participants had returned their questionnaire. The independent research assistant followed up the athletes who had not returned the questionnaire phone call. When the unnamed questionnaires were received by the independent research assistant they were removed from the envelopes and passed on to the student researcher to ensure confidentiality of the subjects.

The second set of address labels were used in the organisation of focus groups. One invitation to participate in the focus groups arranged in Christchurch, Wellington, Palmerston North and Auckland in December 2008 was sent out to all participants and did not receive any responses to attend. This may have been due to being in close proximity to Christmas so another round of focus groups was planned for February 2009. Although there were very few respondents there were not enough to warrant a focus group at this time either. Instead the Manawatu Rugby Academy volunteered to run a focus group with their academy players (some of who had previously completed the questionnaire for this research). There were nine players, and their sports nutritionist present.

A number of questions were developed for use in the focus group by the researcher to prompt the athletes with the aim of initiating discussion. Several props were used including cookbooks and pamphlets/booklets.

Data analysis

Analysis of the questionnaires was carried out to provide results. The data was analysed with SPSS v14.0.

OVERALL FINDINGS

100 athletes from five sports returned questionnaires for this research project. The distribution of sports and level of competition can be seen in Table 1:

Table 1: The distribution of sports and level of competition

Level	Basketball	Football	Netball	Rugby	UWH	TOTAL
Regional	1	0	11	19	0	31
National	16	2	7	5	1	31
International	15	12	1	4	2	34

The mean age of all of the athletes was 16.64 years (std dev 1.937). 55.8% of the athletes compete in more than one sport, with athletes from Netball (68.4%) and Basketball (61.76%) more likely to partake in more than one sport. Rugby (39.2%) and UWH (33.3%) were the least likely to take part in more one sport. However, the UWH group is not large enough to get a clear result.

BASIC NUTRITION KNOWLEDGE RESULTS

The athletes were asked to complete a series of questions designed to address basic nutrition knowledge. The scores were tallied and compared for each sport. UWH athletes had the highest number of correct responses but the very small sample size of this group means that this is disputable. Football was seen to have the next highest correct response rate, followed by netball and then rugby. These results are given in table 2:

Table 2: % of correct responses to questions on basic nutrition knowledge by specific sports.

Sport	Basketball	Football	Rugby	Netball	UWH
% answers correct	60.99 % Std dev 3.35	68.32 % Std dev 2.43	63.20 % Std dev 4.43	66.36% Std dev 2.96	78.26 %* Std dev 2.00

There was no significant difference between gender and basic nutrition knowledge.

SPORTS NUTRITION KNOWLEDGE RESULTS

The athletes were also questioned on sports nutrition knowledge using a series of questions. Athletes ranked the importance of sports nutrition highly and had a positive belief in sports nutrition improving performance. The full results of these questions are shown in table 3.

Table 3: Overall results of attitudes to sports nutrition

Attitudes towards Sports Nutrition	Percentage of athletes
Importance of Sports Nutrition question: "How important do you consider sports nutrition to be in your sporting plans?"	
Very important	79%
Slightly important	16%
Very/slightly important	2%
Not important	2%
Belief in Sports Nutrition to improve performance question: "Do you believe that specific sports nutrition strategies could improve your performance?"	
Yes definitely	88%
Maybe	12%
No	-
Average rating of sports nutrition knowledge Question: "How would you rate your sports nutrition knowledge on a scale of 1 (non-existent) to 10 (excellent)?"	

Rating Standard deviation Variance	5.87 1.584 2.508

The answers to these questions were also divided into sporting code. All UWH athletes rated sports nutrition as very important (100%). 100% of them also believed that sports nutrition can improve performance. It is important to remember that this was a very small sample and therefore the results cannot be deemed representative.

UWH athletes also rated their sports nutrition the highest of all the sports with a rating of 7.0 out of a possible 10. The small sample of UWH athletes also had the highest score of correct sports nutrition knowledge questions. These results are shown in tables 4 and 5.

Table 4: Sport specific attitudes to sports nutrition

Question	Sports				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Importance of sports nutrition					
Very important	83.3%	78.6%	68.4%	78.6%	100%
Slightly important	11.1%	14.3%	21.1%	21.4%	-
Not Very/slightly important	2.8%	7.1%	-	-	-
Not important	-	-	10.5%	-	-
Belief in sports nutrition to improve performance					
Yes definitely	82.9%	85.7%	94.7%	96.4%	100%
Maybe	17.1%	14.3%	5.3%	3.6%	-
Rating of knowledge					
Average rating	5.76	6.50	5.76	5.64	7.0
Standard deviation	1.555	1.387	1.719	1.632	1.000
Variance	2.417	1.923	2.955	2.664	1.000

Table 5: Percentage of correct responses to questions on sports nutrition knowledge by specific sports.

Sport	Basketball	Football	Netball	Rugby	UWH
% answers correct	38.73% Std dev 0.50	37.1% Std dev 0.54	43.86% Std dev 0.50	42.26% Std dev 0.50	47.33%* Std dev 0.51

Again, there was no significant difference in the sports nutrition knowledge by gender.

There were a number of worrying results seen on the overall research, especially on the role of protein in the body. Overall the athletes were not clear on the role of protein and often had misguided knowledge in this area. When asked about the roles of a number of the food components, the subjects showed differing levels of knowledge. When asked which food component contained the most energy, 88% of the subjects incorrectly stated that carbohydrates, protein or alcohol had the most energy of the food component options given (alcohol, protein, carbohydrates and fat). Only 4 % were correct in agreeing that fat has the highest amount of energy with the remainder unsure. Table 6 shows that overall 68.2% of the athletes thought that eating a very high protein diet would increase muscle mass. Only 17.5% knew that eating more overall would help, and 63.9% also knew that weight training played a role in increasing muscle mass. These results are consistent with other research which shows that adolescents often have incorrect knowledge on the role of protein, especially in the area of muscle gain (Rosenbloom et al, 2002, Harrison et al, 1991, Jacobsen et al, 2001).

Table 6: The role of protein in increasing muscle mass

Question	Percentage who agreed to the statement	Actual answer
Eating a very high protein diet	68.2%	**False**
Eating more overall	17.5%	**True**
Having protein shakes after every workout	40.2%	**False**
Weight training	63.9%	**True**
Eating egg whites after every meal	21.6%	**False**

Sports drinks were another area that showed a lack of knowledge in these subjects. 85.7% of the athletes reported that they use a sports drink. 14.3% did not use sports drinks. The sports drinks that these 85.7% of the subjects used are shown below in table 7. 26.8% of the athletes reported using more than one sports drink.

