Nutrition Knowledge of New Zealand Premier Club Rugby Coaches

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF PUBLICATIONS AND PRESENTATIONS FROM THESIS

Publications

Zinn, C., Schofield, G.M. & Wall, C. (2004). *Development of a sports nutrition knowledge questionnaire* (Submitted to Journal of Science and Medicine in Sport).

Zinn, C., Schofield, G.M. & Wall, C. (2004). *Evaluation of sports nutrition knowledge of New Zealand premier club rugby coaches* (To be submitted to International Journal of Sports Nutrition and Exercise Metabolism, upon acceptance of above paper).

Presentations

Zinn, C., Schofield, G., & Wall, C. (2003). *Nutrition knowledge of New Zealand premier club rugby coaches.* Paper presented at the International Conference on the Science and Practice of Rugby, Brisbane, Australia.

Zinn, C., Schofield, G., & Wall, C. (2004). *Do New Zealand premier club rugby coaches provide sound nutrition advice to their players?* Paper presented at the New Zealand Sports Medicine and Science conference in Auckland, New Zealand.

ATTESTATION OF AUTHORSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgment is made in the acknowledgments.

Signed…………………………………………

Date……………………………………………

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The Auckland University of Technology Ethics Committee granted ethical approval for this research on 2 April 2003 (reference number 03/32).

ABSTRACT

In a club rugby union environment, sports nutrition information is frequently delivered to players by the central team figure, the coach. Rugby coaches in New Zealand undertake negligible formal nutrition training to become a coach, and the development of their knowledge base remains their responsibility. There is currently no literature on the nutrition knowledge level of New Zealand coaches. Internationally, literature on coaches' nutrition knowledge and dissemination of that knowledge is scarce. Research to date has used questionnaire techniques to quantify coaches' knowledge. These questionnaires have not been assessed for their psychometric properties. As such, a true measure of knowledge cannot be guaranteed from any of these contemporary studies. Therefore, the aims of this thesis were: 1) To design a nutrition knowledge questionnaire satisfying adequate statistical measures of validity and reliability; 2) To utilise the validated questionnaire to investigate the nutrition knowledge level of these coaches 3) To investigate whether or not New Zealand premier club rugby coaches provide nutrition advice to their athletes and the factors affecting this; and 4) To investigate the factors that predict coaches' knowledge.

Study 1 involved designing a questionnaire that satisfied acceptable psychometric criteria of validity (content and construct) and reliability (test-retest). It was designed by an expert panel of sports dietitians and distributed to five groups, dietitians, university business staff, and nutrition, business and fitness students, selected for their expected variation in sports nutrition knowledge. Construct validity was high as indicated by significant mean knowledge score differences between the groups ($p = 0.0001$). Dietitians and nutrition students achieved significantly greater mean scores than the remaining groups. The questionnaire was administered a second time to the business staff and the dietitians to assess test-retest reliability, for which two methods were used. The first method involved a Pearson's product-moment correlation, and demonstrated acceptable reliability (r = 0.74-0.93), aside from the fluid sub-category (r = 0.52). The second, and more robust, method involved a percentage calculation of questions answered in an identical manner on both test occasions. A good test-retest concordance was achieved, with 81.2% duplication of responses of all questions. The findings of this study indicated that the questionnaire was suitably valid and reliable to determine the sports nutrition knowledge of New Zealand premier club rugby coaches.

In Study 2, coaches (n = 168) completed the validated questionnaire, received by Internet, linked via e-mail, or (in case of inaccessibility), standard mail. Coaches responded correctly to 55.6% of all knowledge questions. Those who provided nutrition advice to their players (83.8% of the group) obtained a significantly greater knowledge score, 56.8%, than those who did not provide advice, 48.4% ($p = 0.008$). The study also examined the factors determining nutrition knowledge level. Significant relationships were identified between total knowledge score of all coaches and their qualifications ($p = 0.0001$), their own knowledge rating ($p = 0.0001$), whether or not they underwent nutrition training ($p = 0.002$) and whether or not they provided nutrition advice ($p = 0.004$). It can be concluded that New Zealand premier club rugby coaches are inadequately prepared to impart nutrition advice to athletes and could benefit from further nutrition training.

CHAPTER 1: INTRODUCTION

The relationship between food and athletic performance dates back to 450 B.C. when a Greek called Dromeus of Stymphaus proposed that athletes who consumed muscle meat gained muscle strength, and consequently increased their performance (Maughan & Burke, 2000). Legendary Greek wrestler, Milo of Crotona, who ate huge amounts of meat, was not brought to his knees at any one time over five Olympiads (Nieman, 1999). In 1902, EC Bredin, a middle distance runner, recommended that a light meal be consumed on race day and stressed that the inside of a chop and one glass of port was sufficient sustenance for most men (Maughan & Burke, 2000). In the 1960's, Australian boxer, Lionel Rose fasted to make weight for his morning weigh-in prior to competition. He then ate a steak, a whole chicken and then completed his meal with even more steak before his evening competition (Maughan & Burke, 2000). 1962 brought the use of the needle biopsy by Jonas Bergstrom and enabled measurement of the metabolic responses of muscles to exercise (Maughan & Burke, 2000). As scientific techniques improved, theories changed and different nutrients were put forward as 'performance-enhancing' nutrients. While Olympic marathon runners were continuing to skip breakfast and proudly boasting their enormous intake of ice cream, cookies, pastries, soft drink and beer, many athletes began to improve their dietary habits. Dave Scott, former world-record holder in the Ironman triathlon began putting into practise a diet rich in complex carbohydrates (74% of total calories). His daily food intake consisted of brown rice, tofu, low fat dairy products and 20 pieces of fruit and vegetables (Nieman, 1999).

Even today the science of sports nutrition is constantly evolving. As new technology emerges and research progresses, so too does our knowledge on appropriate dietary consumption for sports performance. The pace of this sports nutrition advancement renders the advice we impart to athletes today vastly different to that given even a decade ago. Nutrition most often ranks third, behind talent and training as a factor that affects athletic performance. However by putting into practise sound sports nutrition principles, athletes can optimise this talent and training (Nieman, 1999). Along with the refinement of our recommendations, athletic performance continues to be enhanced and world records continue to be broken.

With continued scientific evolution, the target market of sports nutrition information delivery has extended beyond the elite athlete, and now reaches many levels of athletes interested in achieving optimal performance in their chosen sport. Registered dietitians and sports nutritionists have become very much an integral part of the sports science / medicine team at many levels (Wolinsky, 1998). Their role is to integrate the principles of nutrition and exercise to maintain optimal health and achieve optimal sports performance. Because of limited resources such as funding and geographical separation, dietitians and sports nutritionists are not able to be involved with all sports teams, and their services are most often utilised at the elite level. At a recreational or club level, nutrition knowledge may be imparted to athletes by those working with teams on a regular basis, such as the team coach or trainer.

In New Zealand, coaches most often assume a volunteered position in a club rugby situation, while trainers are seldom part of teams. The coach, being the central team member, and having regular contact with athletes, often assumes the responsibility for controlling their nutrition practices (Juzwiak, 2004). Nutrition misinformation is abundant, easily accessible and often used by athletes to support practices that are questionable and often harmful. The supplement market is a multi million-dollar industry sustained by a motive of selling product rather than the promotion of sound nutrition practices through food alone. Athletes may have the assumption that these aids will improve their health, help them lose or gain weight or improve their performance. The competitive edge is constantly being sought after and this often exists in the form of dietary manipulation (Parr, Porter & Hodgson, 1984).

Many coaches may not be adequately trained in nutrition to impart scientifically sound information or to recognise nutrition misinformation. Despite this, they often prescribe meals, diet regimes, supplements and often expect weight gain / loss from their athletes (Wolinsky, 1998).

Purpose Statement

In order to best serve athletes, it is necessary to know the nature of the nutrition advice that coaches are imparting to them. The majority of the surveys investigating nutrition knowledge of coaches reveal that overall, their nutrition knowledge base is poor and that there is a need for nutrition training in this group in order for them to be adequately equipped to deliver scientifically sound nutrition advice to athletes (Baer, Dean, & Lambrinides, 1994; Bedgood & Tuck, 1983; Corley, Demarest-Litchford, & Bazarre, 1990; Graves, Farthing, Smith, & Turchi, 1991; Juzwiak, 2004; Parr et al., 1984; Rockwell, Nickols-Richardson, & Forrest, 2001; Wolf, Wirth, & Lohman, 1979; Spear, Lummis, Craig, & Feinstein, 1991).

Research focusing on the relationship between nutrition knowledge and dietary behaviour has failed to find any substantial associations between these two concepts (Axelson & Brinberg, 1992; Parmenter & Wardle, 1999). A possible reason defending this notion is that nutrition knowledge has not to date been precisely measured in studies. In the majority of studies that have investigated nutrition knowledge of coaches, a general criticism can be made regarding the psychometric quality of the nutrition knowledge questionnaires used. Questionnaires have not been adequately assessed for validity and reliability, hence a true measurement of knowledge cannot be confirmed. Before further exploration into the relationship between nutrition knowledge and behaviour can proceed, the identification of a true measure of nutrition knowledge is crucial.

Study aims

The aims of this research were as follows:

1. To design a nutrition knowledge questionnaire that satisfies adequate statistical measures of validity and reliability.

2. To utilise the nutrition knowledge questionnaire to investigate the nutrition knowledge level of New Zealand premier club rugby coaches.

3. To investigate whether or not New Zealand premier club rugby coaches disseminate nutrition advice to their players and the factors affecting this.

4. To investigate the factors that predict the level of knowledge of New Zealand premier club rugby coaches.

Significance of the research

This research is significant because it will enhance the limited body of knowledge internationally on the knowledge and dietary advice practices of coaches. It will also be the first investigation into the nutrition knowledge of rugby coaches in New Zealand.

The sports nutrition knowledge questionnaire developed in study one of this research will be the first of its kind that is psychometrically assessed and that has a focus on the speciality of sports nutrition, with an intended target group of coaches. This questionnaire may be used or adapted for future research with the purpose of investigating nutrition knowledge of a similar target group in New Zealand or internationally. In response to the findings of the second part of this research (i.e. investigating the level of nutrition knowledge of coaches), strategies may be put in place to assist New Zealand club rugby coaches to address the nutrition aspect of their rugby teams in the future.

Assumptions

The following evidence-based assumptions were made about the two studies that were described in this research.

1. The participants in both studies truthfully, and to the best of their ability, completed the nutrition knowledge questionnaire and did not receive any outside assistance when doing so.
2. The use of participant incentive, in the second study of this research, did not bias the final sample used in analysis.

Limitations

1. It was the researcher's intention that the main method of questionnaire distribution in the second study was via e-mail/Internet. However, a larger proportion of the study population than envisaged (i.e. 60%) did not have access to the Internet or e-mail and therefore did not possess e-mail addresses. These coaches received their questionnaires by standard mail.
2. The contact details of numerous rugby coaches were incorrect. The database provided by the New Zealand Rugby Union was the most recently updated one, however its accuracy relies on the rugby coaches to update their own details.
3. The time at which the questionnaires were distributed to the rugby coaches was one month following the conclusion of the club rugby season. At this point in time, the teams that did not progress to the semi-finals or the finals of the competition would have concluded their rugby season even earlier. Due to a more lengthy process than initially planned in developing the nutrition knowledge questionnaire and subjecting it to extensive psychometric testing, the questionnaire was distributed to coaches at a later date than intended. Coaches involved with unsuccessful teams may not have been as interested in participating in this research as they may have been during the playing season.
4. Due to time limitations, the four fluid questions, which were added to the final questionnaire, had not undergone psychometric validation.
5. The foods and fluids selected for inclusion in the questionnaire were all based on the New Zealand variety. This limits the use of this exact questionnaire in countries other than New Zealand.
6. The actual information that coaches provided to their athletes was not investigated in this study.

Delimitations

1. The sport selected for this research was rugby union.
2. The population under study was restricted to the premier club level coach in New Zealand.

Note to the Reader

This thesis is presented as a main literature review, followed by two research papers and finally, a conclusion, that operate synergistically to illustrate a comprehensive representation of the assessment of the nutrition knowledge of New Zealand premier club rugby coaches. The first research paper has been submitted for publication and is currently under review. The second paper can only be submitted once the first paper has been accepted for publication. Due to the chosen submission format of this thesis, there is some repetition in content. The thesis format fulfils the Auckland University of Technology Master of Health Science guidelines by constructively critiquing sports nutrition literature, while also adding to the body of literature by conducting independent research into the New Zealand situation.

Paper contribution

The contributions to the papers by the three authors are as follows:

Paper 1:

Development of a sports nutrition knowledge questionnaire.

Zinn, C., (75%), Schofield, G. (15%) & Wall, C. (10%)

Paper 2:

Evaluation of sports nutrition knowledge of New Zealand premier club rugby coaches.

Zinn, C., (75%), Schofield, G. (20%) & Wall, C. (5%)

CHAPTER 2. LITERATURE REVIEW

This review is centered on sports nutrition issues relating to athletes and coaches. It provides a comprehensive appraisal on the macronutrient intakes of football code athletes, on the nutritional knowledge and practices of coaches with their athletes, and on nutrition knowledge questionnaire development. The review does not explore the derivation of nutritional requirements for athletes. It merely uses current international best practice nutritional guidelines in the discussion and comparison of athletes' intakes from the available literature. The focus of the review will be restricted to sports of the football code, where possible, except in the section on the development of nutrition knowledge questionnaires, where all literature is carefully considered.

Physical characteristics of rugby union players.

Rugby union is a sport that enjoys popularity in many countries. The game is a field-based sport, played over two 40-minute halves separated by a half-time 10-minute break. Match analysis has indicated that rugby is an interval or intermittent sport and players must be able to perform a large number of intense efforts of 5-15 seconds duration with less than 40 seconds recovery between each bout of high intensity activity. These repeated sprints as well as the high frequency of contact elicits a variety of complex physiological responses by the body (Duthie, Pyne, & Hooper, 2003; Nicholas, 1996). Players as a group are not homogenous in their physical characteristics. A team will comprise a variety of sizes and body compositions, typically matched to different playing positions on the field (Frail, 1993). In the past, coaching has been centered on skill related to the game, rather than physical and physiological requirements.

Since the introduction of professionalism in 1995, the demands of the game have elicited rapid changes in the fitness profile of elite players. The physiological characteristics of rugby players vary between the different positions. Backs usually possess a lower percent body fat than forwards, as body fat may be disadvantageous in sprinting and running activities. Forwards spend greater time in physical contact with the opposition where extra body fat may serve as a protective buffer. A larger body size correlates with scrummaging forces and competitive success. However, where extra mass consists of body fat rather than lean muscle tissue, the power-to-weight ratio is reduced, resulting in decreased horizontal and vertical acceleration (Duthie et al., 2003). These observations give some insight into the physiological demands of rugby players and are a pre-requisite in the development and prescription of training programmes and dietary regimes in preparing players for competition. In order to achieve players' anthropometric goals and maintain optimal levels of lean muscle mass and body fat for specific positions, the combination of individualised dietary guidelines with a suitable training protocol is vital.

Dietary practices of athletes

To play at the top of one's game, an athlete requires the combination of physical skills such as strength, agility, endurance, and speed (Duthie et al., 2003). Given the popularity and competitiveness of rugby union, it is important to understand the nutritional needs of these athletes, in order to develop programmes that will improve their dietary behaviour and enhance their performance. The high level of competitiveness seen in many sports may render athletes susceptible to the latest fad diet or dietary supplement, and they may be willing to attempt many dietary manipulations to enhance their performance (Jonnalagadda & Rosenbloom, 2001). In addition to the stresses of training and competition, athletes have the pressure of school or university study and work commitments, which could further challenge, or compromise, optimal dietary intake. Unsound dietary practices can have a negative impact not only on performance, but also on the overall health of the athlete. Given the vulnerability of this group, the provision of adequate knowledge that will help them to make healthy dietary choices and to recognise the importance of good nutritional practices is critical (Jonnalagadda & Rosenbloom, 2001).

Many studies have measured the dietary practices of a wide range of athletes (Nieman, 1999). However few studies have investigated the specific eating behaviours of rugby union players. In general, the nutritional requirements for the sport follow the same principles that apply to all athletes, particularly those involved in sports, which combine the skills of endurance, strength, power, speed and agility (Frail, 1993). The following literature reviewed is confined to sports of the football code (i.e. rugby union, rugby league, Australian rules, and soccer). Table 1 presents dietary intake data from a number of studies conducted on football players.

Table 1. Dietary Practices of Football Players.

Study	Level of sport / sample size	Method used	Mean daily energy intake MJ / (kcal)	Mean daily carbohydrate intake g g/kg % of total energy	Mean daily protein intake g g/kg % of total energy	Mean daily fat intake g % of total energy	Mean daily alcohol intake g
Schokman, Rutishauser, & Wallace (1999)	Elite Australian Rules football 40	4-day weighed food records	13.2 MJ (3158 kcal)	415 g 4.8 g/kg 51.7 %	138 g 1.6 g/kg 18 %	104 g 19 %	1.25 g
Graham & Jackson (1998)	Elite Australian Rules football 10	4 day food diary (3 week days, 1 weekend day), followed by food frequency questionnaire	14 MJ (3349 kcal)	489 g 5.9 g/kg 57.4 %	148 g 1.8 g/kg 19 %	88 g 23.5 %	2.2 g
Maughan (1997)	Scottish Premier league soccer 51	7-day weighed food diary	Team A: 11 MJ (2632 kcal)	354 g 4.4 g/kg 51.4 %	103 g 1.3 g/kg 15.9 %	93 g 31.5 %	9 g
			Team B: 12.8 MJ (3062 kcal)	397 g 5 g/kg 48.4 %	108 g 1.4 g/kg 14.3 %	118 g 35 %	13 g
Wray, Jackson, & Cobiac (1994)	Elite Australian Rules football 15	Quantitative food frequency questionnaire	13.6 MJ (3254 kcal)	410 g 4.7 g/kg 48.2 %	138 g 1.6 g/kg 17 %	116 g 31 %	7.1 g

Frail (1993)	Australian rugby union N/A	7-day food diary	13.5 MJ (3230 kcal)	383 g 4 g/kg 46 %	161 g 1.7 g/kg 20 %	112 g 31 %	14 g
Burke & Read (1988)	Senior club Australian Rules football 56	Diet history, food frequency, 7-day food diary	14. 2 MJ (3395 kcal)	373 g 4.5 g/kg 44 %	126 g 1.5 g/kg 15 %	14 g 37 %	20 g
Hickson & Duke (1987)	Intercollegiate football 88 senior 46 junior	24-hour dietary recall	Senior: 14.1 MJ (3365 kcal)	366 g 4.8 g/kg 44 %	133 g 1.8 g/kg 15.8 %	154 g 41 %	N/A
			Junior: 10.6 MJ (2523 kcal)	302 g 5 g/kg 48 %	91 g 1.5 g/kg 14 %	109 g 39 %	

N/A: Not available

Macronutrients

The studies presented in Table 1 reveal a pattern of dietary intake of carbohydrate (CHO) that is well below the current recommended dietary intakes for the athletic population under study. The mean range of 4.4-5.9 g CHO/kg body weight noted falls short of the currently recommended range of 6–8 g/kg for all sports with a high aerobic component, such as players in a football team (New Zealand Dietetic Association, 1998). Athletes performing more endurance exercise as part of the game, such as the loose forwards, require up to 10 g/kg of CHO, hence a definite shortage in requirements (Burke, Cox, Cummings, & Desbrow, 2001). This trend of low CHO intake is also noted in similar studies of footballers that have not been presented in Table 1. (Hassapidou, Grammatikopoulou, & Liarigovinos, 2000; Leblanc, Le Gall, Grandjean, & Verger, 2002). Despite these low intakes, it appears that the Australian footballers' CHO intake has increased from 1988 to 1998 (Burke & Read, 1988; Ebert, 2000; Schokman et al., 1999), although it deteriorates again in Schokman et al.'s (1999) sample. Ebert (2000) suggests that the involvement of dietitians in professional clubs has resulted in the improvement of dietary practices by these athletes. While there has not been a substantial change in the amount of energy consumed, changes have been made over time in the CHO, fat and alcohol categories, with CHO quantities increasing and fat and alcohol quantities decreasing. It is worthy to note that the majority of the studies reviewed in Table 1 were conducted in elite football players, whose training and competition demands necessitate a high carbohydrate intake. Club football players may not necessarily require this level of carbohydrate intake because of lesser demands. However, it is most likely that the same difficulties of obtaining optimal carbohydrate intakes exist in this non-elite population.

Assessing the dietary intakes of individual, or groups of athletes is complex and a number of limitations need to be pointed out. Firstly, the differences in survey collection methods and in the databases used to estimate nutrient intakes should be recognised when analyzing and comparing data between studies. Hickson & Duke (1987) used 24-hour dietary recalls in their study. To overcome the limitation of the day of data collection being an atypical day and not representing usual food intake, they repeated it four times in order to represent a usual food intake. While this method is speedy, it carries with it the limitation that it relies on the subjects' honesty, memory, and food knowledge, which is not always optimal. Food intake may have been under-reported in this study.

Graham & Jackson (1998) acknowledged that the food frequency questionnaire used in their study was inappropriate for use with individual or small groups of athletes. Reasons supplied were the inability of athletes to visualise serving sizes and consequently over- or underestimate consumption, as well as the food items in the questionnaire not being reflective of their usual intake. The questionnaire used in this study was developed several years ago for the assessment of dietary intakes of the general population of Australia. It did not include ergogenic aids, sports foods and new convenience foods. However, a 4-day food record was used in combination to provide a more precise estimate of dietary intake (Graham & Jackson, 1998).

Wray et al. (1994) used only a food frequency questionnaire with no food record combination. It is doubtful that, without combining this with a written/weighed food diary along with instructions, a representative food intake of these athletes was obtained. Other studies used what is considered to be the gold standard for dietary assessment, weighed written dietary records (Burke & Read, 1988; Frail, 1993;

Maughan, 1997). Inaccurate reporting of dietary intake is a universal problem of self-reported dietary assessments. Athletes may alter or under-report their food intake during the recording period, thereby not reflecting their usual intake. Factors explaining under-reporting include omitting food items (especially second helpings and snacks) because of the inconvenience of recording, or failing to report items considered ‘unhealthy’. Athletes with busy lifestyles and those with a sense of obligation about what they should be eating typically under-report eating habits (Burke, et al., 2001). In addition, athletes may erroneously quantify or describe their food intake. Dietary survey literature on athletes indicates that actual CHO intake values may be underestimated by 10-20% (Burke, et al., 2001). If that is the case, then the true range of CHO consumed by the surveyed athletes may be greater. Despite this, the lower end of this true range would still not be in the recommended CHO range for these athletes.

Secondly, caution must be applied when comparing data because of the considerable differences in nutritional analysis results produced by various computerised food composition databases. Inaccuracies and variability may occur when usual foods are not readily available on the database, such as ethnic and commercially prepared foods, formula products and specific sports foods (Burke et al., 2001).

Lastly, it is with caution that macronutrient intakes expressed as a percentage of energy intake ratios are discussed. This traditional method of expressing macronutrients has lead to some confusion in the area of sports nutrition dietary guidelines, particularly for those athletes requiring a greater intake of CHO for their sport or for the position they play on the field. A more appropriate way of representing CHO intake would be the amount of CHO required relative to body mass. An example of how this confusion may arise can be noted in Schokman et al.’s study (1999) on Australian footballers. Although the CHO percentage reported was greater than it had been in other studies (Burke & Read, 1988; Ebert, 2000), the amount of CHO consumed per kilogram of body weight (4.8 g/kg), was still well below that recommended for athletes (6-10 g/kg). While a general guideline can be made that sports people should be consuming CHO in the range of 55-70% of their total daily energy intake (Burke et al., 2001, Howe, Hellemans, Rehrer, & Pearce, 2000), they may achieve this percentage range without consuming enough CHO per gram of their body weight. This is because the intake of the other macronutrients can influence the percentage contribution of CHO, but not the total amount of CHO consumed in grams per kilogram of body weight.