Table 7: Percentage of athletes who report using specific named sports drinks

Sports Drink	Percentage of athletes who report using the named sports drink
PowerAde	82.9%
Horley's Replace	23.2%
Endura	1.2%
Gatorade	8.5%

Although sports drinks can provide an advantage when used correctly, many of the athletes did not know why they used a sports drink and most could not back up usage with correct reasoning. This is also consistent with previous research (O'Dea, 2003, Pratt & Walberg, 1998, Chapman & Toma, 1997, Rosenbloom et al, 2002). Subjects were asked to identify the functions of a sports drink. Over 50% of the subjects knew that using a sports drink makes the body retain fluid and that it replaces carbohydrates. Only 37.1% knew that a function of a sports drink was to replace sodium, yet 50.5% agreed that a sports drink replaces sweat. When asked in another question 68% of the subjects stated that sports drinks contain carbohydrates, 63.3% stated that they contain salt (compared to 37.1% saying it replaces sodium), and 22.4% thought that they contained fat (in question C.23. 8.2% of the subjects thought that a function of a sports drink was to burn body fat). 24.5% were unsure whether sports drinks contained salt, whereas 16.5% were unsure if sports drinks contained carbohydrates. Just over half of the subjects knew that sports drinks did not contain fat (56.1%). Full results of this question can be seen in table 8.

Table 8: Results of questions on the functions of a sports drink

Answer	Percentage of athletes who agreed to the statement	Correct response
It makes the body retain fluid	52.6%	TRUE
It helps to burn body fat	8.2%	FALSE
It replaces sweat	50.5%	TRUE
It tastes good compared to water	40.2%	TRUE
It replaces sodium	37.1%	TRUE
It replaces carbohydrates	58.8%	TRUE
It replaces protein	12.4%	FALSE
It is a source of water	35.1%	TRUE

The reasons that subjects gave for the use of the named sports drinks are shown in table 9:

Table 9: Reasons that subjects use the named sports drinks

Sports drink	A sample of athletes reasons for Sports Drink usage
PowerAde®	"because it has a good reputation in sports drinks and tastes good" "told good by coach" "coach said to drink hour beforehand" "cos nice" "because its nice" "told to" "retain the losses of water in your body" "good source of electrolytes for faster rehydration" "taste/recommended" "nice, think your doing something good" "don't know" "thirst quenching and tastes nice" "because they tell us too" "fast rehydration and recovery"
Horley's Replace®	"because I know it helps and they tell us too" "stops cramps" "for vitamins and minerals, stops me cramping" "it tastes good" "to not get dehydrated, replace the electrolytes lost" "to 'replace' sodium etc that you lose"
Endura®	"replaces my electrolytes"
V*	"it helps me personally"

**V is not regarded to be a sports drink as it contains more than 8% carbohydrate but this answer is used in this table to demonstrate that young athletes may perceive it to be a sports drink.*

Athletes were also questioned on the recommendations for pre, during and after exercise in respect to fluid and food intake. The UWH athletes had a good understanding of recovery food timing (when) but had low scores on the rest of these questions. None of the UWH athletes knew the pre event food or recovery food (amount) recommendations. Many of the other sports also had low scores for majority of these questions. Overall results and results for each sport can be seen in table 10.

Table 10: The results of athlete's knowledge of the recommended guidelines for food and fluid before, during and after exercise.

Question	Sports					
	BBall	**Football**	**Netball**	**Rugby**	**UWH**	**TOTAL**
Pre event food (Question C.13.)	8.82%	0%	15.79%	0%	33.33%	5.10%
During event fluid (Question C.15.)	17.65%	21.34%	26.32%	17.86%	0%	20.14%
During event food (Question C.16.)	14.75%	7.14%	10.53%	17.86%	33.33%	14.29%
Recovery food (amount) (Question C.19.)	17.65%	14.29%	42.10%	14.29%	0%	17.5%
Recovery food (when) (Question C.20.)	91.18%	64.29%	42.10%	71.43%	100%	77.1%

PREVIOUS SOURCES OF INFORMATION & METHODS FOR THE FUTURE

The athletes were also questioned on how they had received previous nutrition education, and what they would like to have in the future. The overall result s of these two questions are shown in table 11.

Table 11: Overall Results of what methods of nutritional advice athletes have received in the past and what methods of nutritional advice they would like to receive in the future.

Session Type	**Percentage of athletes who have had this method of nutritional advice**	**Percentage of athletes who have would like to receive this method of nutritional advice**
Individual session with a sports nutritionist/dietitian	35.4%	73.68%

Supermarket Tour	16.2%	26.23%
Group cooking session	39.4%	31.58%
Group workshop	47.5%	47.37%
Menu plans developed	35.4%	N/A
Hydration workshops	17.2%	15.79%
Athlete as a guest speaker	40.4%	52.63%
Nutrition Quiz session	17.2%	15.91%
Lectures	N/A	15.79%
Written resources	N/A	42.11%
Recipe lists	N/A	31.58%
Interactive website	N/A	21.05%

The results were broken down in specific sports to show what methods the athletes had received in the past. All of the UWH athletes had taken part in a hydration workshop but none had taken part in an individual session with a sports nutritionist/dietitian in the past. In addition to this, none had participated in group cooking sessions or group workshops. The results by sport are shown in table 12:

Table 12: Results of what methods of nutritional advice/education athletes have received in the past by sport.

Session Type	**Percentage of athletes by sport, who have received this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	17.14%	30.77%	26.32%	10.7%	0%
Supermarket Tour	25.71%	30.77%	10.53%	57.1%	33.3%
Group cooking session	22.86%	7.69%	5.26%	17.9%	0%
Group workshop	77.14%	15.38%	36.84%	32.1%	0%
Menu plans developed	45.71%	69.23%	57.89%	50%	33.3%

Hydration workshops	25.71%	46.15%	15.79%	21.4%	100%
Athlete as a guest speaker	8.57%	30.77%	21.05%	21.4%	33.3%
Nutrition Quiz session	51.43%	69.23%	26.23%	25%	33.3%

The athletes were also asked to comment on what nutrition education they would like in the future. These results can be seen in table 13.

Table 13: Results of what methods of nutritional advice athletes would like to receive in the future by sport.

Session Type	**Percentage of athletes by sport, who have would like to receive this method of nutritional advice**				
	BBALL	**FOOTBALL**	**NETBALL**	**RUGBY**	**UWH**
Individual session with a sports nutritionist/dietitian	0%	0%	73.68%	78.6%	0%
Supermarket Tour	59.24%	46.15%	26.23%	57.1%	0%
Group cooking session	41.18%	76.92%	31.58%	78.6%	100%
Group workshop	5.88%	0%	47.37%	14.3%	0%
Hydration workshops	8.82%	16.67%	15.79%	10.7%	33.3%
Athlete as a guest speaker	8.82%	15.38%	52.63%	14.3%	33.3%
Nutrition Quiz session	23.53%	30.77%	15.91%	28.6%	0%
Lectures	26.47%	23.08%	15.79%	25%	0%
Written resources	14.71%	53.85%	42.11%	17.9%	0%
Recipe lists	23.53%	84.62%	31.58%	25%	0%
Interactive website	52.94%	46.15%	21.05%	35.7%	66.7%

When questioned on whether they use information which is provided to them overall 43% said that yes they did use nutrition information. 46.2% stated that they sometimes used information, whilst 10.8% said they did not use information. 7 responses were missing for this question. This is an important component to be addressed in working with adolescents and for further research to assess the factors which inhibit athletes from using information which they receive. If they do not use information which has been provided there are clearly barriers to the intended behaviour occurring.