A number of factors may influence the achievement of such high carbohydrate targets. Excessive alcohol intake may be one of these factors. While total energy intake may be sufficient to maintain body weight, calories from alcohol may displace the much needed calories obtained from carbohydrate. In addition, an inadequate intake of overall energy could limit absolute intake of carbohydrate.

Finally, another potential problem with the analysis of athletes' mean dietary intake is that across the range of surveys, there are individual athletes within a group that report higher CHO intakes and others whose CHO intakes fall below the recommended intake. The large standard deviations often produced between athletes' intakes indicates the likelihood that within a group appearing to meet their CHO needs, there are indeed some athletes who are consuming less than optimal amounts of CHO for their sport.

From Table 1 it can be seen that protein intake ranged between 1.3-1.8 g/kg or (13-19% of total daily energy intake). Protein requirements for male football players have been estimated at 1.4-1.7 g/kg per day, depending on the amount of strength training that is involved in the individual athletes' training programme (Tarnopolsky, 2000). Due to limited literature on the protein requirements of adolescent athletes, it is difficult to make precise recommendations (Thompson, 1998). However, up to 2 g/kg per day has been recommended due to increased growth needs during the adolescent period (Lemon, 1998). Hickson & Duke's (1987) adolescent athletes did not achieve this protein requirement. Because protein requirements are different for athletes of certain ages, team positions and training requirements, it becomes difficult to interpret a mean protein intake for the team of football athletes as a group. Some athletes may over-consume protein and some may under-consume protein. While an intake of 2 g/kg per day would have been an over-consumption for adult athletes, this quantity would have been optimal for adolescent athletes. This is evident in Frail's (1993) study, where her athletes consumed a range of 1-2.4 g/kg body weight, indicating some athletes over-consuming and some under-consuming protein.

Recommended intakes of fat are typically expressed as a percentage of total daily energy intake, rather than in grams per kilogram. Diets containing 20-25% of energy from fat are advocated to facilitate adequate CHO intake, provide essential fatty acids and fat-soluble vitamins, and maintain body weight. Intakes above this can compromise CHO intake and result in an increase in body fat stores, which is undesirable for athletes (American College of Sports Medicine, American Dietetic Association, & Dietitians Canada, 2000). A mean intake of less than 25% of total daily energy intake was found in only two of the studies presented in Table 1 (Schokman et al., 1999). However the same analysis problems exist and can be noted when comparing Schokman et al.'s (1999) fat intake of 19%, which appears low, yet amounts to a high 104 g of fat. Of particular concern was the high mean fat intake of 41% (or 154 g) obtained in Hickson et al.'s (1987) sample of high school footballers.

Micronutrients and general food intake

Burke & Read (1988) reported mean intakes of the four vitamins (thiamin, riboflavin, niacin and Vitamin C) and the two minerals (calcium and iron) above the Australian recommended dietary intakes. Similarly, Graham & Jackson (1998) reported that mean intakes of anti-oxidant vitamins A, C, and E and minerals iron, magnesium, zinc and calcium exceeded requirements. Frail's (1993) athletes' micronutrient levels were also all above the Australian recommended dietary intakes. Despite achieving their micronutrient requirements, a lack of interest in every day eating patterns was reported by 30% of Burke & Read's (1988) football players. Erratic meal timing and missing of meals was habitual, especially on weekends.

In contrast, Hickson & Duke (1987) reported that 19-36% of their senior group and 26-43% of their junior group achieved less than 70% of the recommended daily intake of vitamins thiamin, Vitamin A and Vitamin C. For the minerals iron, calcium and zinc, 28-34% of seniors and 20-54% of juniors were below 70% of their recommended daily intakes. A possible explanation for the differences reported between this study and the three discussed above is that all the athletes in the three studies were part of an elite squad, while Hickson & Duke's (1987) sample were lower level football players. In addition, Hickson & Duke (1987) used a 24 hour recall to access dietary intakes, whereas the other studies reviewed in Table 1 used food records. This could have resulted in an underestimation in micronutrient intake in Hickson & Duke (1987)'s sample of athletes.

In addition to the failure to meet micronutrient requirements, 19% of these athletes missed breakfast, 13% missed lunch and 3% missed dinner. When athletes were questioned about their reasoning for missing meals, answers reported included sleeping through breakfast, being too busy or just forgetting to eat. Subjects who had missed meals often did not make up for lost energy in snacks.

Fluid intake

Team sports require players to perform multiple periods of work at near maximal effort, interspersed with low intensity intervals or rest for the duration of the game. A significant amount of fluid is lost from the body during this time, which can have a negative impact on performance and temperature regulation (Burke & Hawley, 1997). In many codes of football it was often tradition to abstain from consuming fluid during training and competition to "toughen up" the players. It is now recognised that a fluid loss of only 2% of body weight can cause a decline in performance (Saltin & Costill, 1988). In fact, fluid deficits of less than 2% of body mass have been reported to result in impaired performance in endurance exercise. (Walsh, Noakes, Hawley, & Dennis, 1994).

Many studies have been conducted on fluid balance in football codes, however few have focused specifically on rugby union. Fluid losses were measured in 15 first grade rugby union players in temperatures of 24-25 °C. Authors reported a mean body fluid deficit (i.e. 2.5% of body mass), with forwards sustaining greater levels of hypohydration compared with backs (2.9% vs. 2.1%, respectively). A limitation of this study was that fluid intake was not determined, resulting in a possible underestimation in total fluid losses. An estimation of fluid intake was made at 0.15 L. (Cohen, Mitchell, Seider, Kahn, & Phillips, 1981).

Goodman, Cohen, & Walton (1985) reported similar findings when they measured fluid losses during three matches played in the same temperature but varying humidity. Mean sweat losses varied from 1.7-2.3 L per match, while fluid intake was 0.75 L. A mean fluid deficit of 1.5% of body mass was the outcome. Similar levels of fluid deficits were reported in Australian football players in the 1980's (Pohl, O'Halloran, & Pannal, 1980; Pyke & Hahn, 1980).

It is worthy to note that these studies were conducted prior to 1990. In 1994, the importance of optimal fluid intake was highlighted by the development of the Australian Football League (AFL) Medical Officers' Association position paper on the prevention of thermal injuries in AFL football (Burke & Hawley, 1997). This paper highlighted the need for education, consideration to the game time, acclimatisation, and possible rule changes that would assist in minimal thermal injuries. Globally, increased scientific awareness of the disadvantages of dehydration has arisen and so too has the conception of the "sports drink".

Sports drinks contain added CHO, which not only provides a substrate for the exercising muscle, but also promotes water absorption in the small intestine. The added sodium stimulates CHO and water uptake into the small intestine, helps to maintain extracellular fluid volume and maximises the effect of rehydration (Maughan, 2000).

Despite the growing awareness of optimal fluid intake, more recent studies are still reporting below optimal levels of fluid intakes. Jonnalagadda & Rosenbloom (2001) found that American Division I footballers' fluid intakes were low, with only 26% of athletes reporting consumption of five or more 250 ml cups of fluid during a typical training session. Consumption of 3-5 cups, which is equivalent to 750-1250 ml, was reported by 52% of the sample, 1-2 cups by 19%, and 3% of the sample reported not consuming any fluids during a training session. However, this study was merely descriptive with no measurements of fluid intake or losses carried out. Furthermore, the length of a typical training session was not quantified. These limitations do not allow for a true determination of fluid intake in this study.

There is an absence of current literature on fluid losses on rugby union, Australian Rules or league players. However, a recent study investigating fluid losses in 24 English premier league soccer players revealed players did not consume adequate fluid during their training sessions to match sweat losses, and all players lost weight. Players were weighed prior to and after a 90-minute training session and sweat losses were measured. Players exhibited a mean body mass loss of 1.1 ± 0.43 kg, equivalent to a level of dehydration of 1.37 ± 0.54%. Average fluid intake was 971 ± 303 ml and mean sweat losses (once urine output was accounted for) was 1345 ± 275 ml/hour. Despite the fluid intakes of these players being greater than those identified in the aforementioned studies, fluid deficits and dehydration were still reported. Greater fluid intakes could be explained in this study due to players being aware of measurements being taken and therefore more conscious of fluid intake. Moreover, this study was conducted in warmer weather than usual, so both coaching staff and players may have been especially vigilant in encouraging a high fluid intake. It is also important to consider that, as a result of the rules of the game of soccer, opportunities to consume fluid are limited during the course of the game. This study investigated fluid balance during training, where more opportunities to consume fluid may occur. Fluid intake may therefore not have been representative of the amount normally consumed in a match situation (Maughan, Merson, Broad, & Shirreffs, 2004).

The consumption of alcohol following a football match is customary, and to footballers it is often more than merely an alcoholic beverage. Alcohol and alcohol consumption-related behaviours (e.g., drinking games and races) are often a representation of team bonding, team spirit and a source of relaxation after the match (Ebert, 2000). Burke & Read (1988) reported a mean alcohol post-match intake of 120 g, in their sample of footballers, supplying 19% of total energy intake on that day. Fourteen athletes showed a positive blood alcohol reading at a Sunday morning training session. Four of them were over the legal driving limit, reflecting the large consumption from the previous night. Over half of Jonnalagadda & Rosenbloom's (2001) sample of Division 1 collegiate footballers avoided alcohol. This high percentage could be due either to the fact that the mean age of the players was 18 years of age and the legal drinking limit was 21 years, or to the fact that due to alcohol being a sensitive issue, truthful reporting of consumption could be questionable.

Because of the vasodilatory effect of alcohol, excessive alcohol consumption delays the repair of muscle and soft tissue injuries, and due to its diuretic effect, it hinders the rehydration process. If a high blood alcohol reading persists into days following consumption, training performance may be compromised (Burke & Maughan, 2000). Over the latter part of the twentieth century, there has been an increase in professionalism and commitment towards sport. As such, this may have reduced alcohol consumption of many elite footballers. However, at an amateur level, athletes still indulge in alcohol consumption post game (Ebert, 2000). Taking into consideration the tradition of alcohol consumption, perhaps it is unrealistic to advise total abstinence following a game. However education regarding the need for immediate post-exercise rehydration and nutrient replacement before alcohol is consumed, as well as safe drinking and driving limits, is mandatory.

Recovery nutrition

In the past, appropriate food intake following a game has been neglected. A focus on CHO consumption has been on the evening prior to a game; with little consideration given to the need to recover muscle glycogen levels post game. The traditional after-match meal for footballers has very much been a 'pie and beer affair', whereas nowadays there is an increased emphasis on the recovery meal. There is a need to recover empty muscle glycogen stores as well as muscle damage resulting from collisions and tackling events immediately following exercise to facilitate optimal preparation for the next session (Burke & Read, 1988). Due to the nature of football, when training can typically occur anywhere between two and five times between matches, the recovery meal is one of the most important considerations for the footballer. Athletes should be consuming a minimum of 1g of high glycaemic index CHO food per kilogram body weight as well as some protein to assist in muscle repair and regeneration (Costill, Pearson, & Fink, 1988; Coyle, 1991). The literature reviewed on dietary practices of footballers focuses on alcohol intake rather than food as a recovery issue. However Burke & Read (1988) report that previous studies have observed a failure of athletes to restore muscle glycogen between exercise sessions, resulting in fatigue and deteriorating performance. This suggests that their food-related recovery practices are sub-optimal.

Supplements

The sports world is filled with pills, potions, powders and special foods that promise to provide a performance edge. Claims from advertisements and testimonials for supplements include prolonged endurance, faster recovery, fat loss, increases in muscle mass and strength and resistance to illness and infection. Such promises are attractive to athletes involved in elite sport, where competition is endemic and minute differences separate the winners from the rest of the pack. However, considerable interest in supplements also extends into the recreational athletic world where body composition goals such as weight loss and weight gain are increasingly popular (Burke & Deakin, 2000; Nieman, 1999; Wolf et al., 1979).

In 1996 the general population spending on supplements in the United States amounted to $6.5 billion and increased to $12.8 billion by the following year. Creatine supplements, first publicised in 1992, after the Barcelona Olympics, now have annual sales at approximately 2.7 million kilograms (Burke, Desbrow, & Minehan, 2000). There is considerable exaggeration and misinformation regarding the relationship between vitamin and mineral supplements in athletes. The message that large amounts of vitamins and minerals are needed to boost energy levels, maximise performance, compensate for poor diets, and to meet high nutrient needs are sent to athletes via coaches, popular fitness magazines, and training practices of sports stars. Despite what appear to be adequate diets in terms of micronutrient content, athletes feel the need to supplement their diets (Nieman, 1999).

Supplement use among athletes

It is estimated that 50-80% of elite athletes use vitamin/mineral supplements on a regular basis (Nieman, 1999). Sobal & Marquart (1994) conducted an extensive study looking at the use of supplements among high school athletes and their influences. After reviewing 51 studies using 71 different athletic groups, they reported that the mean prevalence of supplement use in this group was 54%. These researchers also reported that 62% of athletes believed vitamin/mineral supplementation improved athletic performance. The Australian Sports Medicine Federation survey reported that beliefs within a sport strongly influencing supplementation practices stemmed largely from the coach (Sobal & Marquart, 1994). Studies by Wolf et al. (1979) and Bentivegna, Kelley, & Kalenak (1979) reported that 35% and 68%, respectively, of coaches in the samples studied recommended their athletes take supplements.

A study conducted by Krowchuk, Anglin, Goodfellow, Stancin, Williams, & Zimet (1989) indicated that the majority of high school athletes believed that by supplementing their diets with vitamins or extra protein, their performance would improve. Furthermore, the athletes believed that using the supplements would impose little or no health risk. In a study investigating oral creatine supplementation in male collegiate athletes, 75% of athletes exceeded the dosage for supplementation. In the same study 87% of the sample reported the strength and conditioning coach as being their primary source of information regarding creatine (Juhn, O'Kane, & Vinci, 1999). During the Olympic Games in Sydney in September 2000 information about medication and supplements taken was collected. Of the 2758 athletes tested, 51% were taking vitamins, 21%, minerals, 12.5% amino acids and 22.5% other supplements. The highest percentage of vitamin users in one sport was modern pentathlon (75%), followed by wrestling (72%) and weightlifting (70%). Approximately 46% of football players reported consuming vitamins (Corrigan, 2003).

While there are risks associated with the use of vitamin/mineral supplements, other ergogenic aids such as steroids and amphetamines present a greater risk to athletes. Education and counselling with athletes by suitably qualified professionals is vital to ensure that side effects and consequences detrimental to health are avoided. A study conducted in 1992 surveyed twelve issues of bodybuilding and popular health magazines. Researchers found 89 brands of 311 products, mostly for muscle growth, shown in these magazines. Unidentifiable substances in a list of 235 ingredients were also identified, with only 77.8% of the products listing ingredients (Philen, 1992). Supplements are readily available to athletes and can be accessed with ease through health stores as well as via the Internet. Sports coaches may not be aware of how popular supplements are, or of the nature of a particular supplement's side effects or consequences. It is crucial that coaches receive regularly updated information in order to be able to provide sound advice to their players regarding supplement use.

Supplement use among football players

Table 2 represents the few studies that have been conducted on supplement use among football players.

Table 2. Supplement use among football players.

Study	**Level of sport / Sample size**	**Percentage of athletes using supplements (type of supplement)**
Jonnalagadda & Rosenbloom (2001)	Freshman collegiate football players 31	42% (dietary supplements) 36% (creatine) 23% (vitamins)
McGuine, Sullivan, & Bernhardt (2001)	High school football players, grades 9-12 1349	30% (creatine) in total 10.4% from 9th grade 50.5% in 12th grade
Swirinski, Latin, Berg, & Grandjean (2000)	High school football players 170	3.7% (vitamin/mineral) 28% (creatine)
Graham & Jackson (1998)	Australian football league 10	70% regularly (dietary supplements: Vitamin C, E, iron, multivitamin)
Burke & Read (1988)	Senior club Australian Rules football 56	48% (vitamin/mineral)
Short & Short's study (as cited in Jonnalagadda & Rosenbloom, 2001)	University football players 1 team (exact sample size not available)	50% (multivitamins) 30% (Vitamin E) 20% (Vitamin C) 24% (calcium) 15% (iron)

From the literature reviewed, it is evident that a moderate percentage of football players use sports nutrition supplements, with vitamin/mineral supplements and creatine being the most commonly used supplements. Despite adequate levels of micronutrients, Burke & Read (1988) reported that almost half of their elite Australian football players used vitamin and mineral supplements. Out of these players, 15% of them used the supplements on a regular basis, while 33% on an occasional basis. The most common supplements taken were a multi vitamin/mineral preparation or B-complex mixture with a mild stimulant. These players reported taking supplements to improve performance (22%), however the most common reasons supplied for supplement use were to compensate for poor nutrition and lifestyle practices, to combat respiratory infections and in response to excess alcohol consumption (Burke & Read, 1988). This data suggests that athletes need information regarding the limited benefits as well as the potential risks of supplement use (Krowchuk et al., 1989; Swirinski et al., 2000). As supplements are often expensive and are of limited use to a well-nourished individual, athletes' diets need to be assessed before the use of any supplements should be contemplated (Sobal & Marquart, 1994).

There is a paucity of literature on the use of performance enhancing drugs in the football population. A study was conducted to determine the frequency of use of performance-enhancing drugs in elite Australian Rules football players. Nine hundred randomised unannounced urine testing (according to Olympic International Committee protocols) were conducted during the period from 1990-1995. No positive results were obtained for anabolic steroids, diuretics, caffeine, or peptide hormones. The five positive tests that were obtained were explained by them being inadvertent medical doping, in which medicines were declared prior to testing. Authors of the study concluded that drug doping was not a problem in the Australian football league (Hardy, McNeil, & Capes, 1997).

Weight control

Weight control is a topical, yet controversial area of sports nutrition. Several sports require athletes to be a certain weight in order for them to compete and each sport has its own procedures for prescribing and monitoring weight classes for competitions. Sports that fall into these categories include wrestling, weightlifting, boxing, rowing, horse racing and lightweight American football. The weight categories exist in order to establish fairness on the field for sports where athletes with greater muscle mass will have a clear advantage. It is expected that athletes with greater muscle mass will generate more power in strength events and therefore matching them by weight should level out the physical inequalities and theoretically make a safer and fairer sport (Walberg-Rankin, 2000). In these scenarios, athletes are often required to alter their weight in order to compete in weight-specific categories. In a study conducted on the weight loss practices and attitudes of lightweight footballers, athletes were using inappropriate weight loss methods such as fasting, sitting in saunas, wearing rubber suits, vomiting and using diet pills, laxatives and diuretics. In addition, these practices were reported to be frequently interfering with their extracurricular activities (Depalma, Koszewski, Case, Barile, Depalma, & Oliaro, 1993). Club rugby in New Zealand categorises players into teams based mainly on age. In addition to these categories, a weight-restricted category does exist. At a junior level, all rugby teams are graded according to players’ weights, the intention being to ensure the game is safe for young players. Recently, New Zealand rugby unions have received complaints from parents and coaches of players undertaking harmful weight loss practices in order to shed weight. Reports of children starving themselves and sitting in saunas prior to weigh-ins are common (Richardson, 2004). In rugby teams where no weight-class is specified, weight reductions or gains are frequently desired by coaches in order to match a player to the physical requirements of that particular position on the field.

Current international best practice on the recommended amount of weight loss that is deemed safe and sustainable for any athlete is 0.5-1 kg per week (O'Connor, Sullivan, & Caterson, 2000). Athletes' goals should be to reduce their body mass through the reduction of body fat levels, a process that should commence weeks or even months prior to an event. With rapid weight loss over a short period of time, athletes reduce lean muscle mass and water (Roemmich & Sinning, 1997; Walberg, Leidy, Sturgill, Hinkle, Ritchey, & Sebolt, 1988). Once the weight is lost and the weigh-in has occurred, the goal is then to regain the lost weight before the competition takes place in an attempt to recover pre-weigh-in performance. Evidence suggests that this goal is frequently not achieved and often results in impairment of health or performance (American Medical Association, 1998; Walberg-Rankin, 2000).

Under any circumstances that weight gain or reduction is required in sport, a good comprehension of weight control principles is required in order for athletes to safely meet their goals. It is essential that coaches ensure athletes receive sound nutrition information, by either providing it themselves or by referring them to appropriately qualified professionals for assistance.

Nutrition knowledge of athletes

There is a paucity of literature identifying the nutrition knowledge of football players in isolation, therefore the following review will explore the status of nutrition knowledge of athletes involved in a variety of sports. The measurement of nutrition knowledge in any population is a complex matter and will be addressed in detail further on in this review. Table 3 provides an overview of the nutrition knowledge of athletes and some of the misconceptions that are prominent in the athletic world.

Table 3. Nutrition knowledge of athletes.

Study	Population	Sport	Knowledge score	Knowledge misconceptions
Rosenbloom, Jonnalagadda, & Skinner (2002)	237 male, 92 female Division 1 National Collegiate Athletic Association (NCAA) athletes	Football, track and field, baseball, basketball, swimming, tennis, golf, softball, volleyball	Mean correct score: 53%	67% males, 53% females believed vitamin and mineral supplements increase energy levels 47% males, 43% females believed protein is the main source of energy for the muscle
Shoaf, McClellan, & Birskovich (1986)	75 male college athletes	Track, baseball, football	Mean correct score: 43%	Less than half of the sample could correctly list food sources of CHO, define glycogen loading and recommend a suitable pre-game meal. 27% could recognise a list of fat soluble vitamins 54% did not know the functions of vitamins
Jacobson, Sobonya, & Ransone (2001)	330 NCAA male and female college athletes	Football, baseball, track and field, volleyball, swimming, basketball, softball, tennis, soccer, golf.	N/A	3% correct identification of fat requirements 11.5% correct identification of protein requirements 29.5% correct identification of CHO requirements 30.3% believed vitamins provide immediate energy
Harrison, Hopkins, MacFarlane, & Worsley (1991)	122 elite and non-elite male and female New Zealand athletes	Field hockey, basketball, powerlifting, netball, rugby union.	Mean correct score: 67% (elite), 56% (non-elite) Range for four vitamin /mineral questions: 19-50% (elite), 9-32% (Non-elite)	30% (elite) and 44% (non-elite) believed vitamins provide energy

N/A: Not available

A range of mean correct scores were obtained when comparing the studies presented in Table 3, with the New Zealand elite athletes in Harrison et al.'s (1991) study obtaining the greatest mean correct score. Despite the high score, these athletes still obtained a high proportion of incorrect answers for certain questions. For example 49% of this elite group (and 54% of the non-elite athlete group) provided the incorrect response to the following statement "At half time in a game, it's a good idea to drink sweetened drinks to provide energy for the second half" (Harrison, et al., 1991). The scores obtained in the studies reviewed in Table 3 are higher than those obtained in other similar studies (Barr, 1987; Frederick & Hawkins, 1992). A score range of 22.5-26.5% was obtained on a nutrition knowledge questionnaire by college dancers and track athletes, respectively, (Frederick & Hawkins, 1992) and a score of 34% obtained by female university athletes from the sporting codes of basketball, swimming, rowing, track and field, volleyball, gymnastics and field hockey (Barr, 1987).

A misconception common to the studies reviewed was that pertaining to the function of vitamins. A range of 30-67% of athletes across the studies believed that vitamins and minerals provided energy. This same erroneous belief was reported by 80% of Heredeen & Fellars' (1999) sample of college football linemen. These athletes (70%) also believed that bread and potatoes should be avoided when trying to lose weight.

Almost half of both the male and female Division 1 athletes believed that protein was the main energy fuel for muscles and that protein supplements were necessary for increased lean muscle mass gains (Rosenbloom et al., 2002). A similar finding was reported by Marquart & Sobal (1993), who investigated the beliefs and information sources pertaining to muscle development among 742 high school athletes. The majority of athletes believed that protein supplements (73%) and vitamins (61%) were important for muscle development.