The athletes were also asked to identify who else should be involved in their nutrition education. The results of this question can be seen in table 14. The results of this question clearly show that adolescents believe that both parents and coaches should be involved with their nutrition education.

Table 14: Results of question C.27. - Who else should be involved in your nutrition education?

	Parents	**Coaches**	**Other***
Overall percentage of athletes who thought others should be involved in their nutrition education	81.6%	64.3%	18%
Basketball athletes only	47.1%	94.1%	76.5%
Football athletes only	53.8%	92.3%	61.5%
Netball athletes only	84.2%	89.5%	21.1%
Rugby athletes only	25%	60.7%	39.3%
Underwater Hockey athletes only	33.3%	66.7%	66.7%

**Other responses were teammates and team members, members of the athletes flat, nutritionist, friends, in the same sport, teachers, the trainer, and partners.*

CONCLUSION & RECOMMENDATIONS

In conclusion it is recommended that resources and educational programmes are designed for adolescent athletes. These should take the following points into consideration:

- They must be developmentally appropriate
- They must have a performance based focus and be positive
- It is possible that they could be more successful if they involve a top sportsperson or sports team as a role model(s)

Recommendations are:

- Females may need information on iron status and in particular a weight based focus
- Resources that are specifically targeted at adolescents need to be developed and made available through as many avenues as possible to adolescent athletes and their parents

- A programme which has more than one nutrition session is likely to more successful in educating athletes about sports nutrition and changing behaviour
- Coaches (especially) and parents need to be educated in sports nutrition so that they can provide correct, and relevant advice to adolescent athletes. Trainers and other members of the support team need to be educated to provide sound advice or refer the athlete to a specialist
- Information needs to be shared within nutritionists
- There are not enough sports nutritionists to work with all teams and often team funds do not cover for a nutritionist. Trainers and coaches must improve their nutrition knowledge if this is this is to remain the same
- More research needs to be conducted on the levels of knowledge in New Zealand adolescent athletes, and the ways of educating this group.

LIMITING FACTORS OF THE RESEARCH

There are a number of limiting factors which need to be considered in the ANKAA study. The athletes were posted the questionnaires and therefore the researcher did not have control of the situation in which they did the questionnaire. Subjects were asked to complete the questionnaires by themselves but it is not known if any of the respondents were given help by parents, caregivers or coaches. Respondents may have been more inclined to participate if they had more of an interest in nutrition as the questionnaire was distributed and noted to be voluntary to all participants. If the parents were more interested in nutrition this may have influenced who sent back completed questionnaires. Some athletes may have been encouraged more by their NSO than others and this may have influenced who responded to the questionnaires.

The focus groups were a part of this research which did not perform as well as expected. Two series of focus groups were organised and the participants were invited by letter to these. It has been suggested that "attendance is likely to be higher if the group consist of a pre existing social group utilizing an established meeting venue and time for a formal pre existing group can also improve attendance" (Bloor, 2001,pg 36) and that the job of recruiting attendees for the focus group can be done more effectively if the researcher can use an intermediary person for the job, who has contact with a pre existing group (Bloor, 2001). This method was successful with the focus group which was run with the Manawatu Rugby Academy. In future this would be a better method of recruitment for adolescent athletes for focus groups, instead of directly contacting the individual athletes and asking them to attend.

The study needs a larger sample size to give a clear indication of results. The current study had a small sample size so to confirm the results seen, more participants are needed. The study also only used subjects from five sports which were all team sports. To get a clearer indication of adolescent nutrition knowledge and methods of education it is important to widen the types of sports that athletes are selected from, and include individual sports.

ACKNOWLEDGEMENTS

The author gratefully acknowledges:

- the athletes who so willingly participated in this study
- the National Sporting Organisations; Basketball New Zealand, Netball New Zealand, New Zealand Rugby Union, New Zealand Football and New Zealand Underwater Hockey for their support
- SPARC (Sport and Recreation New Zealand) who awarded this project a Research Grant
- Dr Jane Coad, student supervisor
- Dr Janet Weber
- Mrs. Chris Booth, who worked as the independent third party researcher on this project

For further information the author can be contacted via email: sarah@sportsnutritionist.co.nz

REFERENCES

Bloor , M. *Focus groups in social research – Introducing qualitative methods* (2001). Sage, London.

Chapman, P., Toma, R. B. (1997). Nutrition knowledge among adolescent high school female athletes. *Adolescence*, 32(126):1-8.

Croll, J. K., Neumark-Sztainer, D., Story, M., Wall, M., Perry, C., Harnack, L. (2006). Adolescents involved in weight-related and power-team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. *The Journal of the American Dietetic Association,* 106:709- 717.

Harrison, J., Hopkins, W. G., MacFarlane, D. J., Worsley, A. (1991). Nutrition knowledge and dietary habits of elite and non-elite athletes. *Australian Journal of Nutrition and Dietetics,* 48:124-127.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., Beck, N. C. (2004). Nutrient intakes and dietary behaviours of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:389-404.

Jacobson, B.H., Sobonya, C., Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research,* 15:63-68.

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Health education Research,* 18:98-107.

Position of the American Dietetic Association: child and adolescent food and nutrition programs. (1996) *The Journal of the American Dietetic Association,* 96:913-917.

Pratt, C.A., Walberg, J.L. (1988). Nutrition knowledge concerns of health and physical education teachers. *Journal of the American Dietetic Association,* 88, 840-841.

Rosenbloom, C.A., Jonnalagardadda, S.S., Skinner, R. (2002). Nutrition Knowledge of collegiate athletes in a division 1 national athletic association institution. *Journal of the American Dietetic Association,* 102:418-420.

Story, M., Neumark-Sztainer, D., French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *The Journal of the American Dietetic Association*, 102:3, S40-S51.

Index

References

Abusabha, R., Peacock, J., Achterberg, C. (1999). How to make nutrition education more meaningful through facilitated group discussions. *Journal of the American Dietetic Association*, 99:72-76.

Alves, C., Lima, R. V. (2009). Dietary supplement use by adolescents. *Journal of Paediatrics (Rio)* 285(4):287-29*4.*

Aerenhouts, D., Hebbelinck, M., Poortmans, J. R., Clarys, P. (2008). Nutritional habits of Flemish adolescent athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 18(5):509-523.

Anderson, A.A., Cox, D.N., McKellar, S., Reynolds, J., Lean, M.E.J. & Mela, D.J. (1998). Take five, a nutrition education intervention to increase fruit and vegetable intakes: impact on attitudes towards dietary change. *British Journal of Nutrition* 80:133-140.

Andreasen, A. R. (1995). *Marketing Social Change: Changing behaviour to promote health, social development, and the environment.* San Francisco, California: Jossey-Bass Publishers.

Armstrong, N., Welsman, J.R. (1994). Assessment and interpretation of aerobic fitness in children and adolescents. *Exercise and Sport Sciences Reviews,* 22:435-476.