Jacobson & colleague's (2001) study involved conducting a comparison between nutrition knowledge in a survey carried out on college athletes in 1998 and a similar survey conducted in 1992. Despite recommendations resulting from the 1992 study to increase nutrition education of athletes, minimal changes were noted in nutrition knowledge over the six-year period. Authors from each of the studies reviewed above made the recommendation that the nutrition knowledge of athletes could be improved and that they would benefit from nutrition education.

Despite Shoaf et al.'s (1986) athletes achieving a low mean nutrition knowledge score, up to 70% of them believed they had adequate knowledge. It is the author's belief that individuals, especially athletes, often consider themselves to have adequate nutrition knowledge, even when this may not be the case. The reason for this is that general nutrition concepts are frequently portrayed as being reasonably straightforward, often with simple messages being promoted, such as 5+ a day (which promotes the daily consumption of more than 5 servings of fruit and vegetables). Eating and drinking are acts that individuals perform each day of their lives and aspects of food and nutrition are featured regularly in the media, be it in television programmes or advertisements, magazines or supermarket promotions. As a result of this, many people would believe they have an idea of which foods are considered 'healthy' and which are not. The reality is that nutrition is a complicated science, of which sports nutrition is a speciality. Research advances what is known and advised on nutrition concepts, with advice given to athletes going beyond the simple concepts of healthy vs. unhealthy foods. In addition, even if athletes were knowledgeable about nutrition, people often consume foods and fluids for which they have a preference, despite the effect these foods have on their health or their sports performance.

The main sources of nutrition information most frequently identified by Shoaf et al.'s (1986) athletes were parents, high school physical education/health courses, college health courses, high school coaches and home economics courses. Jacobson et al., (2001) reported similar sources with an addition of magazines, friends or television. While these athletes believed that nutrition could influence performance, only 10% of their sample cited nutritionists/dietitians as sources of their nutrition information. Marquart & Sobal (1993) reported that their sample of footballers sourced nutrition information from friends (25%), coaches (23%), magazines (17%), television (16%) doctors (15%), parents (14%) and trainers (14%). Athletes were asked which personnel they believed provided accurate nutrition information. Doctors (76%), trainers (68%), parents (38%), teachers (33%), and other athletes (33%) were common responses.

Use of nutrition professionals in team sports

Individual athletes in most sports in the last decade have discovered the value of nutrition in the pursuit of optimal sports performance. It has only been in recent years that team sport players have realised the benefits of sports nutrition. In 1985, Pennsylvania State University in the U.S. employed a dietitian for 20 hours per week to work with athletes, coaches, and trainers involved with athletics. In 1991, the position became full-time (Clark, 1994). Since then nutrition professionals have been hired or consulted with by U.S. university or college athletic departments to provide nutrition education and counseling for athletes (Vinci, 1998). In the Australian Rugby Football Union's planning for the 1991 World Cup, it was decided that a consultant sports dietitian be employed to address the nutrition strategies for the squad (Frail, 1993).

Sports nutrition has developed into an integral part of AFL clubs. In the 1980's, dietitians began introducing some AFL clubs to the importance of nutrition and how it could influence optimal performance. Today all AFL clubs utilise the services of qualified sports dietitians. Their role is to monitor nutrient intakes of athletes, provide practical nutrition advice, design pre-, during and post-game nutrition strategies and manage overseas travel nutrition issues. These clubs now understand that nutrition is as important to performance as other aspects, which historically have always been a priority (i.e. weight training, sprint work, skill development, aerobic fitness) (Ebert, 2000; Frail, 1993; Wray, 1999).

New Zealand professional teams, such as the National Rugby League team and the Super 12 and All Blacks rugby union teams have utilised the services of consultant dietitians since the mid 1990's (Anderson, D, personal communication, September 12, 2003). The use of sports dietitians as consultants to elite, but non-professional sport has increased since the inception of the New Zealand Academy of Sport in August 2000. This system operates by providing funding to qualified sports dietitians, on a consultancy basis, to deliver nutrition services to selected sports (Pfitzinger, P, personal communication, November 14, 2003). However this funding system applies to elite sport only, and consequently at a non-elite level, the services of dietitians are utilised less frequently.

Dietary advice practices of coaches

Although the advice from a dietitian is important, it is the coach that occupies the position in a sports team that gives them significant influence over the dietary practices of athletes. Coaches are present at every training session and every game and are able to see the food and fluid that athletes bring to the session, how much fluid they consume during the session, and their recovery food and fluid practices. Coaches are responsible for making important decisions regarding many aspects of the team, i.e. positions, fitness regimes, training schedules, match-day preparation and post match activities. In addition, coaches often assume the responsibility for controlling the nutrition practices of their athletes (Dawson, M, personal communication, October 24, 2004). Surveys conducted on the dietary advice practices and knowledge of rugby coaches are sparse. However numerous studies have investigated these issues where coaches are involved in a variety of sports. Several of these studies are presented in Table 4.

Table 4. Studies investigating coaches' dietary advice practices to athletes and nutrition knowledge.

Study Place	Sample / response rate	Sport	Nutrition training	Information source	Nutrition practises / knowledge	Study outcome
Juzwiak (2004) Brazil	55 coaches working with adolescent athletes (35.5%)	Gymnastics, tennis, swimming, judo	41% attended nutrition course	Non-technical magazines (58%) Textbooks (38%) Other coaches (44%)	Practices: 100% gave nutrition advice during training 27% recommended deleterious weight control practices Supplements: General: Recommended by 26% Protein or amino acids: Recommended by 16% Knowledge: Mean score: 70% 46% believed protein is the main source of energy for the muscle	Compulsory nutrition course needed for all coaches. Develop specific nutrition education materials.
Rockwell et al. (2001) Virginia	35 coaches, 18 trainers Division 1 University (57%)	Basketball, football, volleyball, athletics, swimming, diving, baseball, golf, softball, tennis, soccer	N/A	Magazines (47%) Scientific journals (37%) Videos (11%) Books (40%) Internet/television, food labels (42%) Dietitians (30%) Physicians (40%)	Practices: Supplements: Vitamin / mineral: Recommended by 40% Protein: Recommended by 34% Creatine monohydrate: Recommended by 26% Knowledge: Mean score: 67% >60% did not know recommended protein range	Provide coaches with additional nutrition training, resources and support from qualified nutrition professionals.
Baer et al. (1994) Ohio	135 (45%) High school coaches	Football	31% attended nutrition course	Newspapers, magazines or journals (75%) 0% consulted with a dietitian/nutritionist	Practices: 98% advised players on gaining lean body mass 47% believed protein intake should be increased 30% believed protein powders are necessary to increase lean body mass Knowledge: 100% did not know recommended protein range	Coaches need a better understanding of nutrition. Further training is needed.

Graves et al. (1991) North Carolina	303 (37%) School coaches (152) Trainers (91) Dual coach-trainer (29)	Athletics	23% coaches and 7% trainers never attended course / seminar	Physician (68%) Sports trainer (45%) Coaches (35%) School nurse health teacher (14%)	Knowledge: Mean score: 59% (coach) Mean score: 64% (trainer) Mean score: 53% (dual role)	Coaches need nutrition training. Trainers are better prepared to give advice to the athlete.
Spear et al. (1991) Alabama	342 high school coaches (N/A)	All sports	N / A	N / A	Practices: 54% encouraged high protein, high fat pre-event meals Supplements: Protein: Recommended by 32% Vitamin / mineral: Recommended by 62% Knowledge: 59% unable to identify composition of an athlete's diet	Need for continuing education for high school coaches.
Corley et al. (1990) North Carolina	106 (36%) College coaches	Athletics, swimming, tennis, basketball, gymnastics, golf, football, wrestling	18% attended nutrition course	Books on health (58%) Textbooks (26%) Physicians advice (17%) Dietitian/nutritionist advice (2%)	Practices: 60% supervise weight control Supplements: Protein: Recommended by 15% Knowledge: Mean score: 70%	Coaches need nutrition training. Need to incorporate nutrition principles into training.
Parr et al. (1984) US	348 coaches, 179 trainers High school / college (Agreed participation prior to survey distribution: 100%)	Athletics	61% coaches: no formal training 73% trainers: nutrition course	Athletes source: Rank 1: Parents Rank 2: Television, commercials, magazines Rank 3: School Rank 4: Coach Rank 5: Trainer Rank 6: Other athletes	N/A	Coaches need nutrition training. Trainers are better prepared to give advice to the athlete

Bedgood & Tuck (1983) Texas	96 (63%) High school male coaches	Athletics Football Basketball	11% attended nutrition course 64% received nutrition as part of another course	Professional journals, (66%) Magazines/ newspapers (52%) Radio/television (36%) Physician/nurse (41%) Home economics teacher (10%) No source (10%)	<u>Practices:</u> 86% gave advice <u>Knowledge:</u> Mean score: 55%. Range: (28-84%) 15% of coaches scored >70%, considered knowledgeable 50% did not know recommended protein range	Need for nutrition education for coaches
Wolf et al. (1979) United States	137 (74%) coaches of 153 men's and women's teams	Basketball, football, athletics, diving, fencing, field + ice hockey, golf, gymnastics, softball, tennis, volleyball, wrestling	N / A	Magazines, journals, team trainers, physicians, other coaches, players	<u>Practices:</u> 65% prescribed weight loss diets 16% prescribed weight gain diets <u>Supplements:</u> General: Recommended by 35%, half self-dispensed Protein: Recommended by 15% <u>Knowledge:</u> N/A	Need for a greater nutrition knowledge base of coaches.

N/A: Not available

Supplements

A range of 15-60% of coaches in the studies presented in Table 4 recommended the use of supplements to their athletes. In those studies that specify protein as a recommended supplement, Corley et al. (1990), Juzwiak (2004) and Wolf et al. (1979) all reported a similar percentage of coaches recommending them. However, Juzwiak (2004) speculated that this was not reflective of the true rate of supplement recommendation by coaches. There is a general lack of information available on the safety of supplement use in adolescents to advocate their regular usage amongst this age group. Hence, a general caution regarding their usage is often advised. Juzwiak (2004) hypothesised that perhaps coaches, being aware of this fact, may have under-reported recommending supplements to athletes. Spear et al. (2001) reported that double the percentage of coaches (32%) recommended protein supplements to high school athletes. Sports in which supplements were commonly recommended in Wolf et al.'s (1979) study were basketball, cross-country, gymnastics, swimming and track and field. Football had the highest rate of supplementation for protein supplements. Even though the conclusive evidence for supplementation is scarce, coaches still prescribed them to their athletes.

Almost half of Rockwell et al.'s (2001) coaches recommended vitamin and mineral supplements, and 26% recommended creatine monohydrate supplements. In addition 28% of coaches actually provided athletes with creatine monohydrate supplements. In concordance with this rate of supplementation, coaches in this study were knowledgeable about creatine and the types of athletes that would benefit from its supplementation. The popularity of creatine supplementation has been widespread among both elite as well as recreational athletes (Jonnalagadda & Rosenbloom, 2001; LaBotz & Smith, 1999; McGuine et al., 2001; Swirinski et al. 2000). In contrast to coaches being knowledgeable about creatine, they were least knowledgeable about micronutrients, despite 40% of them recommending vitamin and mineral supplements (Rockwell et al., 2001). Almost two thirds of Spear et al.'s (1990) group of high school coaches recommended vitamin/mineral supplements to their athletes, despite 60% of them being unable to correctly identify the composition of an athlete's diet. It is irresponsible practice to recommend supplementation, which can be both expensive and often unnecessary, without having prior knowledge of the athlete's dietary intake. As a large percentage of these coaches did not know the basic dietary recommendations for athletes, it is evident that their recommendation of supplementation was not subsequent to dietary analysis of the athlete. Supplements are often recommended as protection against the effects of a poor diet. Coaches need to be knowledgeable enough to appreciate that supplementation does not compensate for a poor diet and that supplements should not be routinely recommended or prescribed. As the sporting community is presented with a plethora of misinformation regarding supplements, it is necessary to ensure that reliable sources of information about supplements are available to coaches and athletes.

Hydration

The disparity between nutrition knowledge and practice was evident in relation to hydration issues in the study conducted by Juzwiak (2004). While coaches obtained correct responses to most of the hydration questions, they did not recommend fluid in all stages of exercise, and the frequency and volume of fluid intake was not in accordance with guidelines. The reasoning that judo coaches would not allow fluid during exercise was that it broke athletes' concentration and interfered with their discipline (Juzwiak, 2004). While not being able to ascertain the accurate level of knowledge of hydration issues in Corley et al.'s (1990) coaches, their hydration practices were varied. Only one third of all coaches reported that they monitored dehydration among their athletes. Of these coaches, more than half of them displayed good practice by using weight records to monitor hydration status, however, 41% of them used visual observation. Visual observation is not a scientific method to monitor hydration status in athletes. When dehydration can be recognised visually, overt enough for the coach to acknowledge, symptoms would include thirst, flushed skin, apathy, impatience, muscle spasms, headache and dizziness. At this stage, a severe level of dehydration would be depicted, with body weight losses of 4-6% (Hoffman, 2002). Performance would have deteriorated significantly, a situation that should be avoided in all sporting situations.

Weight control

Many coaches monitor weight and encourage or prescribe weight control diets. In one of the earliest studies to identify coaches' practices, many coaches indicated that their preferred approach in determining optimal weight of their athletes was "by appearance" and by "performance in preseason". Use of more objective methods such as skinfold, circumference, and body width measurements were reported by 24% of the coaches in this study. Although many equations for the prediction of body fat measurements did exist in the 1970's, it is only in more recent times that they have been validated in athletic populations (Wolf et al., 1979). Despite this fact, similar findings, of using non-objective methods to assess weight, have also been reported in studies conducted in the 1990's (Corley et al., 1990; Griffin & Harris, 1996). The use of physical assessment alone is inadequate for the decision to embark on a weight loss programme. It carries with it a risk of resulting in underestimates of optimal body weight. It may encourage dangerously low weight loss goals and promote the belief that appearance is the most important goal for the athlete (Griffin & Harris, 1996). Recently, more objective measures have been put in place to measure weight.

One half of Rockwell et al.'s (2001) coaches indicated that they weighed athletes less than once per week, and 11% weighed athletes more frequently than once per week. A further 10% of coaches used body fat measurements on their athletes. To promote changes in body weight and composition, 48% of coaches recommended some form of alteration in diet and exercise, while 15% of coaches instructed athletes to "go on a diet". Despite reasonably high knowledge scores, Juzwiak (2004) reported that one quarter of her coaches recommended deleterious weight control practices.

Nutrition information sources

From the studies reviewed in Table 4 coaches reported obtaining nutrition information from a variety of sources, including both in the form of reading material as well as in the form of personnel. Reading material sources common to the majority of studies included magazines, books, newspapers and journals, while personnel sources included doctors, team trainers, other coaches, players, and in some cases, dietitians. Bedgood & Tuck (1983) reported that 66% of their coaches sourced nutrition information from professional journals. This finding can be contrasted with that reported by Wolf et al. (1979). Despite citing information sources, they reported that reading about nutritional aspects of coaching was a rarity in 69% of their sample of coaches. An outcome of the study was a need to introduce more scientific nutrition information to coaches. Despite the availability of traditional methods of communicating nutrition information, such as journals and magazines, the needs of these coaches were not being adequately met by these traditional means of communication (Wolf, et al., 1979).

Additional information sources to the aforementioned cited in both Rockwell et al.'s (2001) and Bedgood & Tuck's (1983) study were videos, the Internet and television. Bedgood & Tuck (1983) also cited unscientific sources such as "self experience" and "common sense". Graves & colleagues (1991) indicated that manuals containing nutrition information were not identified as being a mechanism by which information was obtained. A manual developed in 1982, which was targeted as a resource for school personnel, was found to be used by only 12% of respondents in a study undertaken by Anderson (1982), as cited in Graves et al. (1991). However, there was no mention of the quality of information in the manual or how the information was presented in the manual.

Doctors and trainers were the most common personnel sources of nutrition information. The use of dietitian/nutritionist services was poor or non-existent in all but one of the studies reviewed. While Corley et al. (1990) reported that 2% of their coaches consulted dietitians for nutrition information, not one coach in Baer et al.'s (1994) study ever consulted with a dietitian or nutritionist. It was assumed that if there was no mention of a dietitian or nutritionist in the studies reviewed, their services or support was not called upon.

Corley et al. (1990) suggested that dietitians might need to be more proactive with the marketing of their services. They proposed that to create an awareness of the benefits of good nutrition practices in sports teams is a challenge because athletes may not view nutrition as an important aspect of their training and performance goals (Corley et al., 1990). It is possible that the awareness has increased recently as evidenced by the improved usage of dietitians noted in more recent studies. For example, 30% of Rockwell et al.'s (2001) coaches and 55% of Sossin, Gizis, Marquart & Sobal's wrestling coaches (1997) used the services of dietitians. It is possible that the increased utilisation of dietitian's service in Sossin et al.'s (1997) study was as a result of three tragic deaths of college wrestlers in 1997. All wrestlers were undertaking a rapid weight-loss regimen that promoted dehydration through perspiration. They died from hyperthermia in an attempt to “make weight” for a competition weigh-in. (American Medical Association, 1998). The consequent alteration of weight management rules in wresting may have prompted coaches and athletes to seek specialist help to ensure that weight loss in wrestlers was achieved safely.

In Rockwell et al.’s (2001) study, a comparison was made between the nutrition sources and personnel that were available to, and used by, coaches. The category of dietitians was the only one, for which utilisation equaled availability, suggesting that coaches and trainers with knowledge of and access to dietitian services were fully making use of their expertise. All other sources were reportedly available to a greater degree than they were used. This may have indicated that despite available resources, they were not sufficient or appropriate, resulting in coaches and trainers actively seeking information from alternate sources.

Nutrition training

An important nutrition practice and knowledge determinant factor to identify in coaches is their level of nutrition training. Despite the vast number of coaches imparting advice to their athletes, as noted by the studies reviewed in Table 4, few were trained in nutrition. Aside from Graves et al.’s (1991) and Bedgood & Tuck’s (1983) sample of coaches, all other studies displayed concurrency in their findings with regard to nutrition training. Less than 50% of coaches in each study had undergone formal nutrition training, one study reporting a low 18% (Corley et al., 1990). Unfortunately little is discussed in these studies regarding the scope of the nutrition training undertaken. Even though a greater sample of coaches in Graves et al.’s (1991) and

Bedgood & Tuck's (1983) studies had undertaken some form of formal nutrition training, their coaches' knowledge scores were still considered poor by the authors.

Reflection on these studies reveals that the majority of coaches disseminate nutrition advice to their athletes, advice that includes the controversial areas of weight control and supplements. It is evident that coaches have not undertaken sufficient nutrition training and may therefore not be equipped with adequate knowledge to guarantee optimal advice being supplied to their athletes. While trainers may be more competent to provide nutrition advice to athletes (Graves et al., 1991; Parr et al., 1984), not all athletes or sports teams have the full-time use of their services. The personnel best equipped to support coaches in either providing them with, or in delivering good quality nutrition information, i.e. dietitians and nutritionists, are not well accessed by coaches. However, the utilisation of their services may be increasing with time. The main outcomes and recommendations put forward by authors of the studies reviewed were all consistent with each other. Authors identified the need for further coach education in the area of nutrition as well as the development of additional appropriate education material by nutrition professionals. A detailed account of the training that coaches in New Zealand may undertake is presented in Appendix 1.

Nutrition knowledge of coaches

Coaches' nutrition knowledge scores in the studies reviewed in Table 4 ranged from 55-70%. Juzwiak (2004), Rockwell et al. (2001) and Corley et al. (1990) reported high mean scores. Corley et al.'s (1990) questionnaire included statements for which the coaches were asked to respond "true" or "false" and to indicate one of three degrees of certainty for each response. Despite high scores obtained, coaches indicated a low level of certainty with responses. Rockwell et al.'s (2001) sample of coaches was small and she acknowledged that despite achieving a greater response rate than in similar studies (Corley et al., 1990; Graves et al., 1991; Juzwiak, 2004), those that responded may have been most interested or knowledgeable about nutrition. It may therefore not have been a representative sample of the intended population group studied. The same can be said of Corley et al.'s (1990) study in which a good sample size but a low response rate was obtained. Despite reasonably high scores, Juzwiak (2004) acknowledged methodological weakness in her study, a low response rate and small sample size, reflecting a very small proportion of coaches in Brazil. The above justification could explain the high scores achieved in these three studies. Knowledge scores reported by Graves et al. (1991) and Bedgood & Tuck (1983) were lower than that reported in the above three studies. Despite this, 86% of Bedgood & Tuck's (1983) coaches regularly dispensed nutrition information and 73% believed themselves to be well prepared to provide nutrition advice.

Many coaches in the studies reviewed responded poorly to some basic nutrition concept questions, such as the identification of the recommended macronutrient composition of athletes' diets. Only a small sample of Corley et al.'s (1990) coaches (20%) correctly identified the recommended distribution of calories from the macronutrients fat, carbohydrate and protein. Spear et al. (1990) reported similar findings. More than three quarters of Juzwiak's (2004) coaches incorrectly held the belief that certain foods, such as pineapple, have special value in weight loss diets as they claim to burn body fat. These beliefs, held by coaches contribute to the enormous body of misinformation that exists in the weight loss industry, as well as to the confusion of athletes regarding the most appropriate means to decrease body fat. While two thirds of Corley et al.'s (1990) coaches reported supervising their athletes' weight control practices, knowledge questions addressing weight control concepts were absent from their knowledge questionnaire. The coaches' understanding of the nutritional principles involved in weight control issues could therefore not be assessed. As a consequence, it was not possible to determine whether or not the nutrition advice that coaches were providing to their athletes regarding weight control was scientifically sound.

The role of protein in athletic performance appears to be a source of confusion for the coaches. This is evidenced by the incorrect belief, held by slightly under half of Juzwiak's (2004) coaches, that protein is the main fuel source for muscles. Authors of similar studies reported comparable findings (Baer et al., 1994; Bedgood & Tuck, 1983; Parr et al., 1984). Bedgood & Tuck (1983) reported that 66% of their coaches believed that energy for short-term athletic events is derived from protein. These coaches also believed (66%) that protein supplementation aids in body mass increases and that for an athlete who has an adequate protein intake, protein supplements offer a nutritional advantage (52%). Pratt & Walberg (1979, as cited in Baer et al., 1994) reported that more than one third of health and physical education teachers who advised athletes on nutrition believed protein to be the primary energy source for muscle. These erroneous beliefs suggest that coaches need a better understanding of nutrition.

Knowledge on hydration concepts produced some mixed results across studies. The majority of Bedgood & Tuck's (1983) coaches responded correctly to three out of the five statements on fluids and hydration, suggesting a good level of knowledge on this topic. However, 77% failed to recognise the fact that thirst is not a good indicator of the need for water, a very basic hydration concept. Only one question on dehydration was asked in Corley's et al.'s (1990) study, yielding a correct response of 89%. This would indicate a good knowledge merely on the concept being asked. A good knowledge on one hydration question does not necessarily represent an overall good knowledge on hydration principles. Further concepts would need to be tested in order to establish an overall good level of knowledge. These studies demonstrate, in general, that coaches are lacking in adequate knowledge to enable them to provide sound nutrition advice to athletes.

Assessing nutrition knowledge

As research into the relationship between diet and health expanded in the early 1900's, the links between diet and diseases, such as cancer and cardiovascular disorders became well documented world-wide. Since then, education has been the main means to attempt to improve health status. The approach adopted has been that the provision of knowledge to people, on appropriate food selection, will result in improved food choices and ultimately, an improvement of diet. There has been much interest from health researchers and practitioners in the measurement of nutrition knowledge as a possible mediator of behaviour (Parmenter & Wardle, 1999). Two trends in nutrition education research have emerged over the past decade. The first one is that a large percentage of Americans have a good grasp on nutrition basics, such as the fact that a high fat and salt intake relate to heart and arterial disease. However, more sophisticated knowledge is required for individuals to correctly interpret this information and to enable them to make wise dietary decisions. A second trend has been an increased interest in social cognitive approaches when attempting to explain dietary behaviour (Sapp & Jensen, 1997). However, research in this area fails to find significant associations between nutritional knowledge and dietary behaviour (Axelson & Brinberg, 1992; Parmenter & Wardle, 1999). If this is in fact true, and knowledge does not improve behaviour, then resources developed to improve nutrition knowledge may be a matter of wasted time, effort and money. An alternative explanation that has been put forward for this inconsistent association between nutrition knowledge and dietary behaviour, is that the assessment of nutrition knowledge is poor.