Axelson, M. L., Federline, T. L., Birnberg, D. (1985). A meta-analysis of food and nutrition related research. *Journal of Nutrition Education,* 17:51-54.

Baer, J.T., Dean, D.J., Lambrinidies, T. (1994). How high school football coaches recommend their players to gain lean body mass. *Journal of Strength and Conditioning Research,* 8 (2):12-75.

Bandura, A. (1986). *Social foundations of thought and action: A Social Cognitive Theory.* Prentice-Hall, Englewood Cliffs, NJ.

Baranowski, T., Cullen, K. W., Baranowski, J. (1999). Psychosocial correlates of dietary intake: advancing dietary intervention. *Annual Review Nutrition,* 19:17-40.

Bar-Or, O. (2001). Nutritional considerations for the child athlete. *Canadian Journal of Applied Physiology,* 26:186.

Bar-Or, 0, Wilk, B. (1996). Water and electrolyte replenishment in the exercising child. *International Journal of Sports Nutrition,* 6:93-99.

Barr, S. (1994). Associations of social and demographic variables with calcium intakes in high school students. *The Journal of the American Dietetic Association,* 94:260-266, 269.

Bartholomew, L.K., Parcel, G.S., Kok, G. (1998). Intervention mapping: a process for developing behaviour theory- and evidence-based health education programmes. *Health Education and Behaviour*, 25:545-563.

Bedgood, B.L., Tuck, M.B. (1983). Nutrition knowledge of high school athletic coaches in Texas. *Journal of the American Dietetic Association,* 83:672-677.

Benardot, D. (1996). Working with young athletes: Views of a nutritionist on the sports medicine team. *International Journal of Sports Nutrition,* 6:110-120.

Benson, J., Gillien, D.M., Bourdet, K., Loosi, A.R. (1986). Nutrition habits and knowledge in competitive adolescent female athletes. The *Phyiscian and Sports Medicine,* 8:118-130.

Benton, D., Sargent, J. (1992). Breakfast blood glucose and memory. *Biological Psychology,* 33**:** 207–210

Berenson, G. S., Wattigney, W. A., Tracy, R. E., Newman, W. P. 3rd, Srinivasan, S. R., Webber, L. S., et al. (1992). Atherosclerosis of the aorta and coronary arteries and cardiovascular risk factors in persons aged 6 to 30 years and studied at necropsy (The Bogalusa Heart Study). *American Journal of Cardiology*, 70:851-8.

Bergman, E.A., Erikson, M.L., Boyungs, J.C. (1992). Caffeine knowledge, attitudes and consumption in adult women. *Journal of Nutrition Education,* 17:51-54.

Berning, J.R., Troup, J.P, Van Handel, P., Daniels, J., Daniels, N. (1991). The nutritional habits of young adolescent swimmers. *International journal of Sport Nutrition,* 1:240-248.

Bingham, S. A. (1987). The dietary assessment of individuals; methods, accuracy, new techniques and recommendations. *Nutrition Abstracts and Reviews,* 57:705-742.

Black, A. E., Prentice, A. M., Goldberg, G. R., et al. (1993). Measurements of total energy expenditure provide insights into the validity of dietary measurements of energy intake. *Journal of the American Dietetic Association,* 93:572-579.

Bloor , M. *Focus groups in social research – Introducing qualitative methods* (2001). Sage, London.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design.* Cambridge Mass: Harvard University Press.

Burke, L., Cox, G. R., Cummings, N. K., Desbrow, B. (2001). Guidelines for daily carbohydrate, do athletes achieve them? *Sports Medicine,* 31(4):267-299.

Burke, L., Deakin, V. *Clinical Sports Nutrition* 2nd Ed. (2000). McGraw-Hill Publishing: Sydney.

Burke, L. M. (2006). Fluid Guidelines for Sport: Interview with Professor Tim Noakes. *International Journal of Sport Nutrition and Exercise Metabolism*, 16:644-652.

Burns J, Dugan L. (1994). Working with professional athletes in the rink: The evolution of a nutrition program for an NHL team. *International Journal of Sports Nutrition*, 4:132-134.

Burns, R.D., Schiller, M.R., Merrick, M.A. (2004). Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutrition counseling. *Journal of the American Dietetic Association,* 104:246-249.

California Project Lean. Food on the Run Campaign (1998). *A summary report on adolescent behaviours, perceptions, values and attitudes on health, nutrition and physical activity. A qualitative exploration.* Sacramento, California: Food on the Run Campaign.

Cavadini, C., Decarli, B., Grin, J., Narring, J., Michaud, P.A. (2000). Food habits and sport activity during adolescence: differences between athletic and non-athletic teenagers in Switzerland. *European Journal of Clinical Nutrition,* 54:16.

Clarkson, P.M. (1991). Mineral: exercise, performance and supplementation in athletes. *Journal of Sport Science,* 9(suppl):91-116.

Chapman, P., Toma, R. B. Tuveson, R. V., Jacob, M. (1997). Nutrition knowledge among adolescent high school female athletes. *Adolescence*, 32(126):1-8.

Cho, M., Fryer, B. A. (1974). What foods do physical education majors and basic nutrition students recommend for athletes? *The Journal of the American Dietetic Association,* 65:541-544.

Coates, T. J., Peterson, A. C., Perry, C. *Promoting adolescent health. A dialog on research and practice.* (1982). New York: Academic Press.

Commonwealth of Australia, Department of Health and Ageing, National Health Research Council and New Zealand Ministry of Health. (2006). *Nutrient reference values for Australia and New Zealand including recommended dietary intakes.* NHMRC, Canberra.

Contento, I., Manning, A. D., Shannon, B. (1992). Research perspective on school-aged nutrition education. *Journal of Nutrition Education,* 24:247-260.

Corley, G., Demarest-Litchford, M., Bazzare, T.L (1990). Nutrition knowledge and dietary practices of college coaches. *Journal of the American Dietetic Association,* 90(5):705-709.

Coyle, F. (2004). Fluid and fuel intake during exercise. *Journal of Sports Sciences,* 22:39 – 55.

Croll, J. K., Neumark-Sztainer, D., Story, M., Wall, M., Perry, C., Harnack, L. (2006). Adolescents involved in weight-related and power-team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. *The Journal of the American Dietetic Association,* 106:709-717.

Cupisti, A., D'Alessandro, C., Castrogiovanni, S., Barale, A., Morelli, E. (2002). Nutrition knowledge and dietary composition in Italian adolescent female athletes and non-athletes. *International Journal of Sports Nutrition and Exercise Metabolism,* 12:207.

Delistraty, D. A., Reisman, E. J., Snipes, M. (1992). A physiological and nutritional profile of young female figure skaters. *Journal of Sports Medicine and Physical Fitness,* 32:149-155.

Douglas, P., Douglas, J.G. (1984). Nutrition knowledge and food practices of high school athletes. *Journal of the American Dietetic Association*, 84:1198-1202.