Nutrition knowledge questionnaires that are poorly designed may not assess knowledge accurately and as a consequence may have little meaning (Parmenter & Wardle, 1999). Both of the emerging trends in nutrition education research (expanding the concept of nutrition knowledge and the increasing attention given to the social cognitive model of nutrition related behaviour) require precise measurements of the reliability and validity of nutrition knowledge (Sapp & Jensen, 1997). The validation of measurement instruments for nutrition knowledge is difficult as no ‘gold-standard’ exists with which instruments can be compared (Steenhuis, Brug, Van Assema, & Imbos, 1996).

Psychometrics

Psychometrics is the science of measuring or scaling psychological attributes and defines a set of criteria for a test that evaluates its validity and reliability. A test is said to be valid if it measures what it sets out to measure. Reliability of a test has two distinct meanings, one referring to the stability over time and the second referring to internal consistency (Kline, 1993). Table 5 presents definitions of psychometric measures of validity and reliability and the statistical test used for each measure.

Table 5. Definitions of psychometric measures of validity and reliability and their statistical tests.

Psychometric measure	Definition	Statistical test
Validity		
Content	Questionnaire developed with expert opinion	N/A
Construct	Questionnaire administered to two or more groups with different training, significantly different scores obtained.	T-test (2 groups) ANOVA (more than 2 groups)
Reliability		
Test-retest	Correlation of scores from a group who are administered the same test twice (stability of test over time).	Pearson's product-moment correlation (r > 0.7)
Internal consistency	Measures the extent to which scale items are highly intercorrelated.	Chronbach's alpha-several possible answers (α > 0.7) Kruder-Richardson formula (KR20)-dichotomous answers (α > 0.7) Spearman's rho

N/A: Not applicable

(Kline, 1993).

For the test-retest reliability measure the time period between test administrations should be long enough for precise answers to be forgotten, and short enough to minimise any real change in the measured attribute. The usual time between administrations of knowledge tests is two weeks (Kline, 1993).

The internal consistency measure is used primarily to assess questionnaires measuring attitudes, beliefs, and opinions, rather than knowledge (Kline, 1993). It would therefore not necessarily be high when measuring a knowledge dimension such as nutrition. Possessing knowledge of one aspect of nutrition does not guarantee knowledge of another. Therefore there is little justification for including internal consistency measures in pure knowledge questionnaires. Because random error is prevalent when any phenomenon is measured, it is difficult to achieve a completely reliable questionnaire.

However, with its construction, it is critical that care be taken to ensure that it is free of systematic error and biases (Sapp & Jensen, 1997).

Psychometrics of existing nutrition knowledge questionnaires

Studies measuring nutrition knowledge typically focus on a particular population, such as children (Anderson, Bell, Adamson, & Moynihan, 2002; Resnicow, Hearn, Delano, Conklin, Orlandi, & Wynder, 1997), adolescents (Hoelscher, Day, Kelder, & Ward, 2003; Johnson, Wardle, & Griffith, 2002; Turconi, Rezzani, Biino, Sartirana, & Roggi, 2003), adults (Parmenter & Wardle, 1999; Sapp & Jensen, 1997; Steenhuis et al., 1996; Towler & Shepherd, 1990), diabetics (Miller & Achterberg, 2000), coaches or trainers (Baer et al., 1994; Bedgood & Tuck, 1983; Corley et al., 1990; Graves et al., 1991; Juzwiak, 2004; Rockwell et al., 2001; Wolf et al., 1979) and athletes (Parr et al., 1984; Rosenbloom et al., 2002; Shoaf et al., 1986). Questionnaires designed in these studies have limited application outside of their field of purpose; a psychometrically sound knowledge questionnaire used with diabetics having little relevance for use with a target group of coaches. Furthermore, investigators involved in the development of nutrition knowledge questionnaires typically have expertise in the area of nutrition and limited, if any, expertise in the area of psychometric issues such as validity and reliability.

Numerous studies have been conducted on developing nutrition knowledge questionnaires for different target groups, with the purpose of validation by reliability and validity measures. Axelson & Brinberg (1992) reviewed articles pertaining to the measurement of nutrition knowledge that appeared in The Journal of Nutrition Education between 1967 and 1991. Out of the 19 studies reviewed, they found that almost one half of them reported reliabilities below 0.7. They concluded that because of the poor measures of validity and reliability in these studies, firm conclusions regarding the relationship between nutrition knowledge and dietary behaviour could not be made.

Tables 6 and 7 summarise the psychometric measures utilised in several of the studies conducted on general nutrition knowledge questionnaires designed for use with adolescents and adults (Table 6) and on sports nutrition knowledge questionnaires for use with athletes and coaches (Table 7).

Table 6. Psychometric measures utilised in general nutrition knowledge studies.

Authors (year)	Target Population	Psychometric Measure
Turconi et al. (2003)	Adolescents	Internal consistency (α = 0.56) Test-retest reliability (r = 0.8)
Steenhuis et al. (1996)	Adults	Test-retest reliability (r = 0.85) Construct validity (significant) Internal consistency (KR20 = 0.68)
McDougall (1998)	Teenagers	Questionnaire developed by author, school teacher and nurse. No measures reported
Sapp & Jensen (1997)	Adults	Internal consistency 1989: KR20 = 0.69, Spearman's rho: 0.66 1990: KR20 = 0.61, Spearman's rho: 0.59 1991: KR20 = 0.58, Spearman's rho: 0.58 Construct validity ($p < 0.1$)
Parmenter & Wardle (1999)	Adults	Content validity Construct validity ($p < 0.001$) Internal consistency (α = 0.7-0.97) Test-retest reliability (r = 0.8-0.97)
Johnson et al. (2002)	Adolescents	Used questions based on Parmenter and Wardle (1999)
Towler & Shephard (1990)	Adults	Construct validity ($p < 0.001$) Internal consistency (KR20 = 0.82)
Anderson, Umapathy, Palumbo & Pearson (1988)	Medical in-patients	Questionnaire developed by authors. No measures reported

Table 7. Psychometric measures utilised in sports nutrition knowledge studies.

Authors (year)	Target Population	Psychometric Measure
Juzwiak (2004)	Coaches	Questionnaire used based on others (Corley et al., 1990; Graves et al., 1991; Sapp & Jensen, 1997).
Rosenbloom et al. (2002)	Collegiate athletes	No measures reported
Rockwell et al. (2001)	Athletic coaches / trainers	Content validity Used questions based on others (Bedgood & Tuck, 1983; Corley et al., 1990; Graves et al., 1991; Wolf et al., 1979).
Baer et al. (1994)	High school football coaches	No measures reported
Graves et al. (1991)	High school coaches and trainers	Content validity
Corley et al. (1990)	College coaches	Content validity Internal consistency ($\alpha = 0.56$)
Parr et al. (1984)	High school and college athletes	No measures reported
Bedgood & Tuck (1983)	High school athletic coaches	Content validity Test-retest reliability ($r = 0.65$)
Wolf et al. (1979)	University coaches	No measures reported

Studies reviewed have revealed that some knowledge questionnaires have been subjected to a comprehensive set of psychometric tests while others have either not been validated at all or have been exposed to limited psychometric analysis. When comparing the studies in Tables 6 and 7, it is evident that nutrition knowledge questionnaires utilised with athletes, trainers and coaches had undergone less psychometric evaluation than those utilised with adolescents and adults. Questionnaires used for sports related target groups are often based on those used in previous studies with similar groups (Juzwiak, 2004; Rockwell et al., 2001). However, the questionnaires used in previous studies had not been subjected to a full set of psychometric criteria. Other studies have reported using questionnaires developed by their authors, however no mention of how items were generated was supplied in these studies and psychometric analysis of questionnaires was absent (Baer et al., 1994; Parr et al., 1984; Rosenbloom et al., 2002; Wolf et al., 1979).

Of all the studies reviewed and presented in Tables 6 and 7, the questionnaire that underwent the most comprehensive set of psychometric tests was that of Parmenter & Wardle (1999). The main aim of their study was to develop a psychometrically reliable and valid questionnaire addressing all aspects of general nutrition knowledge, which could then be used in the future to assess the relationship between nutrition knowledge and dietary behaviour in adults. Content validity was assured by the implementation of two reviews of the questionnaire. They were carried out by a panel of four psychologists and four dietitians to select the best nutrition items from a pool, in terms of question clarity, interpretability and accuracy of the nutrition information being used in the knowledge questionnaire.

Questionnaires were distributed to a range of 900 employees, 43% of them were completed and returned. Results were analysed both qualitatively and quantitatively for question difficulty, item discrimination, internal consistency and respondents' comments. To test construct validity and internal consistency, the questionnaire was then distributed to two groups (dietetic students and computer science students). The questionnaire was administered on two occasions to assess test-retest reliability, allowing for a 2-week time frame between the first and second distributions. Significant differences between the dietetic and computer science scores indicated that the questionnaire had an acceptable level of construct validity. The overall reliability of the questionnaire was high (i.e. test-retest reliability and internal consistency). A few questions, which lacked consistency with the rest of the questionnaire, were retained for the sake of content validity, however the internal reliability remained high. It was concluded that as a result of the rigorous process undertaken to ensure good validity and reliability, this questionnaire was a useful tool in providing a clearer understanding between nutrition knowledge and behaviour in an adult population (Parmenter & Wardle, 1999).

Johnson et al. (2002) developed a questionnaire measuring healthy eating behaviour for use with adolescents. Each component was exposed to a series of psychometric tests to determine its validity and reliability, however the nutrition knowledge section was adapted from that developed by Parmenter & Wardle (1999), who had already deemed it a psychometrically sound knowledge questionnaire.

The authors that subjected their questionnaires to test-retest reliability analysis (Parmenter & Wardle, 1999; Shoaf et al., 1986; Steenhuis et al., 1996; Turconi et al. 2003) all reported favorable Pearson correlation coefficients (ranging from 0.8-0.97) indicating that these questionnaires were all stable over time. One exception was that of Bedgood & Tuck (1983) who reported a lower, and below optimal, correlation ($r = 0.65$) for their test-retest reliability.

Internal consistency was measured in the majority of the studies presented in Table 6, and in only two of the studies presented in Table 7. Results obtained for this measure ranged both above and below the acceptable internal consistency standard of 0.7 (Kline, 1993). The questionnaires of Parmenter & Wardle (1999) and Towler & Shepherd (1990) achieved good internal consistency. Turconi et al. (2003) explained their low internal consistency by the items' variability. Authors reported that items in this section covered all aspects of nutrition knowledge, and were therefore heterogeneous in nature.

This may have lead to the low Cronbach's coefficient obtained. Corley et al.'s (1990) questionnaire also yielded a low Chronbach alpha (0.56), indicating poor internal consistency. This was justified by a small sample size used in the pilot study (22 participants) as well as the large number of "not sure" responses obtained. Sapp & Jensen (1997) used the internal consistency measure, Spearman's rho in addition to the KR20 measure. However, values obtained for all three tests were below the recommended 0.7 for a test to be considered sufficiently reliable. The addition of a "don't know" category to the responses as well as the removal of weaker items from the questionnaire did not increase any of the reliability measures. In spite of an internal consistency measure being utilised in many studies investigating nutrition knowledge, it would not be expected to be high when measuring a knowledge dimension. This psychometric measure is used primarily to assess the internal consistency of questionnaires measuring attitudes and opinions, rather than knowledge (Kline, 1993). A good knowledge about one aspect of nutrition would not necessarily guarantee a good knowledge about another aspect of nutrition. Therefore there is little justification for including internal consistency measures in pure knowledge questionnaires. This could be a likely explanation for the low internal reliabilities reported in four out of the six knowledge questionnaires, on which internal reliabilities were measured (Turconi, et al., 2003; Steenhuis et al., 1996; Sapp & Jensen, 1997; Corley et al., 1991).

The measure of construct validity was performed in half of the studies reviewed in Table 6, yielding significant results in all four studies. This measure was absent from all studies reviewed in Table 7.

In addition to construct validity and test-retest reliability, Steenhuis et al. (1996) used Item Response Theory to assess measurement properties of their questionnaire, a method not used in similar studies in evaluating nutrition knowledge measurement questionnaires. The Rasch model was used to test for uni-dimensionality of knowledge and fitted the data, indicating good measurement properties of the questionnaire, after two items were removed. However it was decided that due to the importance of these two items in measuring a change in knowledge about that specific subject, the questions remained in the questionnaire.

In Parr and colleague's (1984) questionnaire, the questions used to assess the athletes' knowledge were very broad and centered around whether the athletes were "not familiar", "somewhat familiar" or "very familiar" with the basic nutrition concepts of the four food groups, food exchange lists and dietary goals. The results indicated that 68% of the athletes were very familiar with the food groups. Despite this high percentage, the athletes were not required to complete any questions testing this knowledge. While merely stating familiarity with food groups, without this acclaimed knowledge being assessed, the athletes' true knowledge remains unknown. No information in their literature regarding the use of a validated questionnaire or questions used from a previous validated questionnaire was provided (Parr et al., 1984).

A psychometric evaluation of the studies reviewed reveals that the majority of the questionnaires have not been assessed using the full range of psychometric tests. While few of the questionnaires used with coaches, trainers or athletes had undergone some psychometric analysis, none of them had undergone a rigorous enough analysis to be considered sufficiently reliable and valid for use in measuring a true sports nutrition knowledge dimension. Without these statistical measures, it is not known how valid and reliable these questionnaires were in measuring sports nutrition knowledge.

Questionnaire development

When existing questionnaires have not been deemed adequately valid and reliable in measuring knowledge, researchers need to develop their own. When embarking on questionnaire development, it is first necessary to define the scope of measure, i.e., which areas of nutrition knowledge are to be assessed. “Knowledge” and “belief” are two constructs that are often confused, and it is important to distinguish between them. A distinction between them can be made as follows: Knowledge can be conceptualised as factually true, with knowledge questions judged as either correct or incorrect, while beliefs may not be factually true. Knowledge is usually assessed by means of multiple choice or dichotomous items (Parmenter & Wardle, 2000). Beliefs are often measured using a scale ranging from strongly agree to strongly disagree (Shephard & Towler, 1992).

When generating an item pool, questionnaire developers should be clear as to which areas of nutrition they have chosen to include in their questionnaire and why they have selected those areas. The material chosen needs to be a fair representation of the area under study, and the target population for whom the questionnaire is being developed needs to be constantly kept in mind. Extensive literature review, and relevant publications or leaflets aimed at the target population should be used to guide this process. The development of nutrition knowledge questions can often present a challenge as precise dietary recommendations may vary between organisations. When constructing true/false questions, the alternate-choice items need to be classified without doubt. Multiple-choice questions need to assure one correct response along with credible distracter items (Parmenter & Wardle, 2000).

Common problems in nutrition knowledge measurement, which may risk inaccurate knowledge assessment, include ambiguous wording, poor interpretability, inadequate control of guessing, poor instructions and unclear format. Interpretability can be a problem for measure in general. An example of a poorly worded question would be: “Semi-skimmed milk contains very little fat”. The answer to this statement would depend on the respondents’ interpretation of “very little”. Ambiguity may arise if the questionnaire contains an item regarding “beans”. Beans may refer to baked beans, green beans, broad beans as well as a number of other varieties, many of which have different nutritional components from each other. In order to reduce ambiguity, it is therefore important to specify foods and provide examples where necessary. For example if a question refers to “oily fish” an accompanying example of an oily fish would be wise (e.g. salmon) (Parmenter & Wardle, 2000). In Parmenter & Wardle’s (1999) questionnaire, it was concluded that respondents did not answer a question concerning rice because it was not stipulated whether it was white or brown, even though it made no difference to the answer.

Guessing is common when items are answered on questionnaires. In constructing a questionnaire, a “don’t know” or “not sure” category may be included in the response choices to discourage guessing. This option may have some pitfalls in that respondents may select the “not sure” option if they think they know the correct response, however are not confident about their answer. Respondents who could work out the answer with a little thought may also select the “not sure” option as an easier option. The wording of “not sure” as opposed to “don’t know” may appear less negative and also help to reduce guessing (Parmenter & Wardle, 2000).

An important matter to consider when designing a questionnaire is the reason for measuring nutrition knowledge, which is often to establish the relationship between knowledge and dietary behaviour. It is therefore vital to check that questions included are relevant to dietary behaviour. The development of a new questionnaire is extremely time consuming. However, once its reliability and validity is assured, through psychometric analysis, results obtained in studies using the questionnaire will be meaningful and perhaps be able to assist in clarifying the relationship between nutrition knowledge and behaviour (Parmenter & Wardle, 2000).

Conclusion

The literature reviewed has provided an overview of the dietary status of athletes belonging to the football code, as well as an indication of the nutrition knowledge level of athletes and the coaches who provide the athletes with nutrition information. Dietary intake literature indicates that football players as a group consume an imbalance of energy sources and inappropriately utilise dietary supplements. Evidence exists to suggest that both athletes and coaches are not particularly knowledgeable about sports nutrition issues. However critiquing the available literature has identified the absence of a suitable, up-to-date, and adequately psychometrically assessed nutrition knowledge questionnaire for use in research to obtain a true measure of nutrition knowledge. It is for this reason that a previous nutrition knowledge questionnaire was not used in this study to measure the nutrition knowledge of the population of coaches. Before an assumption about athletes’ and coaches’ knowledge can be put forward, and subsequent research can be conducted on the relationship between knowledge and behaviour, a true indication of their level of knowledge needs to be investigated.

To further explore the relationship between nutrition and exercise, we need to develop an understanding of factors that influence athletes' knowledge and food selection. Coaches have regular contact with, and significant influence over athletes and sports teams, however evidence suggests that in general, they are not adequately trained in nutrition and are therefore not equipped to provide sound nutrition advice to athletes. There is a need to advance coaches' level of knowledge in the area of nutrition, as well as to utilise more extensively the specialist services of sports dietitians and nutritionists in the sporting environment. Following this, the effectiveness of these strategies can be measured on athletes' knowledge, food selection and ultimately, sports performance.

CHAPTER 3: DEVELOPMENT OF A SPORTS NUTRITION KNOWLEDGE QUESTIONNAIRE.

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Prelude

The present range of sports nutrition knowledge questionnaires has inadequate psychometric validation, and few are up to date in a rapidly changing discipline. The purpose of this study was to design a sports nutrition questionnaire that satisfied acceptable psychometric criteria of validity (content and construct) and reliability (test-retest). The questionnaire was designed by an expert panel of six sports dietitians and distributed to five groups, selected for their expected variation in sports nutrition knowledge. Dietitians, university business staff, and nutrition students received questionnaires via e-mail. The response rates obtained were 34.4% (n = 33), 21.3% (n = 49), and 72.0% (n = 18), respectively. University business and fitness students completed questionnaires during class time. Response rates were 76.6% (n = 23) and 81.6% (n = 49), respectively. The questionnaire was administered a second time to the business staff and the dietitians to assess test-retest reliability. Two methods were used: 1. Pearson's product-moment correlation, and 2. A percentage calculation of questions answered in an identical manner on both test occasions. Reliability was acceptable with Method 1 yielding acceptable values (r = 0.74-0.93), aside from the fluid sub-category (r = 0.52). Method 2 showed good test-retest concordance with 81.2% duplication of responses of all questions. Construct validity was high as indicated by significant mean knowledge score differences between the groups (p = 0.0001). Dietitians and nutrition students achieved significantly greater mean scores than the remaining groups. The

findings of this study indicate that the questionnaire is suitably valid and reliable to be used in research and practice to determine sports nutrition knowledge.

Introduction

The exploration of sports nutrition as a science has established the relationship between optimal nutrition practices and peak sporting performance. As new research emerges and dietary concepts change, knowledge of nutrition specialists is enhanced (Burke & Deakin, 2000). There has been much interest from health researchers and practitioners in the measurement of nutrition knowledge as a possible mediator of nutrition-related behaviour. Studies investigating this relationship reveal inconsistent results and it is unclear whether or not there is an association, and if there is, how strong this association is (Axelson & Brinberg, 1992; Kristal, Bowen, Curry, Shattack, & Henry, 1990; Steenhuis et al., 1996). The inconsistencies in these findings may be attributed to a number of different causes. One explanation is that the questionnaires used to measure nutrition knowledge have lacked adequate measures of validity and reliability. Poorly designed nutrition knowledge questionnaires may not assess nutrition knowledge accurately and as a consequence results obtained from studies using these questionnaires may have limited efficacy (Parmenter & Wardle, 1999; Steenhuis et al. 1996).

Psychometrics

To verify an optimal dimension of nutrition knowledge, precise measurements of the reliability and validity of the questionnaire are required (Parmenter & Wardle, 1999). Psychometrics, the science of measuring psychological attributes, defines a set of criteria for a test that evaluates its validity and reliability. A test is said to be valid if it measures what it sets out to measure. If questions in a test are developed with input from a group of experts in that field of interest, then content validity is being measured. The measure of construct validity involves obtaining significantly different scores on a test administered to groups with different specialist trainings, one on the topic being measured (Kline, 1993). Reliability of a test has two distinct meanings, one referring to its stability over time and the second referring to internal consistency. Stability over time, or test-retest reliability, is measured by correlating scores from a group of subjects who are administered the same test twice. Internal consistency measures the extent to which questions making up a questionnaire are intercorrelated. Internal consistency would not necessarily be high when measuring a knowledge dimension such as nutrition. This psychometric measure is used primarily to assess questionnaires measuring attitudes, beliefs, and opinions, rather than knowledge (Kline, 1993). Possessing knowledge of one aspect of nutrition does not guarantee knowledge of another. For example an individual may know the quantity of fluid required during exercise, but may not know what type of fluid is optimal. Therefore there is little justification for including internal consistency measures in pure knowledge questionnaires.

In order to characterise the sports nutrition knowledge of individuals, a prerequisite is the availability of a valid and reliable questionnaire (Towler & Shephard, 1990). A review of studies measuring sports nutrition knowledge reveals limitations in the questionnaires in one or more of the psychometric areas discussed above. Table 8 summarises several of these studies.

Table 8. Nutrition knowledge studies conducted with sports coaches, trainers or athletes.

Authors (year)	Population Sample (response rate)	Sport	Psychometric Measure
Rosenbloom et al. (2002)	328 Division I NCAA athletes (100%)	Football, track and field, baseball, swimming, basketball, tennis, golf, softball, volleyball	Content validity
Juzwiak (2004)	55 coaches (N/A)	Gymnastics, tennis, swimming, judo	Content validity
Rockwell et al. (2001)	35 coaches, 18 trainers Division 1 University (57%)	Basketball, football, volleyball, athletics, swimming, diving, soccer, baseball, golf, softball, tennis	Content validity
Corley et al. (1990)	106 college coaches (36%)	Athletics, swimming, tennis, basketball, gymnastics, golf, football, wrestling	Content validity Internal consistency (α = 0.56)
Parr et al. (1984)	348 high school and college coaches, 179 trainers, 2977 athletes (N/A)	Athletics	No measures reported
Bedgood & Tuck (1983)	96 high school male athletic coaches (63%)	Athletics, football, basketball	Content validity Test-retest reliability (r = 0.65)
Wolf et al. (1979)	137 university coaches (74%)	Basketball, football, athletics, diving, fencing, field and ice hockey, golf, gymnastics, softball, tennis, volleyball, wrestling	No measures reported

N/A: Not available

The majority of questionnaires have not been assessed using the full range of psychometric tests. Numerous authors based theirs on questions used from previous questionnaires, many of which are inadequately validated (Corley et al., 1990; Juzwiak, 2004; Rockwell et al., 2001). In contrast, Bedgood & Tuck (1983), and Rosenbloom et al.'s (2002) questionnaires were developed by a panel of sports nutrition experts. However, Rosenbloom et al. (2002) do no further testing with their questionnaire. Beyond content validity, other psychometric measures assessed were internal consistency and test-retest reliability, however it is questionable what value the internal consistency measure was for a pure knowledge questionnaire (Corley et al., 1990). Two of the studies reviewed do not supply any information in their research papers as to how their questionnaires were generated (Parr et al., 1984; Wolf et al., 1979). Without these statistics it is not known how valid and reliable their questionnaires were in measuring the sports nutrition knowledge of their target group.