Dummer, G.L., Heusner, R.W., Roberts, P., Counsilman, J. (1987). Pathogenic weight control behaviors of young competitive swimmers. *The Physician and Sports Medicine,* 15:75-84.

Ellison, R.C., Capper, A.L., Goldberg, R.J., Witschi, J.C., Stare, F.J. (1989). The environmental component: changing school food service to promote cardiovascular health. *Health Education Quarterly,* 16:285-297.

Ells, L. J., Campbell, K., Lidstone, J., Kelly, S., Lang, R., Summerbell, C. (2005). Prevention of childhood obesity. *Clinical Endocrinology and Metabolism,* 19(3):441-454.

Eriksson, B.O. (1974). Physical training, oxygen supply, and muscle metabolism in 11-13 year old boys. *Acta Physiologica Scandinavia*, 384(1):1**.**

Eriksson, O., Salting, B. (1974). Muscle metabolism during exercise in boys aged 11 to 16 years compared to adults. *Acta Paediatrica Belgica,* 28:257.

Filaire, E., Rouveix, M., Pannafieux, C., Ferrand, C. (2007). Eating attitudes, perfectionism and body-esteem of elite male judoists and cyclists. *Journal of Sports Science and Medicine,* 6:50-57.

Fogelholm, M., Himberg, J. J., Alopaeus, K., et al (1992). Dietary and biochemical indices of nutritional status in male athletes and controls. *Journal of the American College of Nutrition,* 11:181.

French, S. A., Perry, C. L., Leon, G. R, Fulkerson, J. A. (1995). Dieting behaviours and weight change history in female adolescents. *Health Psychology,* 14:548-555.

Froiland, K., Kooszewski, W., Hingst, J., Kopecky, L. (2004). Nutrition supplement use among college athletes and their sources of information. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:104-120.

Garcia-Roves PM, Fernandez S, Rodriguez M, Perez- Landaluce J, Patterson AM. (2000). Eating pattern and nutritional status of international elite flatwater paddlers. *International Journal of Sport Nutrition and Exercise Metabolism,* 10:182-198.

Gibson, E. L., Wardle, J., Watts, C. J. (1998). Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. *Appetite,* 31:205-228.

Girard-Eberle, S. *Endurance sports nutrition.* 2nd Ed. (2007). Illinois:Human Kinetics.

Gersovitz, M., Madden, J.P., Smiciklas-Wright, H. (1987). Validity of the 24-hr dietary recall and seven-day food recall for group comparisons. *Journal of the American Dietetic Association,* 78:48-55.

Gracey, D., Stanley, N., Burke, V., Corti, B., Beilin, L. J. (1996). Nutritional knowledge, beliefs and behaviours in teenage school students. *Health Education Resource,* 11:187-204.

Graves, K.L., Farthing, M.C., Smith, S.A., Turchi. J.M. (1991). Nutriton training, attitudes, knowledge, recommendations, responsibility and resources utilisation of high school coaches and trainers. *Journal of the American Dietetic Association,* 91(3):321-324.

Guthrie, H.A. (1986). *Introductory nutrition (6th Ed.)* St Louis: Times Mirror/ Mosby College Publishing.

Hackman, R. M., Katra, J. E., Geertsen, S. M. (1991). The athletic trainer's role in modifying nutritional behaviours of adolescent athletes: putting theory into practice. *Journal of Athletic Training,* 27(3): 262–272.

Halverson, L. S. (1987). Relationships among nutrition knowledge, attitudes and behaviour of Appalachian Middle school children, PhD dissertation, The Ohio State University, Columbus, OH.

Harrison, J., Hopkins, W. G., MacFarlane, D. J., Worsley, A. (1991). Nutrition knowledge and dietary habits of elite and non-elite athletes. *Australian Journal of Nutrition and Dietetics,* 48:124-127.

Hawley, J.A., Burke, L.M., (1997). Effect of meal frequency and timing on physical performance. *British Journal of Nutrition.* 77(1)S91 – 103.

Haymes, E. (1991). Vitamin and mineral supplementation to athletes. *International Journal of Sports Medicine,* 1:146.

Hellemans, I., King, C. M., Rehrer, N. J., Stening, L. (2008). *Position paper of the New Zealand Dietetic Assoication (Inc.) 2008 nutriton for exercise and sport in New Zealand.*

Heredeen, F., Fellers, R.B. (1999). Nutrition knowledge of college football lineman: Implications for nutrition education [abstract]. *Journal of the American Dietetic Association,* 99(suppl):A-38.

Hern, M. J., Gates, D. (1998). Linking learning with health behaviours of high school adolescents. *Pediatric Nursing,* 24:127-132.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., Beck, N. C. (2004). Nutrient intakes and dietary behaviours of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14:389-404.

Hoelscher, D. M., Evans, A., Parcel, G. S., Kelder, S. H. (2002). Designing effective nutrition interventions for adolescents. *Journal of the American Dietetic Association,* 102:3, S52-S63.

Howe, M., Hellemans, I., Rehrer, N., Pearce, J. *Sports nutrition for New Zealand athletes and coaches*. 2002. Reed Publishing:Auckland.

Iuliano, S., Naughton, G., Collier, G., Carlson, J. (1998). Examination of the self-selected fluid intake practices by junior athletes during a simulated duathlon event. *International Journal of Sports Nutrition,* 8:10.

Jacobson, B.H., Aldana, S.G. (1992). Current nutrition practice and knowledge of varsity athletes. *Journal of Applied Sports Science Research* 6(4):232–238.

Jacobson, B.H., Sobonya, C., Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research,* 15:63-68.

Jeukendrup. A., Gleeson, M. *Sport Nutrition: An Introduction to Energy Production and Performance*. (2004). Human Kinetics Publishers, Inc: Leeds, U.K.

Juzwiak, C.R., Ancona-Lopez, F. (2004). Evaluation of nutrition knowledge and dietary recommendations by coaches of adolescent Brazilian athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 14(2):222-35.

Kanarek, R. (1997). Psychological effects of snacks and altered meal frequency. *British Journal of Nutrition,* 77(1)S105 – S120*.*

Kay, D., Marino, F. E. (2000). Fluid ingestion and exercise hyperthermia: Implications for performance, thermoregulation, metabolism and the development of fatigue. *Journal of Sports Sciences,* 18:71-82.

Kelder, S.H., Perry, C.L., Klepp, K.I., Lytle, L.L. (1994). Longitudinal tracking of adolescent smoking, physical activity and food choice behaviours. *American Journal of Public Health,* 84:1121-1126.

Kim, S. H., Keen, C. L. (1999). Patterns of vitamin/mineral supplement usage by adolescents attending athletic high schools in Korea. *International Journal of Sports Nutrition,* 9:391.

Knudsen, K. S., Nowak, R. K., Schulta, L.O. (1988). Body composition and nutritnet intakes of college men and women basketball players. *Journal of the American Dietetic Association,* 88:591-594.

Kreuter, M. W., Oswald, D. L., Bull, F. C., Clark, E. M. (1998). Are tailored health education materials always more effective than non-tailored materials? *Health Education Resources,* 15:305-315.