The literature clearly shows that there is no well-validated and up-to-date sports nutrition knowledge assessment tool. Therefore, a questionnaire with demonstrated validity and reliability is needed in the area of sports nutrition. The present study describes the development and subsequent validation of such an instrument.

Methods

Sports nutrition knowledge questionnaire

A questionnaire was developed which centered on nutrition concepts as they related to sports performance (See Appendix 2). It was developed alongside an expert panel of six practising sports dietitians in New Zealand, employed in an academic as well as a consultancy environment, in order to optimise content validity. Sports nutrition guidelines used in the development of the questionnaire were those developed and adopted by Sports Dietitians Australia (Burke & Deakin, 2000), the Australian national body of sports dietitians, with which New Zealand sports dietitians are affiliated. The first draft was administered to ten employees from an academic institution, outside of the nutrition discipline, as well as ten hockey coaches (one of the many possible intended target groups of the final questionnaire). Respondents were asked to complete the questionnaire, judging it on content difficulty as well as assessing whether the food products used in the questions were all easily recognisable. They were also asked to appraise it for question clarity and comprehension. Respondents' comments were communicated to the authors both verbally and in writing, and alterations were made accordingly. A number of questions were reworded to enhance their clarity and two food products were altered and replaced with similar suggested alternatives.

The final questionnaire comprised five main knowledge sub-categories: General nutrition concepts (46 questions), which comprised questions pertaining to macronutrients and micronutrients, recovery (7 questions), fluid (5 questions), weight control (15 questions) and supplements (11 questions). A number of reasons are proposed to justify the selection of these sub-categories. Firstly, sports nutrition literature served as a basis for sub-category and question selection. Facts and misconceptions frequently held in the sports nutrition industry were incorporated into questions (Burke & Deakin, 2000; Nieman, 1999). Secondly, the extensive experience of the panel of consulting sports dietitians provided a basis for criteria selection. The group determined these sub-categories as being the most relevant to sports nutrition. The final reason for their selection is due to analogous sub-categories being used in questionnaires of similar studies (Bedgood & Tuck, 1983; Corley et al., 1990; Rockwell et al., 2001). The majority of the 84 questions could be answered "yes", "no" or "unsure". Scores were coded as +1 for a correct answer, and 0 if participants selected the incorrect answer or the "unsure" response.

Participants

A total of 441 sports nutrition knowledge questionnaires were distributed to five population groups, which were selected for this study on the basis of their expected variation in sports nutrition knowledge. The population of business staff members at a university was selected and received their questionnaires via e-mail (n = 230). This method of distribution was utilised due to the author having access to an existing electronic database of their e-mail addresses. Convenience sampling allowed selection of one university class each of business students (n = 30) and fitness students (n = 60). These two groups received questionnaires during class time due to the convenience and efficiency in time of the procedure. The final two groups included 96 dietitians, randomly selected from a database belonging to a national body of dietitians, and 25 university nutrition students. Both of these groups received their questionnaires via e-mail, due to the author having access to their e-mail addresses. The Auckland University of Technology ethics committee granted approval for the conduct of this research.

Validity

Content validity. Content validity was assured by the initial collaboration of the expert panel of sports dietitians. The reviewer group of academics and hockey coaches further assured content validity by providing both verbal and written feedback on the comprehension and clarity of the questions.

Construct validity. A comparison of the mean knowledge total score and sub-category scores between the five population groups assessed the construct validity of the questionnaire. This was achieved by performing analysis of variance for a between groups comparison, using SPSS version 12.0.1 for Windows (Release: 11 November 2003) statistical computer package. The level of significance used for this measure was $p < 0.0001$.

Reliability

Test-retest reliability. For the purpose of this measure, the questionnaires were distributed a second time to the respondents of two of the e-mailed groups (i.e., business staff and registered dietitians) who had returned their first questionnaire. A total of 49 questionnaires were sent to the business staff and 33 to the registered dietitians. The reason that these two groups were used for the test-retest procedure was due to convenience of the author possessing their e-mail addresses. The timeframe of two weeks between the two questionnaire administrations was chosen due to it being recommended in psychometric literature as being the optimal time period; long enough for precise answers to be forgotten, and short enough to minimise any real change in the measured attribute (Kline, 1993). This measure of reliability was used to ensure that the responses to the questions were consistent over time. Two measures were used to assess test-retest reliability. Pearson's product-moment correlation was calculated for the first and second mean total and sub-category nutrition knowledge scores. The more similar the results, the higher the correlation coefficient and the more reliable the test is over time. A minimal acceptable correlation coefficient that indicates a reliable test is greater than 0.7 (Kline, 1993).

The second measure of test-retest reliability allowed participants' score for each question to be compared with their second score for that same question. As well as being interested in the reliability of the total sub-category score, interest lies in the reliability of each question. Although the traditional test-retest reliability technique assumes that there is no substantial change in the construct being measured on distinct occasions, a more accurate measure is to identify the change in each question. If a high correlation is achieved between mean scores on two occasions, but on the second occasion, subjects chose different answers for the questions, yet still achieved the same mean score, a falsely high correlation is the outcome. This second method provides a more robust measure of reliability than the mean score reliability (Pearson's product-moment correlation). For this measure, scores were coded as +1 for a correct answer, –1 for an incorrect answer, and 0 if participants selected the "unsure" category.

Results

A breakdown of the response rates and gender differences between groups can be viewed in Table 9. The overall sample comprised more female participants (n = 109) than males (n = 63), and was particularly gender biased in the dietitian and nutrition student groups.

Validity

Construct validity. Mean total and sub-category scores are presented in Table 9. The maximum possible scores for all questions and for each sub-category are listed at the bottom of the table. All the differences in mean knowledge scores between the populations were statistically significant (p = 0.0001), with the dietitians and nutrition students scoring consistently higher scores than the remaining groups for each category. The mean score differences between the dietitians and the nutrition students were not significantly different from each other. The business students consistently achieved the lowest scores compared with all other groups. Scores were significantly lower for the total mean score and for the sub-categories, general nutrition, fluid, and weight control (p = 0.0001).

Table 9. Response rates and mean nutrition knowledge scores by population group (CI: Confidence interval).

Population Group (n) Male (n), female (n)	Response Rate (%)	Mean Total Score CI (95%)	Mean General nutrition Score CI (95%)	Mean Fluid Score CI (95%)	Mean Weight Control Score CI (95%)	Mean Supplement Score CI (95%)	Mean Recovery Score CI (95%)
Business staff (49) Male: 15; female: 34	21.3	51.7 49.7-53.7	33.9 32.5-35.2	2.4 2.0-2.7	8.7 8.1-9.4	2.9 2.3-3.4	3.8 3.4-4.2
Dietitians (33) Male: 2; female: 31	34.4	74.6* 72.6-76.5	43.9* 43.2-44.6	3.2* 2.8-3.7	13.6* 13.0-14.1	7.7* 6.9-8.6	6.2* 5.8-6.5
Business students (23) Male: 15; female: 8	76.6	37.9** 33.0-42.7	24.8** 21.8-27.8	1.2** 0.3-2.1	6.5** 5.3-7.7	2.7 1.8-3.6	3.3 2.5-4.1
Nutrition students (18) Male: 3; female: 15	72.0	71.6* 68.0-75.1	41.9* 40.3-43.5	4.0* 3.7-4.3	12.1* 11.2-13.0	7.4* 6.0-8.9	6.1* 5.5-6.7
Fitness students (49) Male: 28; female: 21	81.6	49.7 47.0-52.4	30.2 28.7-31.7	2.2 1.9-2.5	8.3 7.5-9.2	4.7 4.3-5.3	4.2 3.9-4.4

Each question was scored as follows: Correct response: +1; Incorrect response: 0; Unsure response: 0.

Total score. Maximum: 84
General nutrition score. Maximum: 46
Fluid score. Maximum: 5
Weight control score. Maximum: 15
Supplement score. Maximum: 11
Recovery score. Maximum: 7

* Statistically significantly greater mean scores than the non-nutrition groups. (p = 0.0001)
Not significantly different scores between two nutrition groups.

** Statistically lower mean scores than all the other groups. (p = 0.0001)

Reliability

Test-retest reliability. Thirty-four of the 49 business staff members and 28 of the 33 registered dietitians completed the questionnaires twice, yielding a response rate of 69.4% and 84.8%, respectively. The results of reliability for all questions and for each sub-category using the two methods discussed are presented in Table 10.

Table 10. Test-retest reliability, using two methods: Pearson's product-moment correlation and percentage of identical responses on both test occasions (n = 62).

Nutrition knowledge section	* Pearson's product-moment correlation	** Identical responses supplied on both test occasions by both groups (%)	Identical responses supplied on both test occasions by dietitians (%)	Identical responses supplied on both test occasions by business staff (%)
General nutrition	0.87	89.6	95.9	81.2
Weight control	0.85	81.4	92.6	74.3
Recovery	0.74	82.5	91.8	77.1
Fluid	0.52	74.8	85.0	68.5
Supplements	0.89	70.0	79.5	70.0
Total score	0.93	81.2	90.3	73.7

Each question was scored as follows: Correct response: +1; Incorrect response: -1; Unsure response: 0.

Total number of questions: 84
Number of general nutrition questions: 46
Number of fluid questions: 5
Number of weight control questions: 15
Number of supplement questions: 11
Number of recovery questions: 7

* Test-retest reliability for the total mean score and mean sub-category scores on both test occasions were calculated using a reliability spreadsheet (Hopkins, 2000).

** First and second response comparisons for each item in each sub-category were calculated using a Microsoft Excel 2000 formula devised by the authors.

Using Pearson's product-moment correlation, the test-retest reliability for each sub-category (aside from the "fluid" sub-category) was acceptable. Correlation coefficients ranged from 0.74-0.89, indicating that for these sub-categories, an acceptable temporal stability was achieved. The second method of test-retest reliability compared responses on both test occasions by both groups as well as by individual groups. For both groups, between 74.8 and 89.6% of questions across the sub-categories were answered in an identical manner on both test occasions. Dietitians consistently supplied more of the same responses than the business staff group.

Discussion

This study represents a more comprehensive assessment of a sports nutrition knowledge questionnaire than has been previously achieved. The criterion for construct validity was fulfilled as seen by the significantly greater scores of the dietitians and nutrition students (both groups either working in or studying the topic of nutrition) than those of the remaining groups. For each of the sub-categories aside from “fluid”, the dietitians achieved the highest total mean score, followed by the nutrition students. In the “fluid” sub-category, the nutrition students achieved the highest mean score, followed by the dietitians. A possible explanation for this may be that the nutrition students may have been presented with the most up-to-date sports nutrition information in their current studies, while some of the dietitians may not specialise in sports nutrition. Post-hoc tests revealed that despite slightly different mean scores between the registered dietitians and the nutrition students for each sub-category, none of these differences were significant. The business students consistently achieved the lowest mean scores than all the other groups. A possible explanation for this result could be that these students focused exclusively on business related aspects in their training, which leaves little time to upskill themselves on a non-business related topic. Business staff may have more time to pursue interests in other fields, i.e. nutrition. It was expected that the fitness students achieved greater scores than the business students as they receive a small amount of sports nutrition training in their study. The greater scores can also be explained by the fact that students completing a fitness course as opposed to a business orientated course would naturally be more interested in the fitness genera, of which nutrition plays an enormous part. Background reading on nutrition issues outside what is taught in formal training is common. A possible explanation for the reason the fitness students did not score as well as the nutrition students may be due to the plethora of nutrition misinformation in the media and in the fitness industry.

The acceptable measure of construct validity in the study indicated that the questionnaire measured what it set out to measure, namely sports nutrition knowledge. The psychometric test of construct validity was not assessed in any of the studies presented in Table 8. However the finding from this study is consistent with those identified in numerous non-sports nutrition knowledge specific studies whose authors have subjected their questionnaires to construct validity testing (Parmenter & Wardle, 1999; Steenhuis et al., 1986; Towler & Shephard, 1990).

The test-retest reliability of the questionnaire indicated, that for four out of the five knowledge sub-categories, Pearson's correlation coefficients greater than 0.7 were obtained, indicating acceptable temporal stability. The range of correlations obtained is greater than that obtained by Bedgood & Tuck (1983) and is comparable to those reported in similar non-sports nutrition specific studies. Turconi et al. (2003), Parmenter & Wardle (1999), and Steenhuis et al. (1996) assessed test-retest reliabilities of their nutrition knowledge questionnaires and reported Pearson's correlation coefficients of 0.80, 0.98, and 0.85 respectively. An important factor in the test-retest procedure is the time interval between the administrations of the two tests. A short time interval can lead to an overestimation of the questionnaire's reliability. Bedgood & Tuck (1983) do not report the timeframe used in their study, however Turconi et al. (2003) used a one-week time period between test administrations, which could have influenced their high test retest reliability result ($r = 0.8$).

Using the second method of test-retest reliability, temporal stability of each question was assessed. The high percentage of questions that were identical on both test occasions confirmed an acceptable overall reliability of the questionnaire. The fluid questions failed to demonstrate acceptable reliability using Pearson's product-moment correlation, however acceptable reliability was achieved using this more accurate method of reliability testing. The dietitians were more consistent than the business staff in supplying identical responses on both test occasions. All participants were informed that they were taking the test a second time. During the two weeks in between test occasions, participants may have been curious about items that they did not know and sought out the correct answers. Due to the business staff being less familiar with the subject area, they may have sought correct answers to a greater degree than the dietitians. If this was the case, this could have altered their second score and explain the lower percentage of questions answered identically on the two test occasions. Results indicate that for each sub-category, scores did in fact increase on the second test occasion for the business staff, possibly confirming this notion. According to the author’s knowledge, this measure of test-retest reliability has not been conducted in similar studies.

Each sub-category in this questionnaire has demonstrated acceptable measures of validity and reliability. The fluid questions failed to demonstrate acceptable reliability in one of the methods used, and future researchers may choose to undertake further validation with these questions. Despite this, the overall questionnaire is deemed suitably reliable and valid for use in measuring sports nutrition knowledge.

There are a number of limitations that exist regarding this study and are acknowledged by the authors. It is recognised that the participants who received their questionnaire via e-mail (i.e. the business staff group, the dietitians and the sample of nutrition students) could have had assistance with their responses. This could possibly have altered their responses in a positive manner and given these participants an unfair advantage in choosing the correct responses over the remaining groups. Further research of this nature should ensure that the manner in which questionnaires are distributed is the same for each group.

The food products and brands used in this questionnaire are specific to New Zealand. This may be a limitation with respect to its use by researchers in countries other than New Zealand. However this can simply be resolved by the substitution of New Zealand products with similar ones specific to that country in which the questionnaire is being used. Finally, test-retest reliability measures of the questionnaire could exist as a result of the learning effect. The only way to prevent this is to urge participants not to seek correct answers in the time between the first and second administrations of the questionnaire.

Conclusion

The findings of this study indicate that this questionnaire would be suitably reliable and valid for use in assessing sports nutrition knowledge. This research is important in that it presents the first current sports nutrition knowledge questionnaire that has acceptable psychometric criteria of validity and reliability. It is anticipated that it be used by researchers and practitioners to investigate sports nutrition knowledge in their intended population group. The research may also make an important contribution to the progress towards understanding the relationship between sports nutrition knowledge and related behaviour. Should these behavioural practices be researched in the future, this questionnaire may be used as an initial step in establishing a true measure of knowledge. Further investigation may then proceed in order to ascertain a true linkage between these two paradigms.

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CHAPTER 4: EVALUATION OF SPORTS NUTRITION KNOWLEDGE OF NEW ZEALAND PREMIER CLUB RUGBY COACHES.

Submission pending first paper acceptance.

Prelude

Little is known about if and how team coaches disseminate nutrition information to players. In this study we investigated whether or not rugby coaches imparted nutrition advice to their players, their level of nutrition knowledge, and the factors determining this level of knowledge. In a census survey, New Zealand premier rugby coaches ($n = 168$), completed a psychometrically validated questionnaire, received by Internet, or standard mail if no Internet access (response rate 46%). The majority of coaches provided nutrition advice to their players (83.8%). Coaches responded correctly to 55.6% of all knowledge questions. An independent T-test showed that coaches who imparted nutrition advice obtained a significantly greater score, 56.8%, than those who did not impart advice, 48.4% ($p = 0.008$). Using one-way ANOVA, significant relationships were identified between total knowledge score of all coaches and qualifications [$F(1,166) = 5.28$, $p = 0.0001$], own knowledge rating [$F(3,164) = 6.88$, $p = 0.0001$] and nutrition training [$F(1,166) = 9.83$, $p = 0.002$] and whether or not they provided nutrition advice [$F(1,166) = 8.76$, $p = 0.004$]. Given the low levels of nutrition knowledge, but a willingness to disseminate knowledge, we conclude that these rugby coaches were inadequately prepared to impart nutrition advice to athletes and could benefit from further nutrition training.

Key words***:*** sports nutrition, knowledge, coaches, rugby

Introduction

As the science of sports nutrition has evolved, the target audience has extended beyond the elite athlete, and now reaches many levels of athletes interested in achieving optimal sports performance. Qualified nutrition professionals have become very much an integral part of the sports science team at many levels (Wolinsky, 1998). However, often because of limited resources such as funding, geographical separation, and perhaps a lack of knowledge of the value of sports science services, many sports teams and organisations do not access sports science, including nutrition services. This may be true of the New Zealand club rugby team environment. Coaches most often assume a volunteer position, with few additional resources such as trainers involved with teams. The coach, being the central team member, and having regular contact with athletes, often takes responsibility for advising on nutrition practices (Juzwiak, 2004). They might prescribe meals, diet regimes, supplements, and often expect weight gain/loss from their athletes (Wolinsky, 1998). There is relatively little published data regarding the nutrition knowledge of coaches and type/adequacy of nutrition information they provide. Table 11 summarises several of the more recent studies.

Table 11. Studies summarising nutrition knowledge practices of coaches.

Author (s) Place	Sample / response rate	Sport	Training	Information source	Practices / Nutrition Knowledge Scores	Study outcome
Juzwiak (2004) Brazil	55 coaches (35.5%)	Gymnastics, tennis, swimming, judo	41% attended nutrition course	Non-technical magazines (58%) Other coaches (44%) Textbooks (38%)	Practices: 100% gave nutrition advice during training 27% recommended deleterious weight control practices 27% recommended use of supplements (60% of them recommended protein or amino acids) Knowledge: Mean score: 70% 46% believed protein is the main source of energy for the muscle	Compulsory nutrition course for all coaches. Develop specific nutrition education materials.
Rockwell et al. (2001) Virginia	35 coaches, 18 trainers Division 1 University (57%)	Basketball, football, volleyball, athletics, swimming, diving, soccer, baseball, golf, softball, tennis	N/A	Magazines (47%) Scientific journals (37%) Videos (11%) Books (40%) Dietitians (30%) Physicians (40%) Internet/television, food labels (42%)	Knowledge: Mean score: 67% >60% did not know recommended protein range	Provide coaches with additional nutrition training, resources and support from qualified nutrition professionals.
Baer et al. (1994) Ohio	135 (45%) High school coaches	Football	31% attended nutrition course	Newspapers, magazines or journals (75%). 0% consulted with a dietitian / nutritionist	Practices: 98% advised players on gaining lean body mass 47% believed protein intake should be increased 30% believed protein powders are necessary to increase lean body mass Knowledge: 100% did not know recommended protein range	Coaches need a better understanding of nutrition. Further training is needed.

Graves et al. (1991) North Carolina	303 (37) School coaches (152) Trainers (91) Dual coach-trainer (29)	Athletics	23% coaches and 7% trainers never attended course / seminar	Ranking resource person 1-5 in descending order: Coach: Physician (68%), sports trainer (45%), coach (35%), school nurse health teacher (14%)	Knowledge: Mean score: 59% (coach) Mean score: 64% (trainer) Mean score: 53% (dual role)	Coaches need nutrition training. Trainers are better prepared to give advice to the athlete.
Corley, et al. (1990) North Carolina	106 (36) College coaches	Athletics, swimming, tennis, basketball, gymnastics, golf, football, wrestling	18% attended nutrition course	Books on health (58%) Textbooks (26%) Physicians advice (17%) Dietitian / nutritionist advice (2%)	Knowledge: Mean score: 70% 20% recommended protein supplements 2% recommended protein supplements to increase lean body mass	Coaches need nutrition training. Need to incorporate nutrition principles into training.
Parr et al. (1984) US	348 coaches, 179 trainers High school / college (Agreed participation prior to survey distribution: 100%)	Athletics	61% coaches: no formal training 73% trainers: nutrition course	Athletes source: Rank 1: Parents Rank 2: Television, commercials, magazines, advertisements Rank 3: School Rank 4: Coach Rank 5: Trainer Rank 6: Other athletes	N/A	Coaches need nutrition training. Trainers are better prepared to give advice to the athlete
Bedgood & Tuck (1983) Texas	96 (63%) High school male coaches	Athletics Football Basketball	11% attended nutrition course 64% as part of another course	Professional journals, (66%), popular magazines and newspapers (52%), radio / television (36%), physician / nurse (41%), home economics teacher (10%), no source (10%)	Practices: 86% gave advice Knowledge: Mean score: 55%. Range: (28-84%) 15% of coaches scored >70%, considered knowledgeable 50% did not know recommended protein range	Need for nutrition education for coaches

Wolf et al. (1979) US	137 (74%) coaches of 153 men's and women's teams	Basketball, football, athletics, diving, golf, fencing, field / ice hockey, gymnastics, softball, volleyball, wrestling, tennis	69% rarely read about nutrition issues 78% felt they needed a greater knowledge	Magazines, journals, team trainers, physicians, other coaches, players	Practices: 35% prescribed supplements, half self-dispensed 15% recommended protein supplements 65% prescribed weight loss diets 16% prescribed weight gain diets	Need for a greater nutrition knowledge base of coaches.

N/A: Not available

Coaches' nutrition knowledge scores ranged from 55 to 70% across the studies reviewed, and authors from all studies concluded that coaches were in need of further nutrition training. Three studies reported high mean knowledge scores (Corley et al., 1990; Juzwiak, 2004; Rockwell et al., 2001). Corley et al.'s (1990) questionnaire included statements for which the coaches were asked to respond "true" or "false" and to indicate one of three degrees of certainty for each response. Despite high scores obtained, coaches indicated a low level of certainty with responses. Rockwell et al.'s (2001) sample of coaches was small and they acknowledged that despite achieving a greater response rate than in similar studies (Corley et al., 1990; Graves et al., 1991), those who responded may have been most knowledgeable or interested in sports nutrition. The same can be said of Corley et al.'s (1990) study, in which a good sample size but a low response rate was obtained. Despite reasonably high scores, Juzwiak (2004) reported that one quarter of her coaches recommended deleterious weight control practices.

Knowledge scores reported by Graves et al. (1991) and Bedgood & Tuck (1983) were lower; despite this, 86% of Bedgood & Tuck's (1983) coaches regularly dispensed nutrition information and 73% believed they were well prepared to provide nutrition advice.

Research has found an inconsistent association between nutrition knowledge and dietary behavior (Axelson & Brinberg, 1992; Parmenter & Wardle, 1999). It may be that even if coaches had a good level of nutrition knowledge and disseminated this knowledge to their athletes it would make little difference to the athletes' behavior anyway. However, there may be another explanation for this inconsistent relationship. Poorly designed nutrition knowledge questionnaires have been used to assess knowledge and as a consequence, a true measure of knowledge cannot be guaranteed with any certainty (Parmenter & Wardle, 1999). Indeed, psychometric evaluation of the questionnaires used in the studies in Table 11 reveals inadequate validation. Few studies use only a content validity measure (Bedgood & Tuck, 1983; Corley et al., 1990; Graves et al., 1991; Rockwell et al., 2001) and only one study reports using test-retest reliability measures (Bedgood & Tuck, 1983). Many authors do not supply any information regarding questionnaire psychometrics (Baer, et al., 1994; Parr et al., 1984; Wolf et al., 1979). It is for this reason that previous questionnaires were not used in this study to measure a knowledge dimension. A new questionnaire was designed and validated for use, thereby guaranteeing a valid and reliable measure of coaches' nutrition knowledge. The questionnaire satisfied criteria for validity (content, construct) and reliability (test-retest) (Zinn, Schofield, & Wall, 2004).

The aims of this study were to investigate whether New Zealand premier club rugby coaches imparted nutrition advice to their players, their level of nutrition knowledge, and factors determining this level of knowledge, using a population specific validated instrument.

Methods

Sports nutrition knowledge questionnaire

A two-part questionnaire was distributed to all premier club rugby coaches in New Zealand (See Appendix 6). The first section of the questionnaire presented demographic questions including age, length of time coaching, qualifications, nutrition training, a rating of their own nutrition knowledge, and whether or not they imparted nutrition advice to their players. The second section of the questionnaire had previously undergone extensive validation (Zinn, Schofield, & Wall, 2004). The questionnaire comprised 88 sports nutrition knowledge questions, and was divided into five main knowledge sub-categories: Nutrient types (46 questions), which comprised questions pertaining to macronutrients and micronutrients, recovery (7 questions), fluid (9 questions), weight control (15 questions) and supplements (11 questions). One of the fluid questions was removed and five added to the initial questionnaire, thereby bringing the fluid sub-category up to nine fluid questions. The reason for the removal of one question was due to there not being clear alternatives to the correct response. Questions were added to broaden the content range of this sub-category. Due to time limitations, these additional five questions did not undergo psychometric validation. Each question in the questionnaire could be answered “yes”, “no” or “unsure”. Scores were coded as + 1 for a correct response and 0 for an incorrect or an “unsure” response. The reason for the inclusion of an “unsure” response in each question was to discourage coaches from guessing answers. It was important to differentiate between coaches who possessed accurate knowledge (selected the correct response), coaches that possessed incorrect knowledge (selected the incorrect response) and coaches who did not have any knowledge (selected the “unsure” response).

Participants

The total population of New Zealand premier grade rugby coaches was included in this study (n = 364). The coaches’ details were obtained from a database supplied by the New Zealand Rugby Union. All coaches in the study were male. Each coach was informed of the purpose and procedure of the study, and the return of their questionnaire indicated their consent to participate. The ethics committee of the principal researcher’s university granted approval for the conduct of this research. The New Zealand Rugby Union granted permission to use the database of coaches.

Study procedure

The questionnaire was distributed to participants via two media: The Internet and standard mail. A specialised bulk e-mail handling program called Group Mail Pro (Infacta. Version 3.4.172) was used to manage the Internet mail-outs. The questionnaire data were generated using SSI Web software (Sequim, WA, USA), which allowed tracking and managing of large data sets generated by online questionnaires. Coaches with an e-mail address (n = 148) received an invitation to participate in the study with a personalised hyperlink in their e-mail to the questionnaire (See Appendix 3), along with a participant information sheet, informing them about the study (See Appendix 5). Hard copy questionnaires, along with self-addressed envelopes and the participant information sheet, were distributed to 216 coaches who did not have e-mail access (See Appendix 4). To optimise response rate, a number of strategies were employed. Three follow-up e-mails, one mail-out and phone calls were made to coaches who had not returned their questionnaire by the due date. An incentive in the form of a travel voucher was offered to one winning coach, who was randomly selected from the group that participated in the study.

Data analyses

Descriptive statistics were tabulated for coaches' demographic data and their total and sub-category mean scores. Data were analysed using SPSS version 12.0.1 for Windows (Release: 11 November 2003). Independent *t*-tests, using a level of significance of $p < 0.05$, were used to show mean correct, incorrect and unsure score differences between the two groups of coaches (those providing advice and those not providing advice). One-way analysis of variance was used to determine the relationships between total nutrition knowledge scores for all coaches and the ten variables: age, years of coaching, whether or not the coach believed nutrition is important to improve performance, their highest qualification, a rating of their nutrition knowledge, formal nutrition training, whether or not the coach actually gave nutrition advice, whether or not the coach had undertaken a coaching course, how often each coach read about nutrition issues, and whether or not coaches received nutrition advice as a player. The level of significance used for this measure was $p < 0.05$.

A multiple (stepwise) regression procedure was used to test whether coaches' total nutrition knowledge score could be predicted by factors such as their qualification, a rating of their own knowledge, whether or not they impart advice, and whether or not they underwent formal nutrition training. The level of significance used for this measure was $p < 0.001$

Results

One hundred and sixty eight coaches participated in this study, yielding a response rate of 46%. The response rates of coaches that used the Internet and standard mail-out, as a means of participation, were 57% (n = 96) and 43% (n = 72), respectively. Coaches were spread almost equally between two age ranges, 30-39 years and 40-49 years, and the majority had between two and five years coaching experience. Over half of the sample was not qualified beyond high school level.

Nutrition advice

The majority of coaches (n = 140; 83.8%) provided nutrition advice to their players, while 28 coaches (16.7%) did not provide any advice. The main reasons for not giving advice were no time (7%), not confident of their knowledge (61%), not viewed as important (14%), someone else gives advice (29%) and players involved at higher levels receive advice (7%). Most of the coaches imparted advice on fluid issues (95%), followed by nutrient types (79%), recovery nutrition (34%), supplements (39%) and weight control (27%).

Knowledge rating

Figure 1 presents the coaches' ratings of their sports nutrition knowledge. The majority of coaches that did impart advice rated their knowledge either average or good, with only a few ratings at the extremes of excellent and poor. This contrasted with coaches that did not impart advice, who had fewer ratings in these two categories and more in the poor category. Despite this, 43% of coaches who rated their knowledge as poor still gave advice to their athletes.

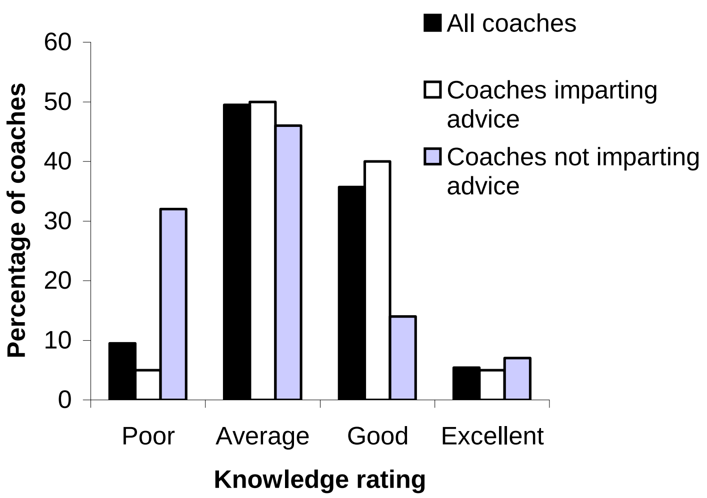

Figure 1. Rating of coaches' own sports nutrition knowledge.

Sports nutrition knowledge

Figure 2 illustrates the mean percentage of correct, incorrect and unsure total scores obtained by coaches on the nutrition knowledge questionnaire. An independent *t*-test showed that coaches who imparted nutrition advice obtained a significantly greater score, 56.8%, than those who did not impart advice, 48.4% ($p = 0.008$). To obtain an impression of the magnitude of this difference in scores, Cohen's effect size was computed to be 0.7, indicating a moderate to large difference between the coaches' scores. The discrepancy in knowledge ratings amongst coaches imparting and coaches not imparting advice were justified, as evidenced by these knowledge scores.

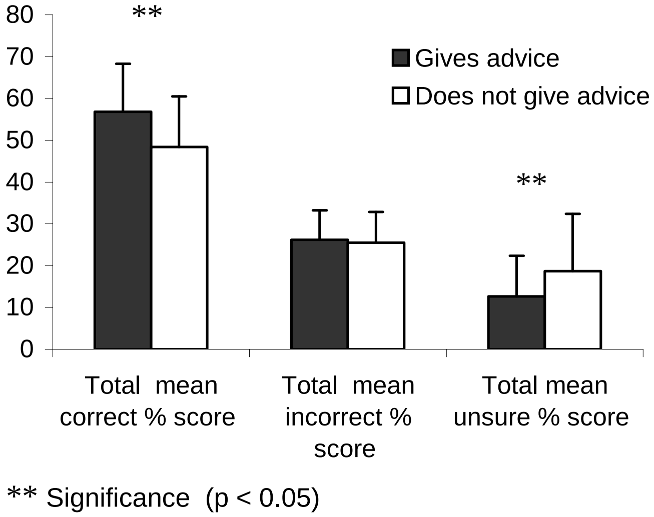

Figure 2. Total mean correct, incorrect and unsure percentage score.

Table 12 presents the mean sub-category percentage of correct, incorrect and unsure scores for all coaches, for those imparting nutrition advice and for those not imparting advice. Independent *t*-tests showed a significant difference between percentage correct scores for the two groups of coaches in the sub-categories fluid ($p = 0.003$) and supplements ($p = 0.001$). The direction of difference was always that those giving advice had a higher score.

Table 12. Mean percentage sub-category score.

Category (Number of questions)	Coach category	Sub-category correct % scores means and standard deviation	Sub-category incorrect % scores means and standard deviation	Sub-category unsure % scores means and standard deviation
Nutrient type (46)	All coaches Give advice Do not give advice	61.5 ± 13.4 62.3 ± 13.3 57.2 ± 13.5	25.6 ± 9.1 25.5 ± 9.2 26.6 ± 8.5	10.2 ± 10.0 9.5 ± 9.2 13.7 ± 12.9
Fluid (9)	All coaches Give advice Do not give advice	54.7 ± 17.0 57.0 ± 15.0* 42.8 ± 21.9	26.0 ± 14.3 25.8 ± 14.0 27.6 ± 15.8	18.8 ± 18.0 16.6± 15.4* 29.6 ± 25.4
Recovery (7)	All coaches Give advice Do not give advice	57.3 ± 24.5 58.8 ± 24.1 49.7± 26.1	18.0 ± 17.1 17.8 ± 17.3 19.0 ±16.3	24.5 ± 12.1 10.5 ± 11.2* 20.1 ± 13.9
Weight control (15)	All coaches Give advice Do not give advice	50.4 ± 15.9 50.9 ± 16.1 47.7 ± 14.9	30.7 ± 13.2 31.1 ± 13.4 28.6 ± 12.1	13.1 ± 13.3 11.9 ± 12.6* 19.3 ± 15.2
Supplements (11)	All coaches Give advice Do not give advice	32.9 ± 21.3 35.1 ± 21.6* 21.9 ± 15.6	25.4 ± 19.0 26.0 ± 18.4 22.2 ± 21.9	40.2 ± 26.6 37.9 ± 25.4 51.9 ± 30.3

* Significant ($p < 0.05$)

Sub-category knowledge

Fluid/hydration. Only half of the fluid questions were answered correctly. The majority of coaches were knowledgeable about specific dehydration issues. However, only 37% of coaches could identify the optimal amount of fluid required in a two-hour training session, and only 14% could identify the correct range of carbohydrate in a sports drink.

Weight control. The four weight gain questions yielded a mean correct percentage range of responses of 9-41%. The belief that protein powder is an essential product to increase lean muscle mass was exhibited by just over one third of the coaches. When presented with the statement “To **lose** weight, a player should stop eating pasta and rice after 4pm”, 45% incorrectly agreed and 18% were unsure.

Supplements. This sub-category was the most poorly answered of all the sub-categories. There were a greater number of unsure responses (40.2%) to these questions than incorrect responses (25.4%). There were also a greater number of unsure responses in this sub-category compared with any other sub-category.

Nutrition training

Table 13 presents the nutrition training characteristics of the coaches. The majority of coaches had not undergone any formal nutrition training. Among the coaches who were imparting advice, just over half were not trained in nutrition.

Table 13. Nutrition training characteristics of all coaches.

Formal nutrition training: n (%)	**When training was undertaken: n (%)**	**Length of training: n (%)**	**Type of training: n (%)**
<u>All coaches:</u>	2000-2003: 31(47.7)	<5 hours: 35 (53.4)	Lectures: 46 (27.4)
Trained: 65 (38.7)	1995-2000: 21 (32.3)	5-15 hours:14 (21.5)	Workshops: 21 (16.7)
Untrained: 103 (61.3)	1990-1995: 9 (13.8)	15-30 hours: 5 (7.7)	Part of course: 32 (25.4)
	Prior to 1990: 4 (6.2)	>30 hours: 11 (16.9)	Distance: 15 (11.9)
<u>Coaching giving advice:</u>			
Trained: 59 (42.1)			
Untrained: 81 (57.9)			

Use of outside professionals

Just under half of the coaches used an outside professional to deliver nutrition advice to their athletes. Professionals most used were doctors (58.4%) and physiotherapists (57.3%), followed by dietitians (47%), trainers (29.2%) and other (5.6%), which included nutrition-store owners, strength and conditioning coaches and rugby academy managers.

Nutrition information sources

The majority of coaches obtained their information from lectures/seminars or courses (57%), followed by the Internet (34%) and magazines (30%). Only two coaches cited journals. "Other" information sources included newspaper, radio, health shops, word of mouth, and pharmacy. Personnel cited included physiotherapists (19%), personal trainers (19%), trainers (15%), doctors (11%) and dietitians/nutritionists (7%). Nutrition information was not sourced at all by 18% of coaches.

Relationship between knowledge and demographics

No statistically significant differences were found between total knowledge score for all coaches and the variables age, years of coaching, receipt of advice as a player, coaching course attendance and belief in importance of nutrition to enhance performance. There were significant differences detected between total knowledge score and the variables qualifications [$F (1,166) = 5.28$, $P = 0.0001$], nutrition training [$F (1,166) = 9.83$, $P = 0.002$], provision of advice [$F (1,166) = 8.76$, $P = 0.004$] and knowledge rating [$F (3,164) = 6.88$, $P = 0.0001$]. Coaches who possessed more advanced qualifications, were formally trained in nutrition, and provided advice to their athletes, achieved greater total scores than less well qualified coaches who did not provide advice, and who had never undertaken formal nutrition training. Similarly, coaches who highly rated their level of knowledge obtained greater knowledge scores than coaches who had given themselves a lower rating of their own knowledge. A stepwise multiple regression analysis revealed that the combination of three variables, qualifications, own knowledge rating, and whether or not coaches provided nutrition advice predicted a greater total knowledge score ($p = 0.0001$).

Discussion

Sports nutrition knowledge

The total mean score achieved by all coaches in this study was 55.6%, a score similar to those reported by Bedgood & Tuck (1983) and Graves et al. (1991). Bedgood & Tuck's (1983) overall and sub-category scores were all significantly lower than an "average" mean standard score of 70%, which was determined in their study by academic precedence. Despite the poor overall score found in this study, it is encouraging to note that coaches who provide nutrition advice to their athletes achieved a significantly greater percentage of correct scores (56.8%) and a significantly lower percentage of unsure responses (12.6%) than coaches who do not provide advice (48.4% and 18.7%, respectively). However these coaches also achieved almost the same percentage of incorrect responses (26.2%) as those not providing advice (25.5%).

While it is important to note that this study does not investigate the actual information that coaches provide to their athletes, a number of speculations regarding this notion have been made. Firstly, one may assume that coaches only provide advice on the sports nutrition aspects about which they feel they possess adequate knowledge. Secondly, if a coach did not know the correct response to a question in this questionnaire, they presumably would have selected the unsure category provided. Furthermore, being uncertain about their knowledge of a topic should deter coaches from providing advice to athletes on that topic. The difficulty arises when they believe they are knowledgeable about a topic, and impart this information to athletes, when in fact the knowledge they possess is inaccurate.

Sub-category knowledge

The sub-categories that achieved the greatest mean score were nutrient type, followed by recovery, fluid, weight control and then supplements. Similarly, Bedgood & Tuck's (1983) coaches achieved their greatest score in the general nutrient category (60.7%). However, this finding is contrasted in two studies where the coaches were least knowledgeable about basic nutrition issues (Corley et al., 1990; Rockwell et al., 2001).

Fluid. Fluid was a topic, on which almost all coaches provided advice to their athletes. While those imparting advice obtained a significantly greater percentage of correct scores (57.0%) than those not imparting advice (42.8%), the scores were still considered poor. The implication of these results is that if coaches believe that their knowledge is sound and they provide advice to athletes based on the questions used in this questionnaire, just over one quarter of the information they impart is incorrect. Coaches did recognise (78%) that thirst is not the best indicator of fluid needs, a finding similar to that reported by Rockwell, et al. (2001).

Weight control. Almost one third of the responses of all coaches regarding weight control issues covered in this questionnaire were inaccurate. This result indicates that coaches' existing knowledge regarding weight control issues may be clouded by the myriad of nutrition myths and misconceptions that predominate in our society today. Recommendations of deleterious weight loss practices such as wearing plastic clothing when exercising, use of saunas and fasting have been reported in numerous studies (Graves et al., 1991; Juzwiak, 2004; Marquart & Sobal, 1994). The same concern as before arises in that the details of the weight control advice provided by coaches have not been investigated in this study. If coaches provided advice to athletes on the weight control issues addressed in this questionnaire, with the belief that their knowledge was sound, almost one third of the advice would be inaccurate.

It was evident that many coaches in this study were confused regarding the role of protein in weight gain and athletic performance, a consistent finding across the numerous studies reviewed (Baer et al., 1994; Bedgood & Tuck, 1983; Corley et al., 1990; Juzwiak, 2004; Parr et al., 1984). It is speculated that the media has played a role in causing this confusion. Fitness magazine articles frequently, but incorrectly, portray protein as the muscle-gaining nutrient of choice. In addition, the food industry has expanded the range of protein-based products so that bars, powders and ready-made beverages are readily accessible and bear claims of enhanced recovery and substantial gains in lean muscle mass. While protein requirements in the diet continues to be a controversial area of sports nutrition there is no evidence that supplementing an already adequate diet will further enhance muscle development (Baer et al., 1994).

Supplements. Coaches as a whole scored the lowest on the supplement sub-category than any other category. A similar low score was reported by Bedgood & Tuck, (1983) (32.6%), while, conversely, Rockwell et al.'s (2001) coaches were most knowledgeable about supplements (89% correct responses to the supplement questions). Coaches providing advice to athletes obtained a greater percentage of unsure responses (37.9%) than incorrect responses (26.0%). Based on the speculations described above, this finding is encouraging as it implies that they may choose not to impart advice on supplements, rather than impart incorrect advice. In contrast, in sub-categories nutrition types, fluid and weight control, a greater number of incorrect than unsure responses were obtained. If advice provided to athletes is based on the questions addressed in this questionnaire, this may result in the delivery of incorrect advice. It is in our opinion that it is preferred for athletes to receive no advice rather than inaccurate advice from their coaches. While not guaranteed, there may be a chance of athletes discovering the correct information from a different source.

Relationship between knowledge and demographics

The result identifying a significant relationship between knowledge and nutrition training and knowledge rating differed from that of Corley et al. (1990) who reported no relationship between knowledge and these two variables. The significant relationship found in this study between knowledge and overall qualifications differed from that reported by Juzwiak (2004). She did however report a weak correlation between nutrition knowledge and years of study. It has been speculated that a stronger correlation may have been reported had the sample size been greater. In this group of coaches, the combination of three variables influenced the nutrition knowledge score. A greater knowledge score can therefore be predicted if a coach provides advice, is more highly qualified and rates their knowledge greater than one who does not provide advice, is less qualified and has a lower rating of their own knowledge.

Nutrition training

The result obtained in this study that 60.7% of the coaches had not undertaken nutrition training was similar to that of comparable studies (Baer et al., 1994; Corley et al., 1990; Graves et al., 1991; Juzwiak, 2004; Parr et al., 1984). The brief training that the majority of coaches in our study undertook suggests that the amount of training received was not substantial enough to possess a well-rounded knowledge of sports nutrition.

At this point in time, in order to increase coaches' knowledge scores, the three predictor variables above would remain unaltered unless the coaches were to undertake nutrition training. This would result in a greater self-knowledge rating, a greater likelihood in providing nutrition advice and ultimately, an improvement in their knowledge score.

Use of outside professionals

Physiotherapists and doctors may be called upon to provide nutrition advice due to their existing regular involvement with the team; hence a more cost-effective option than the additional service of a dietitian. It is also speculated that they are called upon due to the public's perception of this group of professionals possessing a high level of nutrition knowledge, which is not necessarily the case.

Nutrition information sources

This study did not report the same difficulty with non-specificity of journal names as others (Bedgood & Tuck, 1983; Wolf et al., 1979). Only three journals were cited by coaches and all were peer reviewed and of good quality. Gameplan Rugby (The New Zealand Rugby Union coaching magazine), cited by 18% of coaches, contains nutrition articles written by a reputable sports dietitian. Other magazines reported were of the general sporting and fitness genera, the quality of nutrition information of which cannot be determined. The use of dietitians as a source of information was low, which was consistent with that found by Baer et al. (1994) and Corley et al. (1990), however, dietitians were not even cited in some studies Bedgood & Tuck, 1983; Graves et al., 1991; Juzwiak, 2004; Wolf et al., 1979)

The Internet method of questionnaire distribution in our study obtained a greater response rate than standard mail. Several studies between 1986 and 2000 comparing e-mail with paper surveys found that rates were lower with e-mail surveys, but responses were more "honest" and contained fewer errors. In addition using the Internet over standard mail methods enables questionnaire administration to be expeditious, inexpensive and convenient (Best & Krueger, 2002; Sequin, Godwin, McDonald, & McCall, 2004). We suggest that this may be a legitimate method for questionnaire distribution in the future.

Conclusion

While the concepts of sports nutrition may be of benefit to all athletes, it is almost impossible to recruit trained professionals such as dietitians and nutritionists to work with athletes in every club rugby team in New Zealand. As a consequence, the role of knowledgeable coaches becomes important as they are in a position to positively influence eating behaviors. Using a validated questionnaire to measure knowledge, findings suggest that the coaches in this study were not adequately prepared to provide good quality sports nutrition information, a conclusion consistent among similar studies reviewed (Baer et al., 1994; Bedgood & Tuck, 1983; Corley et al., 1990; Graves et al., 1991; Juzwiak, 2004; Parr et al., 1984; Rockwell et al., 2001; Wolf et al., 1979). It is recommended that coaches either source funding to contract a suitably qualified dietitian or nutritionist to provide nutrition information to the team, to obtain additional training to upskill their own nutrition knowledge. This could be achieved in a number of ways: A more substantial nutrition component than the existing one could be incorporated into rugby coaching courses, or club funds could be set aside for the coach to undergo some professional development in the area of nutrition. A nutrition resource specifically for rugby coaches could be developed by a qualified sports dietitian, either in manual form or, considering many coaches can access the Internet, in the form of a nutrition website. It is also recommended that the validated knowledge questionnaire used in this study to measure nutrition knowledge, as well as the internet means of distribution, be used in future studies to identify knowledge in coach populations involved in sports similar to that of rugby union.

A number of limitations regarding this study exist and are acknowledged by the authors. Firstly, because of time limitations, the four fluid questions added to the questionnaire had not undergone psychometric evaluation. Secondly, the contact details of many rugby coaches were incorrect. Although the database provided by the New Zealand Rugby Union was the most up to date one available, response rates were hindered by the quality of the database. Finally, it is not known from this survey the exact nature of the information coaches provide to athletes and whether coaches who imparted nutrition advice only imparted information which was correct and withheld facts they were less sure about.