Kristall, A. R., Shattuck, A. L., Henry, H. J. (1990). Patterns of dietary behaviour associated with selecting diet low in fat: reliability and validity of a behavioural approach to dietary assessment. *The Journal of the American Dietetic Association,* 90:214-220.

Kristiansen, M., Levy-Milne, R., Barr, S. and Flint, A. (2005) Dietary supplement use by varsity athletes at a Canadian university. *International Journal of Sport Nutrition and Exercise Metabolism*, 15, 195-210.

Krowchuk, D.P., Anglin, T.M., Goodfellow, D.B., Stancin, T., Williams, P., Zimet, G.D. (1989). High school athletes and the use of ergogenic aids. *American Journal of Diseases in Children,* 143:486-489.

Krumbach, C.J., Ellis, D.R., Driskell, J.A. (1999). A report of vitamin and mineral supplement use among university athletes in a division I institution. *International Journal of Sports Nutrition,* 9:416-425.

Lin, B. H., Guthrie, J., Blaylock, J. (1996). The diets of America's children: Influences of dining out, household characteristics, and nutrition knowledge. *Washington DC: US Dept of Agriculture; Economic Report Number 746.*

Litt, A. *Fuel for young athletes.* (2004). New York: Human Kinetics.

Loosi, A.R., Benson, J., Gilien, D.M., Bourdet, K. (1986). Nutrition habits and knowledge in competitive adolescent female gymnastics. *The Physician and Sports Medicine,* 14:118-130.

Luepker, R. V., Perry, C. L., McKinlay, S. M., Nader, P. R., Parcel, G. S., Stone, E. J., Elder, J. P., Feldman, H. A., Johnson, C. C., Kelder, S. H., Wu, M. (1996). Outcomes of a field trial to improve children's dietary patterns and physical activity. *Journal of the American Medical Association,* 275:768-776.

Lytle, L. A. (2002). Nutrition concerns of the adolescent. *Journal of the American Dietetic Association,* 102:S8-S12.

Lytle, L. A. (1995). Nutrition education for school-aged children. *Journal of Nutrition Education,* 27:298-311.

Lytle, L. A., Achterberg, C., (1995). Changing the diet of America's children: What works and why? *Journal of Nutrition Education,* 27:250-260.

Lytle, L. A., Seifert, S., Greenstein, J., McGovern, P. (2000). How do children's eating patterns and food choice change over time? results form a cohort study. *American Journal of Health Promotion,* 14:222-228.

Massad, S.J., Shier, N.W., Koceja, D.M., Ellis, N.T. (1995). High school athletes and nutritional supplements: A study of knowledge and use. *International Journal of Sport Nutrition,* 5:232-245.

Maughan, R.J. (1998). The sports drink as a functional food: formulations for successful performance. *Proceedings of the Nutrition Society*, 57:15-23.

McDonnell, G.E., Roberts, D.C.K. & Lee, C. (1998). Stages of change and reduction of dietary fat: effect of knowledge and attitudes in an Australian university population. *Journal of Nutrition Education,* 30:37-44.

McDowall, J. A. (2007). Supplement use by young athletes. *Journal of Sports Science and Medicine*, 6:337-342

McDougall, P. (1998). Teenagers and nutrition: assessing levels of knowledge. *Health Visitor,* 71:62-64.

Mertz, W., Tsui, J.C., Judd, J. T., et al. (1991). What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. *American Journal of Clinical Nutrition,* 54:291-295.

Meyer, F., Bar-Or, O., MacDougall, D., Heigenhauser, G. J. F. (1992). Sweat electrolyte loss during exercise in the heat; effects of gender and maturation. *Medicine and Science in Sports and Exercise,* 24:776.

Ministry of Health. (1998). *Food and nutrition guidelines for healthy adolescents: a background paper.* MoH, Wellington, New Zealand.

Ministry of Health. (2003). *Food and nutrition guidelines for healthy adults: a background paper.* MoH, Wellington, New Zealand.

Ministry of Health. (2003). *NZ Food NZ Children: Key results of the 2002 national children's nutrition survey.* MoH, Wellington, New Zealand.

Moon, A.M., Mullee, M.A., Rogers, L., Thompson, R.L., Speller, V., Roderick, P. (1999). Helping schools to become health promoting environments – an evaluation of the Wessex Healthy Schools Award. *Health Promotion International,* 14:111-122.

Montfort-Steiger, C., Williams, C. A. (2007). Carbohydrate intake considerations for young athletes. *Journal of Sports Science and Medicine,* 6:343-352.

Mullinix, M. C., Jonnalagadda, S. S., Rosenbloom, C. A., Thompson, W. R., Kicklighter, J. A. (2003). Dietary intake of female U.S. soccer players. *Nutrition Research,* 23:585-593.

Nichols, P.E., Jonnalagadda, S.S., Rosenbloom, C.A., Trinkaus, M. (2005). Knowledge, attitudes and behaviours regarding hydration and fluid replacement of collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism,* 15:515-527.

Nicklas, T.A., Johnson, C.C., Myers, L., Farris, R.P., Cunningham, A. (1998). Outcomes of a high school programme to increase fruit and vegetable consumption: Gimme 5 – a fresh nutrition concept for students. *Journal of School Health,* 68:248-253.

Nicklas, T.A., Myers, L., Reger, C., Beech, B., Berenson, G.S. (1998). Impact of breakfast consumption on nutritional adequacy of the diets of young adults in Bogalusa, Louisiana: Ethnic and gender contrasts. *Journal of the American Dietetic Association*, 98:1432-1438.

Nieper, A. (2005) Nutritional supplement practices in UK junior national track and field athletes. *British Journal of Sports Medicine* 39:645-649.

Neumark-Sztainer, D., Story, M., Perry, C., Casey, M. (1999). Factors influencing food choices of adolescents: Findings from focus-group discussions with adolescents. *Journal of the American Dietetic Association,* 99:929-937.

Neumark-Sztainer, D., Story, M., Resnick, M., Blum, R. (1998). Lessons learned about adolescent nutrition from the Minnesota Adolescent Health Survey. *Journal of the American Dietetic Association,* 98:1449-1456.

Nowak, M., Crawford, D. (1998). Getting the message across: adolescents' health concerns and views about the importance of food. *Australian Journal of Nutrition and Dietetics,* 55:3-8.

O'Dea, J. A. (1999). Children and adolescents identify food concerns, forbidden foods, and food-related beliefs. *The Journal of the American Dietetic Association,* 99:970-973

O'Dea, J. A. (2003). Consumption of nutritional supplements among adolescents: usage and perceived benefits. *Health education Research,* 18:98-107.

O'Dea, J. A. (1995). Body image and nutritional status among adolescents and adults--a review of the literature. *Australian Journal of Nutrition and Dietetics*, 52:56-67.

Owen, A. L. et al (1999). *Nutrition in the community: The art and science of delivering services.* Boston: WBC/McGraw Hill.