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CHAPTER 5: CONCLUSION AND IMPLICATIONS

The two main studies conducted as part of this thesis centered around four main aims. The first of these aims was to design a nutrition knowledge questionnaire that satisfied adequate statistical measures of validity and reliability. Because of the absence of an adequately validated questionnaire this was the first important step in the process of investigating nutrition knowledge in rugby coaches. The initial study addressed this by incorporating appropriate psychometric measures to assure validity and reliability. The nutrition knowledge questionnaire was then used in the subsequent study to address the second aim of this research. This aim was to investigate the nutrition knowledge, using a census survey, of New Zealand premier club rugby coaches. In this study, the questionnaire used comprised two sections, one of which was the nutrition knowledge questionnaire, and the other, questions that addressed the third aim of this thesis. This aim was to investigate whether or not New Zealand premier club rugby coaches disseminated nutrition advice to their players and the factors affecting this. This section also included questions assessing the coaches' qualifications, their level of nutrition related education, their beliefs regarding the influence of nutrition of sports performance, and a rating of their own level of nutrition knowledge. The final aim of this thesis was therefore addressed by investigating which of these factors could predict an acceptable level of nutrition knowledge of these coaches. Each of these aims will be discussed in further detail below in relation to the two studies conducted.

Development of a psychometrically assessed sports nutrition questionnaire

Research identifying nutrition knowledge levels in groups have typically focused on a specific area of knowledge like fat or cholesterol, or have covered a broad area of knowledge, but have not been systematic enough to gain a true understanding of what people actually know. This, along with the use of questionnaires to measure knowledge which lack optimal psychometric validation, may explain the variability of the results reported in studies exploring the knowledge-behaviour relationship in the area of nutrition (Baer, et al., 1994; Bedgood & Tuck, 1983; Corley et al., 1990; Graves et al., 1991; Juzwiak, 2004; Parr et al., 1984; Rosenbloom et al., 2002; Rockwell et al., 2001; Wolf et al., 1979). The first study of this thesis was necessary to conduct in order to provide an up-to-date sports nutrition knowledge questionnaire that adequately fulfilled a number of statistical criteria. It was desired that it be psychometrically reliable and valid, cover the main themes of the speciality area of sports nutrition and that it be used in future studies to assess sports nutrition knowledge.

The psychometric criteria used in the first study addressed content and construct validity, and test-retest reliability. The initial process by which the items were generated ensured that all relevant aspects of applied sports nutrition were included. Content validity was assessed using expert panel input. Construct validity was assessed by comparing nutrition knowledge scores between five groups, selected for their expected variation in sports nutrition knowledge. Significantly different scores between the groups ($p = 0.0001$) indicated acceptable construct validity. Test-retest reliability of the questionnaire yielded acceptable results using both methods employed in the study. The only exception to this was the sub-category of fluid, which yielded an unacceptable reliability using Pearson's product-moment correlation. A second technique of analysing test-retest reliability, which had not been previously used in similar studies, yielded a more precise measure of reliability. This technique measured the reliability of each question on the two test instances, rather than that of the mean sub-category scores. Using this method, the fluid questions demonstrated acceptable reliability. The reliability measure of internal consistency is not necessarily an expected outcome for pure knowledge dimensions such as those used in this questionnaire. Its irrelevance in this instance excluded it from the series of psychometric measurements performed in the study. Researchers that conducted the studies reviewed in Chapters 3 and 4 failed to subject their questionnaires to adequate psychometric validation. This has led to the question of whether or not a true measure of nutrition knowledge was attained in these studies. In the broader context of nutrition, numerous knowledge questionnaires that have employed adequate psychometric evaluation do exist. However their content does not assume a sports nutrition focus (Anderson et al., 2002; Hoelscher et al., 2003; Johnson et al., 2002; Miller & Achterberg, 2000; Parmenter & Wardle, 1999; Resnicow et al., 1997; Sapp & Jensen, 1997; Steenhuis et al., 1996; Towler & Shepherd, 1990; Turconi et al., 2003).

The questionnaire in this study included five main content domains of sports nutrition: Nutrient types (which comprised questions on macronutrients and micronutrients), fluid, recovery, weight control and supplements. These areas underlie the main aspects relating knowledge to dietary behaviour:

- Do coaches, trainers, or athletes know which foods provide which nutrients and what their relationships are with sports performance?
- Are they familiar with the types and amounts of fluids recommended for athletes?
- Can they select the optimal recovery foods for their athletes?
- Are they able to aid athletes with their target weight loss and weight gain goals?
- Do they know the conditions under which supplements may be beneficial to their athletes? If so, do they know which supplements would be considered appropriate and inappropriate for use?

To conclude, given that dietary behaviour is complex and multi-dimensional, any attempts to understand it in terms of nutrition knowledge must begin with a clear understanding of knowledge. The questionnaire developed in this study represents a more comprehensive assessment of sports nutrition knowledge than has generally been achieved in similar studies. The findings of the study were important because the validated questionnaire could then be used to investigate the sports nutrition knowledge of New Zealand premier club rugby coaches. These findings would indicate, with confidence, a true level of the sports nutrition knowledge in this population group.

Evaluation of sports nutrition knowledge of New Zealand premier club rugby coaches

In fulfilling the second aim of this thesis, the questionnaire was used to investigate the nutrition knowledge of New Zealand premier club rugby coaches. The overall scores obtained were considered low, indicating a less than optimal level of knowledge, with further nutrition training needed that is appropriate to this population group. Knowledge scores were comparable to those obtained in similar studies, despite these studies not using similarly validated questionnaires (Bedgood & Tuck, 1983; Graves et al., 1991).

Coaches who provided nutrition advice to their athletes in this study were more knowledgeable than those who did not provide advice, as evidenced by their greater mean percentage of correct responses to the questions. However, over one quarter of the questions were answered incorrectly by this group of coaches. Studies reviewed did not separate their scoring of knowledge questions into “correct”, “incorrect” and “unsure” as did this study, hence a direct comparison of incorrect scores cannot be made. However if the unsure and incorrect percentages of this study are grouped together, then the resulting 38.8 % can be compared to similar studies in which a range of 30-45 % of the questions were not answered correctly (Bedgood & Tuck, 1983; Corley et al., 1990; Graves et al., 1991; Juzwiak, 2004; Rockwell et al., 2001). The exact details of the advice that coaches provide to athletes are beyond the scope of this research. It is therefore unknown whether the advice that they provide is scientifically sound. If it were based on nutrition information addressed in these questions, this would indicate that many coaches provide inaccurate advice. The questions in this study were determined by the expert panel of practising and academic dietitians as being the most relevant aspects of sports nutrition about which a coach should possess some knowledge. Coaches have demonstrated that their knowledge level pertaining to these questions is poor.

The majority of coaches (83.8 %) provided nutrition advice to their athletes, thereby addressing the third aim of the thesis. Statistical analyses showed that a number of factors were significantly correlated with the independent variable: provision of nutrition advice to athletes. One of these factors included coaches' rating of their own knowledge [Fischer's exact test = 18.59, $p = 0.0001$]. Coaches who rated their knowledge at a high level were more likely to provide nutrition advice to their athletes. However, 43% of coaches that rated their knowledge as poor still provided advice. Coaches that had undertaken either formal nutrition training [Pearson Chi- square = 4.22, $p = 0.04$] or a coaching course [Fischer's Exact test = 6.88, $p = 0.02$] as well as those who had received nutrition advice as a player [Fischer's Exact test = 6.15, $p = 0.04$] were more likely to provide advice to their athletes. Lastly, coaches who used nutrition professionals to provide advice to their players were also more likely to provide advice themselves [Fischer's Exact test = 11.30, $p = 0.003$]. A possible explanation for this could be that coaches may increase their knowledge by being present when nutrition professionals address their team/athletes. This may increase their level of confidence in their knowledge and encourage them to provide advice to their athletes.

The final aim of the thesis was fulfilled by the identification of four main factors that influenced the coaches' level of sports nutrition knowledge. Coaches who provided advice to their athletes, were more highly qualified, were formally trained in nutrition, and rated their knowledge higher than their counterparts, were more knowledgeable about sports nutrition issues. These factors all displayed a statistically significant correlation with total knowledge scores. The magnitude of these correlations was determined by Cohen as being small to moderate (Hopkins, 2000). Despite the three variables: qualification, knowledge rating and the provision of advice, acting together as predictors of nutrition knowledge, collectively, they only accounted for 23% of the variance in nutrition knowledge scores.

The incorporation of nutrition, an important sports science discipline, into the rugby philosophy and practice is not a priority for many coaches at this level. The nutrition component in the compulsory coaching course that all coaches undertake is negligible. It is therefore the coaches' responsibility to upskill their knowledge in this area. Findings indicate that almost two-thirds of the population group had not undertaken any formal nutrition training, and it is therefore evident that the nutritional aspects of rugby do not feature to any extent in these coaches' list of education needs. The relationship between good nutrition practice and optimal sports performance has been established in the literature. If optimal nutrition can assist performance of club rugby players at the premier level then the delivery of sound nutrition advice to athletes is clearly an area that needs further support. Optimal strategies to provide assistance in this area need to be determined either at a national level, by the New Zealand Rugby Union, or by individual clubs.

Limitations and future applications

The questionnaire used in this study has been psychometrically assessed and found to be adequately valid and reliable to measure sports nutrition knowledge in this population group. The delimitations of the research were that the population under investigation was restricted to coaches of the rugby union code, at a premier level, in New Zealand. With minor adjustments, the questionnaire could be used in future studies to investigate the sports nutrition knowledge of numerous different population groups. These groups may include athletes, trainers, and coaches involved at a variety of levels, with a variety of sports. While some sporting codes typically involve events lasting for short periods of time (track and field sprints), their training sessions often last for a similar length of time as those of the football code, with similar physiological demands placed on athletes.

Nutrition practices of athletes should be very similar, even among distinctly different sporting codes. This questionnaire may therefore be used with groups from sports other than the football code. It could also be used to assess knowledge of coaches or athletes at a variety of sporting levels. The nutritional requirements are very similar at different levels of sport. The main difference is that at an elite level, a greater amount of energy may be expended during exercise sessions causing nutrient requirements to increase. This questionnaire did not address the exact requirements of athletes and questions were suitable for application to all levels of exercise. The questionnaire may also be asked of any other group who may be expected to possess knowledge on sports nutrition issues. Such groups may include dietitians or nutrition students, and a questionnaire such as this may be a good assessment tool to measure their level of sports nutrition knowledge.

Should a similar study be reproduced with an athlete or coaching group during a sporting season, it is important to ensure optimal timing of questionnaire distribution and data collection. The optimal time would be during the last few rounds of the competition when all teams are still participating. In this study, the questionnaire was distributed one month following the conclusion of the club rugby season. A time delay with the initial development process of the questionnaire resulted in this limitation. At this time, some coaches could have lost interest in rugby-related issues, possibly resulting in a reduction of participant numbers.

The second study of this thesis indicated that at least for this population the Internet is a good method of distributing research questionnaires for a census study. The method is more time and cost-effective than using standard mail, and perhaps more convenient for the participants who have access to the Internet. This was reflected in the greater response rate obtained by this method than by standard mail. The limitation that fewer coaches than expected could access e-mail, could have limited the overall number of coaches that participated in the study. In the future, it is likely that access to e-mail and the Internet will be more widespread and it is recommended that this distribution method be used more frequently in future research.

Another limitation of this research was the use of New Zealand brands of food and fluid in the questionnaire. While this limits the use of the exact questionnaire in countries other than New Zealand, this limitation can be easily overcome. Local food brands, which are similar or even identical to those used in this questionnaire, can be substituted for the purpose of participant familiarity. Meal types could be adapted for different cultures by substituting cultural foods with the same nutritional value for those used in the New Zealand version. Should the sports nutrition knowledge level of population groups spanning a number of countries be investigated, generic food groups, rather than brand names could be used in the majority of the questions.

The true sports nutrition knowledge status of a representative sample of the population of New Zealand premier club rugby coaches is now known. The path is now clear for future research to take place based on the findings of these studies. An in-depth investigation into the advice practices of coaches would be valuable in order to assess the extent of the accuracy or inaccuracy of the advice that they provide.

Because the questionnaire used in this study was deemed to be sufficiently valid and reliable, a true measure of sports nutrition knowledge was obtained. This provides a starting point for future investigation into, and perhaps some clarification of, the relationship between nutrition knowledge and nutrition-related behaviour.

In conclusion, the ease at which the food types in this questionnaire may be adapted for country specificity, as well as the broad range of population groups for which it is appropriate, renders it a useful instrument, both nationally and internationally, for the measurement of sports nutrition knowledge.

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APPENDICES

Appendix 1. Coach training in New Zealand.

In New Zealand, in order to officially practise as a coach, the only compulsory training required is an injury prevention course, run by the New Zealand Rugby Union (NZRU). A large number of spinal injuries in early 1996 prompted the development of this compulsory course. Prior to this time, there was no compulsory training required for coaches. This brief injury prevention course did not cover any aspect of nutrition. However, since 2001, the courses have been based on the ACC SportSmart 10 point plan for sports injury prevention, and have been called “RugbySmart” courses. The ten points of the plan include nutrition and hydration as one of them to prevent injury. The component comprises a three-page document addressing some basic principles of hydration and nutrition as they apply to rugby. It is now a requirement set out by the NZRU board that all coaches, assistant coaches, and referees of all grades of tackle rugby attend a RugbySmart course annually. In 2003, an online test became available to coaches who had attended RugbySmart in the previous year to demonstrate their knowledge of safe techniques. The test includes two multiple-choice questions on nutrition, one pertaining to hydration and one to general nutrition. Only about 8% of coaches sat and passed the test (Quarrie, 2003).

Should coaches choose to undertake further coaching training, they have a number of options. Again, through the NZRU, they may undertake a 20-hour course focusing on the principles of rugby coaching, in which two of those hours cover basic nutrition principles. They can undertake a two-day advanced coaching course, in which there are two hours of basic nutrition education. A third option they have is to complete a Certificate in Rugby Coaching through Massey University. In order to obtain this certificate, undergraduates are required to undertake four papers (which do not include any nutrition education) and a rugby practicum. Post-graduates are required to undertake three papers and a rugby practicum. One of the three papers includes three, two-hour lectures on nutrition. This is at a very basic level and introduces students to some basic nutritional concepts and how they relate to exercise in general (Chu, M, personal communication, August 12, 2004). It is evident that at a compulsory level, coaches are exposed to almost no nutrition education. At a tertiary level coaches are not exposed to nutrition education in any depth should they choose to undertake a rugby coaching course.

Appendix 2. Sports nutrition questionnaire. Paper 1.

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Sports Nutrition Questionnaire

Below are 23 questions identifying a variety of sports nutrition topics. Based on **your** current knowledge, please answer the questions as best you can.

Nutrients

1. Do you think these foods are *high* or *low* in carbohydrate? (Tick one box per food).

	High	Low	Unsure
Chicken	☐	☐	☐
Baked beans	☐	☐	☐
White bread	☐	☐	☐
Butter	☐	☐	☐
Cornflakes cereal	☐	☐	☐
Creamed rice	☐	☐	☐

2. Do you think these foods are *high* or *low* in protein? (Tick one box per food).

	High	Low	Unsure
Chicken	☐	☐	☐
Baked beans	☐	☐	☐
Fruit	☐	☐	☐
Margarine	☐	☐	☐
Cornflakes cereal	☐	☐	☐
Peanuts	☐	☐	☐

3. Do you think these foods are *high* or *low* in fat? (Tick one box per food).

	High	Low	Unsure
Avocado	☐	☐	☐
Baked beans	☐	☐	☐
Pasta	☐	☐	☐
Polyunsaturated margarine	☐	☐	☐
Cottage Cheese	☐	☐	☐
Creamed rice	☐	☐	☐

Peanuts	☐	☐	☐
White bread	☐	☐	☐
Honey	☐	☐	☐
Hard yellow cheese (Such as Cheddar / Tasty)	☐	☐	☐

4. Do you think these foods are *high* or *low* in saturated fat? (Tick one box per food).

	High	Low	Unsure
Butter	☐	☐	☐
Canola margarine	☐	☐	☐
Whole milk	☐	☐	☐
Red meat	☐	☐	☐
Salmon	☐	☐	☐
Chocolate	☐	☐	☐
Peanuts	☐	☐	☐

5. The following foods contain cholesterol. (Tick one box per food).

	True	False	Unsure
Red Meat	☐	☐	☐
Eggs	☐	☐	☐
Fish	☐	☐	☐
Margarine	☐	☐	☐
Whole milk	☐	☐	☐

6. Would you *agree* or *disagree* with the following statements? (Tick one box per statement).

a. A high carbohydrate diet helps to reduce protein breakdown in the body.
☐ Agree ☐ Disagree ☐ Unsure

b. Tannins in tea decrease the amount of iron absorbed from food.
☐ Agree ☐ Disagree ☐ Unsure

c. Spinach and silverbeet are good sources of iron that is available to the body.
☐ Agree ☐ Disagree ☐ Unsure

d. Ascorbic acid (Vitamin C) increases the amount of iron absorbed from food.
☐ Agree ☐ Disagree ☐ Unsure

7. Would you *agree* or d*isagree* with the following statements? (Tick one box per statement).

a. There is more protein in a glass of whole milk than in a glass of non-fat milk.
☐ Agree ☐ Disagree ☐ Unsure

b. There is more calcium in a glass of whole milk than in a glass of non-fat milk.
☐ Agree ☐ Disagree ☐ Unsure

c. Calcium is easily obtained in the diet through green leafy vegetables.

☐ Agree ☐ Disagree ☐ Unsure

d. If someone wanted to cut down on fat, but didn't want to give up chips, choosing thick cut chips would be a better choice than thin cut chips.

☐ Agree ☐ Disagree ☐ Unsure

Fluid

8. In a two-hour intense training session, the optimum amount of fluid needed during this session is:
(Tick one box only.)

1 X 750ml water bottle ☐
2 X 750ml water bottles ☐
3 X 750ml water bottles ☐
4 X 750ml water bottles ☐
Unsure ☐

9. The following drink is not a sports drink: (Tick one box only).

Mizone ☐
Gatorade ☐
Replace ☐
Restore ☐
Unsure ☐

10. The percentage of carbohydrate in a 'sports drink' should be: (Tick one box only).

4-8% ☐
8-10% ☐
10-15% ☐
20-25% ☐
Unsure ☐

11. Which is the most appropriate fluid to consume before a two-hour training session? (Click on one box only.)

Fruit juice ☐
Replace ☐
Coke ☐
'V' ☐
Unsure ☐

12. Which is the most appropriate fluid to consume <u>after</u> a 2-hour training session? (Tick <u>one</u> box only).

Fruit juice ☐
Sportsdrink ☐
Coke ☐
Water ☐
'V' ☐
Unsure ☐

Recovery

13. The most important nutrient to replace after a one -hour run is: (Tick <u>one</u> box only).

Carbohydrate ☐
Protein ☐
Fat ☐
Unsure ☐

14. Which <u>one</u> of the following set of two snacks would you suggest that a player eat <u>after</u> training. (ie. i. 4 slices white bread, 2 tsp nutella <u>OR</u> 1 packet hot chips). (Tick <u>one</u> box for each question a-d).

a. 4 slices white bread, 2 tsp nutella ☐ **OR** 1 packet hot chips ☐ Unsure ☐

b. 1 Chelsea Bun ☐ **OR** 2 sausage rolls ☐ Unsure ☐

c. 100g jellybean ☐ **OR** 2 apples ☐ Unsure ☐

d. 2 low fat meat pies ☐ **OR** 1 X 440 g can creamed rice ☐ Unsure ☐

15. Click on <u>one</u> snack (per set of 2 snacks) which provides more carbohydrate. (ie. i. 100g bag of marshmallows <u>OR</u> 100g bag of peanuts). (Tick <u>one</u> box for each question a-d).

a. 100g bag of marshmallows ☐ **OR** 100 g bag of peanut M & M's ☐ Unsure ☐

b. ½ cup chopped dried dates ☐ **OR** 1 meat pie ☐ Unsure ☐

c. 1 X 180 g skinless chicken breast ☐ **OR** 2 slices white bread, 2 tsp marmite ☐ Unsure ☐

d. 340 ml can of Coke ☐ **OR** 3 cups of green salad (lettuce, tomato, cucumber, low fat dressing) ☐ Unsure ☐

16. The <u>optimal</u> time for a rugby player who is training daily to eat after exercise is: (Tick <u>one</u> box only).

Within 30 minutes ☐
Within 45 minutes ☐
Within one hour ☐
Between 2-3 hours ☐
Unsure ☐

17. Which of these is the most accurate definition of the term 'Glycaemic index'. (Tick <u>one</u> box only.)

The amount of carbohydrate a food contains ☐
The extent to which carbohydrate food raises blood sugar levels ☐
The extent to which protein food raises blood sugar levels ☐
The extent to which carbohydrate food raises blood pressure ☐
Unsure ☐

Weight gain

18. Do you *agree* or *disagree* with the following statements? (Tick <u>one</u> box per statement.)

a. For lean muscle mass gain to occur, protein is the most important nutrient to increase in the diet.
☐ Agree ☐ Disagree ☐ Unsure

b. Protein powder is an essential product to have if you want to increase lean muscle mass.
☐ Agree ☐ Disagree ☐ Unsure

c. If exercise is unchanged, it is possible for a rugby player to put on weight if they have six glasses of fruit juice **in addition** to their normal food intake.
☐ Agree ☐ Disagree ☐ Unsure

19. A player is eating the following meal for dinner: <u>150g skinless chicken breast, 1 cup cooked rice and 2 cups vegetables (broccoli, carrots, cauliflower).</u> If he kept the rest of his day's diet the same and only altered his dinner meal, which option would be the preferred one to increase his lean body mass?
(Tick <u>one</u> box only).

Eat 200g chicken. ☐
Eat the chicken with the skin on. ☐
Eat 2 cups rice and 180g skinless chicken. ☐
Eat 4 cups vegetables ☐
Eat the same amount, but train harder at the gym. ☐
Unsure ☐

Weight loss

20. If a player was trying to lose weight and they had the following snacks to choose from for morning tea, which <u>one</u> of each of the following set of two snacks should they choose? (Tick <u>one</u> box for each question a-f).

a. 4 salami sticks	☐	**<u>OR</u>**	1 piece fruit	☐	Unsure	☐
b. 2 packets of chips	☐	**<u>OR</u>**	1 cereal bar	☐	Unsure	☐
c. 1 small can creamed rice	☐	**<u>OR</u>**	1 large moro bar	☐	Unsure	☐
d. 100g peanuts	☐	**<u>OR</u>**	1 Primo chocolate milk	☐	Unsure	☐
e. 1 yoghurt	☐	**<u>OR</u>**	1 croissant with salad	☐	Unsure	☐
f. 1 chocolate dairy food	☐	**<u>OR</u>**	6 crackers with cheddar cheese	☐	Unsure	☐

21. Do you *agree* or *disagree* with the following statements? (Tick <u>one</u> box per statement).

If a rugby player wanted to **lose** weight, they should:

a. Exchange 1 tsp of butter on sandwiches for 1 tsp of regular margarine.
☐ Agree ☐ Disagree ☐ Unsure

b. Eat more Cheddar cheese than Edam cheese.
☐ Agree ☐ Disagree ☐ Unsure

c. Eat less salami and more turkey breast.
☐ Agree ☐ Disagree ☐ Unsure

d. Stop eating pasta and rice after 4pm.
☐ Agree ☐ Disagree ☐ Unsure

e. Exchange his yoghurt, muesli bar and fruit snacks for protein shakes.
☐ Agree ☐ Disagree ☐ Unsure

Supplements

22. Do you *agree* or *disagree* with the following statements? (Tick <u>one</u> box per statement).

a. Creatine supplement would be most beneficial to a player wanting to increase peak power output.
☐ Agree ☐ Disagree ☐ Unsure

b. Creatine supplement has more of an effect when natural body stores are low.
☐ Agree ☐ Disagree ☐ Unsure

c. The performance-enhancing mechanism of creatine is that it aids to increase fat metabolism.
☐ Agree ☐ Disagree ☐ Unsure

d. Creatine is most useful to those players wanting to increase fitness for endurance exercise.
☐ Agree ☐ Disagree ☐ Unsure

23. Do you *agree* or *disagree* with the following statements? (Tick one box per statement).

a. Multivitamin tablets should be taken by most athletes.

☐ Agree ☐ Disagree ☐ Unsure

b. Iron tablets should be taken when a player feels extremely tired and is pale.

☐ Agree ☐ Disagree ☐ Unsure

c. Vitamin C should be routinely supplemented by athletes.

☐ Agree ☐ Disagree ☐ Unsure

d. B vitamins should be taken when feeling low in energy.

☐ Agree ☐ Disagree ☐ Unsure

e. The main performance-enhancing effect of hydroxy-methyl butyrate (HMB) is that it helps to breakdown body fat during exercise.

☐ Agree ☐ Disagree ☐ Unsure

f. Salt tablets should be used for players that get a cramp during exercise.

☐ Agree ☐ Disagree ☐ Unsure

g. Appetite suppressants (i.e. thermogenic tablets) are recommended to be taken by athletes when weight loss is a goal.

☐ Agree ☐ Disagree ☐ Unsure

Thank-you for your time, it is very much appreciated.

Appendix 3. E-mailed invitation to participate letter to coaches.

AUT
AUCKLAND UNIVERSITY OF TECHNOLOGY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

NEW ZEALAND RUGBY UNION

Dear coach,

In conjunction with the NZRFU, Auckland University of Technology is seeking to understand some of the practices of N.Z. premier club rugby coaches. In particular we are interested in the nutrition information you give to your players, if any. The research consists of a questionnaire, which will take about 15 minutes to complete.

By completing the questionnaire you will help us understand and support coaches better in the future

AND YOUR NAME WILL BE PUT IN A DRAW
TO WIN A $500 TRAVEL VOUCHER.

The entrants in this draw are only N.Z. premier rugby coaches who complete and return the survey - so your chances are good!

As a N.Z. premier coach, you have been invited to participate in this project, conducted by Auckland University of Technology (AUT) and endorsed and assisted by The New Zealand Rugby Football Union. By clicking on the URL below, you will be taken to the internet site of the study. Here you will find all the details of the study (in the participant information sheet) as well as the questionnaire.

Once you have submitted your questionnaire, your name will automatically go into a draw to win the travel voucher. Please complete and submit your questionnaire NO LATER than Thursday 25th September. Your confidentially in this research will be assured. Your name will not be associated with the results in any way and no other individual, aside from the primary researcher and research assistant will have access to your name or your data, both when managing the data and when conducting the prize draw. Should you wish to remain anonymous, you may, however, we you will not be eligible for entry into the prize draw. This is simply due to the fact that we will not know who to contact to award the voucher.

Once you have read all the instructions (on the website), should you have further questions, please do not hesitate to contact me.

You only have ONE opportunity to enter into this site, so make sure you have 15-20 minutes free to fill out the questionnaire before you click on the URL.

Click here to begin the survey

If your email system does not support HTML then you will need to go to

www.coachnutrition.net.nz

Your username is 99
Your password is 99

Your assistance with this research will be greatly appreciated.

Regards
Caryn Zinn
Primary researcher
AUT Senior Lecturer
(09) 917 9999 ext. 7842
caryn.zinn@aut.ac.nz

Appendix 4. Mail-out invitation to participate letter to coaches.

Dear coach,

In conjunction with the NZRFU, Auckland University of Technology is seeking to understand some of the practices of New Zealand. premier club rugby coaches. In particular we are interested in the nutrition information you give to your players, if any. The research consists of a questionnaire, which will take about 15 minutes to complete.

By completing the questionnaire you will help us understand and support coaches better in the future,

AND YOUR NAME WILL BE PUT IN A DRAW
TO WIN A $500 TRAVEL VOUCHER.

The entrants in this draw are only New Zealand premier rugby coaches who complete and return the survey - so your chances are good!

As a New Zealand premier coach, you have been invited to participate in this project, conducted by Auckland University of Technology (AUT) and endorsed and assisted by The New Zealand Rugby Football Union. Enclosed in this envelope is the participant information sheet (providing all the details of the research), as well as the questionnaire. Once you have completed the questionnaire and returned it in the self-addressed envelope provided, your name will automatically go into the draw to win the travel voucher.

Please complete and submit your questionnaire NO LATER than 25 September. Your confidentially in this research will be assured. Your name will not be associated with the results in any way and no other individual, aside from the primary researcher, will have access to your name or your data, both when managing the data and when conducting the prize draw. You may choose to remain anonymous, however you will not be eligible for entry into the prize draw. This is simply due to the fact that we will not know who to contact to award the voucher.

Once you have read all the instructions, should you have further questions, please do not hesitate to contact me.

Your assistance with this research will be greatly appreciated.

Regards
Caryn Zinn
Primary researcher
(09) 917 9999 ext. 7842
caryn.zinn@aut.ac.nz

Appendix 5. Participant information sheet (mail-out and online versions).

Participant Information Sheet

Project Title: Factors influencing dissemination of nutrition information by premier club rugby coaches to their athletes.

You have been invited to participate in a research project conducted by Auckland University of Technology (AUT) and endorsed and assisted by The New Zealand Rugby Football Union.

What is the aim of the study?

The aim of this project is to investigate whether or not club rugby coaches give nutrition advice to their players, and the factors affecting this.

What are the benefits of taking part?

The outcome of this study could be beneficial to all club rugby coaches and their players. If a gap in this area is identified, it is envisaged that strategies be put in place in order to help coaches address this aspect of sport in the future. A likely strategy could be the development of sports nutrition training courses or nutrition resources for the specific use by rugby coaches with their players.

An added benefit to you is that once you have completed and returned the questionnaire, your name will be put into a draw for a chance to win a travel voucher to the value of $500.

What do I need to do?

The process involves filling in the enclosed questionnaire and returning it in the self-addressed envelope provided. The questionnaire comprises two sections. Section 1 identifies a number of factors that influence whether or not coaches give nutrition advice to their players and section 2 assesses nutrition knowledge. The return of a completed questionnaire will indicate that you have given your consent to participate in this research project. Once the results have been collated and analysed, you will be notified of the outcomes of the study.

If you feel that you do not know anything about nutrition issues, or that you once studied and have since forgotten it, please still complete the questionnaire on your own, without assistance, as best you can. This will be just as useful to us, if not more useful, in making future recommendations regarding nutrition resource development to assist coaches in optimizing player performance.

Is this going to cost anything?

There will be no cost to you in participating in this study.

Are there any risks involved?

There will be no risks to you while participating in this research.

How is my privacy protected?

All data collected for this research will be treated with absolute confidentiality. Your identity as well as your responses to the questions in this questionnaire will not be shared with any other individual aside from the primary researcher. Your name will not be associated with the data in any way and therefore your anonymity will be assured. In addition to this, your name will not be accessible by anyone other than the primary researcher both when managing the data and when conducting the prize draw. Once the data has been analysed, it will be kept for a period of six years in a locked cabinet in a room with limited access. After six years, all copies of the data will be shredded. Should you wish to participate in this study but choose to remain nameless, you will not be eligible for the $500 travel voucher. This is simply due to the fact that we will not know who to contact to award the voucher.

If you have any questions or concerns regarding the project, please contact the researchers.

Primary Researcher: Caryn Zinn
AUT. Division of Sport and Recreation
Private Bag 92006
Auckland 1020
(09) 917 9999 ext. 7842
E-mail: caryn.zinn@aut.ac.nz

Project Supervisor: Grant Schofield
AUT. Division of Sport and Recreation
Private Bag 92006
Auckland 1020
(09) 917 9999 ext 7307
E-mail: grant.schofield@aut.ac.nz

Thank-you for your valuable time and consideration.

Approved by Auckland University of Technology Ethics Committee (AUTEC).
Reference number 03/32.

Appendix 6. Premier club rugby coach sports nutrition questionnaire. Paper 2.

Premier Club Rugby Coach Sports Nutrition Questionnaire.

This questionnaire is ***double-sided*** and consists of 2 sections.
Please mark a tick in the most appropriate box(es) where applicable:

SECTION 1 Name: ______________________________

1. How long have you been coaching club rugby?

☐ Less than 2 years ☐ Between 2-5 years ☐ Between 5-10 years ☐ Longer than 10 years

2. Your age is:

☐ Under 29 yrs ☐ 30-39yrs ☐ 40-49yrs ☐ Over 50 yrs

3. What is the highest qualification that you possess?

☐ High school ☐ 5th form certificate ☐ 6th form certificate

☐ 7th form / university entrance ☐ Diploma

☐ Degree / university papers ☐ Post-graduate study

4a. Do you give nutrition advice to your rugby players?

☐ No ☐ Yes ☐ Don't know / No response

4b. If you have answered 'no' to question 4a, please explain why you do not give nutrition advice.

☐ No time ☐ Not confident with your level of nutrition knowledge

☐ Do not view nutrition as an important issue for the players

☐ Someone else gives them nutrition advice.

☐ Don’t know ☐ Not applicable

☐ Other:

---

5. Does your nutrition advice include the following content? (<u>Please tick as many options as necessary</u>).

☐ Fluid intake ☐ Supplements ☐ Foods to eat before training / games

☐ Nutrient types ☐ Weight loss / gain ☐ Foods to eat after training / games

☐ Other. Please explain________________________________

☐ Not applicable

6. Do you believe that good nutrition practices by rugby players can help improve their sports performance?

☐ No ☐ Yes ☐ Don’t know / No response

7. Do you believe that good nutrition practices by rugby players can help prevent injury?

☐ No ☐ Yes ☐ Don’t know / No response

8. How would you rate your own knowledge of sports nutrition issues?

☐ Poor ☐ Average ☐ Good ☐ Excellent

9. How often would you read about sports nutrition issues?

☐ Never ☐ Weekly ☐ Monthly ☐ Six-monthly

☐ Other ________________________________

10. Where do you source information about nutrition issues? (<u>Please tick as many options as necessary</u>).

☐ Do not source any information. ☐ Internet ☐ Lecture / seminar / course:

☐ Sponsors: Please list names. ________________________________

☐ Magazines. Please list names: ________________________________

☐ Other:________________________________

11. Have you ever used an outside health / sports professional to give <u>nutrition</u> advice to your players?

☐ No ☐ Yes ☐ Don't know / No Response

If 'No' please continue at question 13. If 'Yes', please proceed.

12. Which of the following health / sports professionals have you used to give <u>nutrition</u> advice to your players? (<u>Please tick as many options as necessary</u>).

☐ Team Trainer ☐ Doctor ☐ Physiotherapist ☐ Personal Trainer

☐ Registered Dietitian / Nutritionist ☐ Other. Please list. ___________________

____

13. Have <u>you</u> ever had formal nutrition training?

☐ No ☐ Yes ☐ Don't know / No response

If 'No' please continue at question 19. If 'Yes', please proceed.

14. What was the length of this training?

☐ Less than 5 hours ☐ Between 5-15 hours ☐ Between 15 and 30 hours

☐ Longer than 30 hours ☐ Other. Please list

____

15. What was the training made up of? (<u>Please tick as many options as necessary</u>).

☐ Lectures ☐ Practical workshops

☐ Part of another course ☐ Distance learning course

☐ Other. Please explain

____

____

16. When did you undertake this training?

☐ 2000-2003 ☐ 1995-2000 ☐ 1990-1995 ☐ Prior to 1990

17. Have you had a nutrition update since then?

☐ No ☐ Yes. ☐ Don't know / No response

If 'No' please continue at question 19. If 'Yes', please proceed.

18. When did you undertake this nutrition update?

☐ 2000-2003 ☐ 1995-2000 ☐ 1990-1995 ☐ Prior to 1990

19. What is the highest level of rugby that you have <u>played</u>?

☐ Club level ☐ Representative ☐ National ☐ No rugby playing experience

20. As a player, have you ever received nutrition advice?

☐ No ☐ Yes ☐ Don't know / No response

a. If 'yes', please explain what advice you were given.

____

____

b. Please state who gave you this advice.

____

21. Have you attended any coaching courses?

☐ No ☐ Yes

If 'Yes', please list course(s) attended AND the name the organization(s) that conducted the course.

Name of course(s):

____

Name of organisation:

____

____

22. Did the course(s) include nutrition information?

☐ No ☐ Yes ☐ Don't know / No response

Please proceed to <u>Section 2</u>

SECTION 2: Sports Nutrition Questionnaire

Below are 23 questions identifying a variety of sports nutrition topics. Based on **your** current knowledge, please answer the questions as best you can.

Nutrients

1. Do you think these foods are *high* or *low* in carbohydrate? (Tick one box per food).

	High	Low	Unsure
Chicken	☐	☐	☐
Baked beans	☐	☐	☐
White bread	☐	☐	☐
Butter	☐	☐	☐
Cornflakes cereal	☐	☐	☐
Creamed rice	☐	☐	☐

2. Do you think these foods are *high* or *low* in protein? (Tick one box per food).

	High	Low	Unsure
Chicken	☐	☐	☐
Baked beans	☐	☐	☐
Fruit	☐	☐	☐
Margarine	☐	☐	☐
Cornflakes cereal	☐	☐	☐
Peanuts	☐	☐	☐

3. Do you think these foods are *high* or *low* in fat? (Tick one box per food).

	High	Low	Unsure
Avocado	☐	☐	☐
Baked beans	☐	☐	☐
Pasta	☐	☐	☐
Polyunsaturated margarine	☐	☐	☐
Cottage Cheese	☐	☐	☐
Creamed rice	☐	☐	☐
Peanuts	☐	☐	☐
White bread	☐	☐	☐
Honey	☐	☐	☐
Hard yellow cheese (Such as Cheddar / Tasty)	☐	☐	☐

4. Do you think these foods are *high* or *low* in saturated fat? (Tick one box per food).

	High	Low	Unsure
Butter	☐	☐	☐
Canola margarine	☐	☐	☐
Whole milk	☐	☐	☐
Red meat	☐	☐	☐
Salmon	☐	☐	☐
Chocolate	☐	☐	☐
Peanuts	☐	☐	☐

5. The following foods contain cholesterol. (Tick one box per food).

	True	False	Unsure
Red Meat	☐	☐	☐
Eggs	☐	☐	☐
Fish	☐	☐	☐
Margarine	☐	☐	☐
Whole milk	☐	☐	☐

6. Would you *agree* or *disagree* with the following statements? (Tick one box per statement).

a. A high carbohydrate diet helps to reduce protein breakdown in the body.
☐ Agree ☐ Disagree ☐ Unsure

b. Tannins in tea decrease the amount of iron absorbed from food.
☐ Agree ☐ Disagree ☐ Unsure

c. Spinach and silverbeet are good sources of iron that is available to the body.
☐ Agree ☐ Disagree ☐ Unsure

d. Ascorbic acid (Vitamin C) increases the amount of iron absorbed from food.
☐ Agree ☐ Disagree ☐ Unsure

7. Would you *agree* or d*isagree* with the following statements? (Tick one box per statement).

a. There is more protein in a glass of whole milk than in a glass of non-fat milk.
☐ Agree ☐ Disagree ☐ Unsure

b. There is more calcium in a glass of whole milk than in a glass of non-fat milk.
☐ Agree ☐ Disagree ☐ Unsure

c. Calcium is easily obtained in the diet through green leafy vegetables.
☐ Agree ☐ Disagree ☐ Unsure

d. If someone wanted to cut down on fat, but didn't want to give up chips, choosing thick cut chips would be a better choice than thin cut chips.
☐ Agree ☐ Disagree ☐ Unsure

Fluid

8. In a two-hour intense training session, the <u>optimum</u> amount of fluid needed during this session is:
(Tick <u>one</u> box only.)

- 1 X 750ml water bottle ☐
- 2 X 750ml water bottles ☐
- 3 X 750ml water bottles ☐
- 4 X 750ml water bottles ☐
- Unsure ☐

9. The following drink is <u>not</u> a sports drink: (Tick <u>one</u> box only).

- Mizone ☐
- Gatorade ☐
- Replace ☐
- Restore ☐
- Unsure ☐

10. The percentage of carbohydrate in a 'sports drink' should be: (Tick <u>one</u> box only).

- 4-8% ☐
- 8-10% ☐
- 10-15% ☐
- 20-25% ☐
- Unsure ☐

11. Which is the most appropriate fluid to consume <u>after</u> a 2-hour training session? (Tick <u>one</u> box only).

- Fruit juice ☐
- Sportsdrink ☐
- Coke ☐
- Water ☐
- 'V' ☐
- Unsure ☐

12. Would you *agree* or d*isagree* with the following statements? (Tick <u>one</u> box per statement).

a. Fluid loss of only 2% of body weight can reduce your performance by up to 20%.
☐ Agree ☐ Disagree ☐ Unsure

b. Weighing players before and after training would be a good way to determine each individual's fluid requirements.
☐ Agree ☐ Disagree ☐ Unsure

c. The best advice to give to a player about fluid during a training session would be to drink when they are thirsty.
☐ Agree ☐ Disagree ☐ Unsure

d. Fruit juice is a good fluid to have during a training session and at half time of a game.

☐ Agree ☐ Disagree ☐ Unsure

e. Energy drinks such as 'V' and 'Red Bull' are good drinks to have 30 minutes leading up to exercise.

☐ Agree ☐ Disagree ☐ Unsure

Recovery

13. The most important nutrient to replace after a one -hour run is: (Tick <u>one</u> box only).

Carbohydrate ☐
Protein ☐
Fat ☐
Unsure ☐

14. Which <u>one</u> of the following set of two snacks would you suggest that a player eat <u>after</u> training. (ie. i. 4 slices white bread, 2 tsp nutella <u>OR</u> 1 packet hot chips). (Tick <u>one</u> box for each question a-d).

a. 4 slices white bread, 2 tsp nutella ☐ **OR** 1 packet hot chips ☐ Unsure ☐

b. 1 Chelsea Bun ☐ **OR** 2 sausage rolls ☐ Unsure ☐

c. 100g jellybeans ☐ **OR** 2 apples ☐ Unsure ☐

d. 2 low fat meat pies ☐ **OR** 1 X 440 g can creamed rice ☐ Unsure ☐

15. Click on <u>one</u> snack (per set of 2 snacks) which provides more carbohydrate. (ie. i. 100g bag of marshmallows <u>OR</u> 100g bag of peanuts). (Tick <u>one</u> box for each question a-d).

a. 100g bag of marshmallows ☐ **OR** 100 g bag of peanut M & M's ☐ Unsure ☐

b. ½ cup chopped dried dates ☐ **OR** 1 meat pie ☐ Unsure ☐

c. 1 X 180 g skinless chicken breast ☐ **OR** 2 slices white bread, 2 tsp marmite ☐ Unsure ☐

d. 340 ml can of Coke ☐ **OR** 3 cups of green salad (lettuce, tomato, cucumber, low fat dressing) ☐ Unsure ☐

16. The <u>optimal</u> time for a rugby player who is training daily to eat after exercise is: (Tick <u>one</u> box only).

Within 30 minutes ☐
Within 45 minutes ☐
Within one hour ☐
Between 2-3 hours ☐
Unsure ☐

17. Which of these is the most accurate definition of the term 'Glycaemic index'. (Tick <u>one</u> box only.)

The amount of carbohydrate a food contains ☐
The extent to which carbohydrate food raises blood sugar levels ☐
The extent to which protein food raises blood sugar levels ☐
The extent to which carbohydrate food raises blood pressure ☐
Unsure ☐

<u>Weight gain</u>

18. Do you *agree* or *disagree* with the following statements? (Tick <u>one</u> box per statement.)

a. For lean muscle mass gain to occur, protein is the most important nutrient to increase in the diet.

☐ Agree ☐ Disagree ☐ Unsure

b. Protein powder is an essential product to have if you want to increase lean muscle mass.

☐ Agree ☐ Disagree ☐ Unsure

c. If exercise is unchanged, it is possible for a rugby player to put on weight if they have six glasses of fruit juice **in addition** to their normal food intake.

☐ Agree ☐ Disagree ☐ Unsure

19. A player is eating the following meal for dinner: <u>150g skinless chicken breast, 1 cup cooked rice and 2 cups vegetables (broccoli, carrots, cauliflower).</u> If he kept the rest of his day's diet the same and only altered his dinner meal, which option would be the preferred one to increase his lean body mass?
(Tick <u>one</u> box only).

Eat 200g chicken. ☐
Eat the chicken with the skin on. ☐
Eat 2 cups rice and 180g skinless chicken. ☐
Eat 4 cups vegetables ☐
Eat the same amount, but train harder at the gym. ☐
Unsure ☐

<u>Weight loss</u>

20. If a player was trying to lose weight and they had the following snacks to choose from for morning tea, which <u>one</u> of each of the following set of two snacks should they choose? (Tick <u>one</u> box for each question a-f).

a. 4 salami sticks ☐ **<u>OR</u>** 1 piece fruit ☐ Unsure ☐

b. 2 packets of chips ☐ **<u>OR</u>** 1 cereal bar ☐ Unsure ☐

c. 1 small can creamed rice ☐ **<u>OR</u>** 1 large moro bar ☐ Unsure ☐

d. 100g peanuts ☐ **OR** 1 Primo chocolate milk ☐ Unsure ☐

e. 1 yoghurt ☐ **OR** 1 croissant with salad ☐ Unsure ☐

f. 1 chocolate dairy food ☐ **OR** 6 crackers with cheddar cheese ☐ Unsure ☐

21. Do you *agree* or *disagree* with the following statements? (Tick one box per statement).

If a rugby player wanted to **lose** weight, they should:

a. Exchange 1 tsp of butter on sandwiches for 1 tsp of regular margarine.
☐ Agree ☐ Disagree ☐ Unsure

b. Eat more Cheddar cheese than Edam cheese.
☐ Agree ☐ Disagree ☐ Unsure

c. Eat less salami and more turkey breast.
☐ Agree ☐ Disagree ☐ Unsure

d. Stop eating pasta and rice after 4pm.
☐ Agree ☐ Disagree ☐ Unsure

e. Exchange his yoghurt, muesli bar and fruit snacks for protein shakes.
☐ Agree ☐ Disagree ☐ Unsure

Supplements

22. Do you *agree* or *disagree* with the following statements? (Tick one box per statement).

a. Creatine supplement would be most beneficial to a player wanting to increase peak power output.
☐ Agree ☐ Disagree ☐ Unsure

b. Creatine supplement has more of an effect when natural body stores are low.
☐ Agree ☐ Disagree ☐ Unsure

c. The performance-enhancing mechanism of creatine is that it aids to increase fat metabolism.
☐ Agree ☐ Disagree ☐ Unsure

d. Creatine is most useful to those players wanting to increase fitness for endurance exercise.
☐ Agree ☐ Disagree ☐ Unsure

23. Do you *agree* or *disagree* with the following statements? (Tick one box per statement).

a. Multivitamin tablets should be taken by most athletes.
☐ Agree ☐ Disagree ☐ Unsure

b. Iron tablets should be taken when a player feels extremely tired and is pale.
☐ Agree ☐ Disagree ☐ Unsure

c. Vitamin C should be routinely supplemented by athletes.
☐ Agree ☐ Disagree ☐ Unsure

d. B vitamins should be taken when feeling low in energy.

☐ Agree ☐ Disagree ☐ Unsure

e. The main performance-enhancing effect of hydroxy-methyl butyrate (HMB) is that it helps to breakdown body fat during exercise.

☐ Agree ☐ Disagree ☐ Unsure

f. Salt tablets should be used for players that get a cramp during exercise.

☐ Agree ☐ Disagree ☐ Unsure

g. Appetite suppressants (i.e. thermogenic tablets) are recommended to be taken by athletes when weight loss is a goal.

☐ Agree ☐ Disagree ☐ Unsure

Thank-you for your time, it is very much appreciated.