Paiget, J. (1969). *The intellectual development of the adolescent.* In Caplan, G., Lebovici, S. (eds). *Adolescence: Psychological perspectives.* New York, NY: Basic Books 22-26.

Palumbo, C. M., Clark, N. (2000). Case problem: Nutrition concerns related to the performance of a baseball team. *Journal of the American Dietetic Association*; 100:704-707.

Parcel, G. S., Green, L. W., Bettes, B. A. (1988). School-based programs to prevent or reduce obesity. In: Krasneger, N. A., Grave, G. D., Kretchmer, N. eds. *Childhood Obesity: A Biobehavioural Perspective.* Caldwell, N. J :Telford Press, 143–157.

Parmenter, K., Wardle, J. (1999). Development of a general nutrition knowledge questionnaire for adults. *European Journal of Clinical Nutrition,* 52:298-308.

Parr, R.B., Porter, M.A., Hodgson, S.C. (1984). Nutrition knowledge and practice of coaches, trainees, and athletes. *The Physician and Sports Medicine,* 12:127-138.

Pearce, J. *Eat to compete for young athletes.* (2004) Reed: Auckland.

Perry, C. L. *Creating health behavior change: How to develop community-wide programs for youth*. (1999). Thousand Oaks, CA: Sage.

Perry, C.L, Klepp, K.I., Halper, A. (1987). Promoting healthy eating and physical activity patterns among adolescents: a pilot study of 'Slice of Life'. *Health Education Research,* 2:93-103.

Petrie, H.J., Stover, E.A., Horswill, C.A. (2004). Nutritional concerns for the child and adolescent competitor. *Nutrition*, 20:620-631.

Pirouznia, M. (2001). The association between nutrition knowledge and eating behaviour in male and female adolescents in the US. *International Journal of Food Sciences and Nutrition,* 52:127-132.

Position of the American Dietetic Association: child and adolescent food and nutrition programs. (1996) *The Journal of the American Dietetic Association,* 96:913-917.

Pollitt, E., Lewis, N.L., Garza, C., Shulman, R.J. (1982 – 83). Fasting and cognitive function. *Journal of Psychiatric Research.* 17:169–174.

Poolton, M. A. (1972). Predicting application of nutrition education. *Journal of Nutrition Education,* 4:113-118.

Potter, G.S., Wood, O.B. (1991). Comparison of self- and group-instruction for teaching sports nutrition to college athletes. *Journal of Nutrition Education,* 23:288-290.

Povey, R., Conner, M., Sparks, P., James, R., and Shepherd, R. (1998). Interpretations of healthy and unhealthy eating, and implications for dietary change. *Health Education Research,* 13:171-183.

Pratt, C.A., Walberg, J.L. (1988). Nutrition knowledge concerns of health and physical education teachers. *Journal of the American Dietetic Association,* 88:840-841.

Rankinen, T., Fogelholm, M., Kujala, U., Rauramaa, R., Uusitupa, M. (1995). Dietary intake and nutritional status of athletic and nonathletic children in early puberty. *International Journal of Sports Nutrition,* 5:136.

Read, M. H., Harveywebster, M., Using-Lesquereux, J. (1988). Adolescent compliance with dietary guidelines: health and education implications. *Adolescence,* 23:91.

Rennie, M.J., Tipton, K.D. (2000). Protein and amino acid metabolism during and after exercise and the effects of nutrition. *Annual Review Nutrition*, 20:457-83.

Resnicow, K., Hearn, M., Delano, R.K., Conklin, T., Orlandi, M.A. & Wynder, E.L. (1997). Development of a nutritional knowledge scale for elementary school students: toward a national surveillance system. *Journal of Nutrition Education*, 28:156–164.

Rico-Sanz J, Frontera WR, Mole PA, Rivera MA, Rivera-Brown A, Meredith CN. (1998). Dietary and performance assessment of elite soccer players during a period of intense training. *International Journal of Sport Nutrition*, 8:230-240.

Ritchie, L. D., Welk, G., Styne, D., Gerstein, D. E., Crawford, P. B. (2005). Family environment and pediatric overweight: what is a parent to do? *Journal of the American Dietetic Association,* 105:S70-S79.

Rockwell, M.S., Nickols-Richardson, S.M., Forrest, W.T. (2001). Nutrition knowledge, opinions and practices of coaches and athletic trainers at a division 1 university. *International Journal of Sport Nutrition and Exercise Metabolisms,* 11:174-185.

Rosenbloom, C.A., Jonnalagardadda, S.S., Skinner, R. (2002). Nutrition Knowledge of collegiate athletes in a division 1 national athletic association institution. *Journal of the American Dietetic Association,* 102:418-420.

Ross, S. (1995). "Do I really have to eat that?": a qualitative study of school children's food choices and preferences. *Health Education Journal,* 54:312-321.

Saegert, J., Young, E. A. (1983). Nutrition knowledge and health food consumption. *Nutrition Behaviour,* 1:103-113.

Sapp, S. G., Jensen, H. H. (1997). The reliability and validity of nutrition knowledge and diet-health awareness tests developed from the 1989-1991 diet and knowledge surveys. *Journal of Nutrition Education,* 29:63-72.

Sawka, M. N., Burke, L. M., Eichner, E. R., Maughan, R. J., Montain, S.J., and Stachenfield, N. S. (2007). American College of Sports Medicine Position Stand: Exercise and fluid replacement. *Medicine & Science in Sports & Exercise*, 39:377-390.

Scofield, D.E. and Unruh, S. (2006) Dietary supplement use among adolescent athletes in central Nebraska and their sources of information. *Journal of Strength and Conditioning Research,* 20(2):452-455.

Schilcker, S.A., Borra, S.T., Regan, C. (1994). The weight and fitness status of United States children. *Nutrition Reviews,* 52:11-16.

Schlundt, D.G., Hill, J.O., Sbrocco, T., Pope-Cordle, J., Sharp, T., (1992). The role of breakfast in the treatment of obesity : A randomized clinical trial. *The American Journal of Clinical Nutrition,* 55:645-51.

Schwartz, N. E. (1985). Nutritional knowledge, attitudes and practices of high school graduates. *The Journal of the American Dietetic Association,* 66:28-31.

Searles, R. H., Terry, R. D., Amos, R. J. (1986). Nutrition knowledge and body-image satisfaction of female adolescents. *Journal of Nutrition Education,* 18:123-127.

Silverstein, B., Perdue, L., Peterson, B., Kelly, E. (1986). The role of the mass media in promoting a thin standard of bodily attractiveness for women. *Sex Roles*, 14:519-32

Shepherd, R., (1988). Belief structure in relation to low-fat milk consumption. *Journal of Human Nutrition and Dietetics,* 1:421–428.

Shepherd, J., Harden, A., Rees, R., Brunton, G., Garcia, J., Oliver, S., Oakley, A. (2006). Young people and healthy eating: a systematic review. *Health Education Research,* 21(2):239-257.

Shepherd, R., Stockley. L. (1987). Nutrition knowledge, attitudes and fat consumption. *Journal of the American Dietetic Association,* 87:615-619.

Shepherd, R., Towler, G. (1992). Nutrition knowledge, attitudes and fat intake: application of the theory of reasoned action. *Journal of Human Nutrition and Dietetics,* 5:387-397.

Sigman-Grant, M. (2002). Strategies for counseling adolescents. *Journal of the American Dietetic Association,* 102:S32-S39.

Singh, A., Moses, F., Deuster, P. (1992). Chronic multivitamin mineral supplementation does not enhance physical performance. *Med Sci Sports Exerc,* 24:726.

Smith, A. P. (1998). Breakfast and mental health. *International Journal of Food Sciences and Nutrition, 49: 397-402.*

Sobal, J., Kettle Khan, L., Bisogni, C. (1998). A conceptual model of the food and nutrition system. *Social Science and Medicine,* 7:853-863.

Sobal, J., Marquart, L. F. (1994). Vitamin/mineral supplement use among athletes: a review of the literature. *International Journal of Sports Nutrition,* 4:320.

Spear, B. A. (2002). Adolescent growth and development. *The Journal of the American Dietetic Association,* 102:S23-S29.

Stafleu, A., Van Staveren, W.A., De Graff, C., Burema, J. (1996) Nutrition knowledge and attitudes towards high fat foods and low-fat alternatives in three generations of women. *European Journal of Clinical Nutrition,* 50:33-41.

Steenhuis, I.H.M., Brug, J., Van Assema, P. & Imbos, T.J. (1996). The validation of a test to measure knowledge about the fat content of food products. *Nutrition and Health,* 10:331-339.

Stockley, L. (1985). Changes in habitual food intake during weighed inventory surveys and duplicate diet collections: a short review. *Ecology of Food and Nutrition,* 17:263-269.

Story, M., Neumark-Sztainer, D., French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *The Journal of the American Dietetic Association*, 102:3, S40-S51.

Story, M., Resnick, M. D. (1986). Adolescent's views on food and nutrition. *Journal of Nutrition Education,* 18:188.

Stronck, D. R. (1981). Adolescents' attitudes toward their diets. *American Biology Teacher,* 43(7):397-399.

Swirzinski, L., Latin, R.W., Berg, K. (2000). A Survey of Sport Nutrition Supplements in High School Football Players. *The Journal of Strength and Conditioning Research* 14:464–469.

Tarnopolsky, M. A. Protein and amino acid needs for training and bulking up. In: Burke LM, Deakin V, *Clinical Sports nutrition* 3rd Ed. (2006). Sydney: McGraw-Hill companies Inc.

Tipton, K. D., Wolfe R. R. (2004). Protein and amino acids for athletes. *Journal of Sports Science*, 22 (1):65-79.

Thompson, F. E., Byers, T. (1994). Dietary assessment resource manual. *Journal of Nutrition,* 124(suppl):22445S-2317S.

Trahms, C. M., Pipes, P. L. *Nutrition in infancy and childhood*. 6th Ed. (1997). McGraw-Hill: New York.

Tortora, G. J., Grabowski, S. *Principles of anatomy and physiology.* 9th Ed. (2000). Wiley: New York.

Towler, G., Shepherd, R. (1990). Development of a nutritional knowledge questionnaire. *Journal of Human Nutrition and Dietetics,* 3:255-264.

Truswell, A. S., Darnton-Hill, I. (1981). Food habits of adolescents. *Nutrition Review,* 39:73-88.

Turconi, G., Celsa, M., Rezzani, C., Biino, G., Sartirana, M. A., Roggi, C. (2003). Reliability of a dietary questionnaire on food habits, eating behaviour and nutritional knowledge of adolescents. *European Journal of Clinical Nutrition,* 57:753-763.

Vartianen, E., Puska, P., Pallonen, U., Poyhia, P. (1982). Effect's of two years of education intervention on dietary habits, serum cholesterol and blood pressure among 13 to 15 year old adolescents: the North Kareilia Project. *Acta Cardiology,* 37:199-220.

Vartianen, E., Tossavainen, K., Viri, L., Niskanen, E, Puska, P. (1991). The North Kareilia Youth Programmes, In: Williams, C., Wynder, E., (eds). Hyperlipideamia in Childhood and the Development of Atherosclerosis. *Annuals of the New York Academy of Sciences,* 332-349.

Volpe S. Vitamins and minerals for active people. In: Rosenbloom C, ed. *Sports Nutrition: A Guide for the Professional Working with Active People*. Chicago, IL: American Dietetic Association; 2000:61-93.

Wagner, J. L., Winett, R. A., Walbert-Rankin, J. (1992). Influences of a supermarket intervention on the food choices of parents and their children. *Journal of Nutrition Education,* 24:306-311.

Wardle, J., Parmenter, K., Waller, J. (2000). Nutrition knowledge and food intake. *Appetite,* 34:269-275.

Warren, N., Bonner, J., Stitt, K.R. (1985). Nutrition practices and recommendations of selected high school coaches. *School Food Research Review,* 9:11-15.

Watt, R., Sheiham, A. (1997). Towards an understanding of young people's conceptualization of food and eating. *Health Education Journal,* 56:340-349.

Watt, R.G., Sheiham, A. (1996). Dietary patterns and changes in inner city adolescents. *Journal of Human Nutrition and Dietitics,* 9:451-461.

Weight, L. M., Noakes, T., Labadarios, D. et al (1988). Vitamin and mineral status of trained athletes including the effects of supplementation. *American Journal of Clinical Nutrition,* 47:186.

Werblow, J.A., Fox, H.M., Henneman, A. (1978). Nutrition knowledge, attitudes and patterns of women athletes. *Journal of the American Dietetic Association,* 73:242-245.

Williams, H. M., Woodward, D. R., Ball, P. J., Cumming, F. J., Hornsby, H., Boon, J. (1993). Food perspectives and food consumption among Tasmanian high school students. *Australian Journal of Nutrition and Dietetics,* 50:156-162.

Willenberg, B., Hemmelgarn, M. (1991). Nutrient needs of young athletes. *Elementary School Journal,* 91:445-456.

Worsley, A. (2002). Nutrition knowledge and food consumption: can nutrition knowledge change food behaviour? *Asia Pacific Journal of Clinical Nutrition*, 11(3):S579-S585.

Wright, H.S., Guthrie, H.A., Wang, M.Q., Bernado, V. (1991). The 1987-88 Nationwide Food Consumption Survey: an update on the nutrient intake of respondents. *Nutrition Today,* 26:21-27.

Zabik, M. E. (1987). Impact of ready-to-eat cereal consumption on nutrient intake. *Cereal Foods World,* 32:234-239.

Ziegler, P.J., Nelson, J.A. and Jonnalagadda, S.S. (2003) Use of dietary supplements by elite figure skaters. *International Journal of Sport Nutrition and Exercise Metabolism,* 13:266-276.

Zinn, C., Schofield, G., Wall, C. (2006). Evaluation of sports nutrition knowledge of New Zealand premier club rugby coaches. *International Journal of Sport Nutrition and Exercise Metabolism*, 16:214-225.