Nutritional Supplement Knowledge of Athletes with Spinal Cord Injury

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ABSTRACT

Background:

Nutritional supplements are a temptation for athletes with and without spinal cord injury (SCI) who are attempting to enhance their performance. However, many supplements do not possess convincing scientific merit to advise their use and some even have the potential to cause harm. This is of particular concern for athletes with SCI, who often need to manage secondary health complications for optimal performance. Currently, there is a paucity of research on the supplement knowledge of elite athletes and athletes with SCI, as the majority of research has investigated able-bodied (AB) athletes of junior to university level in countries other than New Zealand (NZ). This emphasises the importance to investigate the supplement knowledge and practices of NZ athletes to evaluate how the SCI population compare with the AB population, and how these groups compare to their overseas counterparts.

Methods:

The present study investigated the nutritional supplement knowledge, practices and reasons for use of 11 elite AB athletes and 15 athletes with SCI in NZ from an online questionnaire.

Results:

The SCI and AB groups demonstrated moderate levels of supplement knowledge (64.8% AB vs. 57.5% SCI) ($p=0.466$). Despite this difference being insignificant, the SCI group reported supplement practices relating to the physiological effects of SCI. Supplement practices may have been used as a prevention method against their

increased risk of illness and infection, and potentially as a compensatory strategy to augment an obligatory loss of muscle size and strength. This was shown by their higher prevalence for the use of vitamin C (p=0.05) and creatine (p=0.012), and supported by their nutritional beliefs and reasons for supplement use.

Conclusions:

Although athletes with SCI have similar levels of supplement knowledge as their AB counterparts, this does not mean their knowledge is adequate. Athletes with SCI appear to be disadvantaged regarding their nutritional education and support, particularly in the present study as the majority of AB athletes attended an elite sporting institute. Moreover, nutrition recommendations for athletes with SCI are non-existent, which emphasizes the need for further research to form the basis of nutritional guidelines for this group. Nevertheless, even with the available nutrition information for AB athletes, it is evident NZ athletes with and without SCI are likely to benefit from further nutrition and supplement education.

PREFACE

This thesis is submitted in partial fulfilment of the requirements for a New Zealand Master's Degree in Dietetics and contains work from January to December 2012. The methodology and development of the questionnaire represents the collaborative work of Jessica Moulds and myself (David Shaw), for which we separately analysed the results regarding alternative areas of nutrition knowledge and practices for elite able-bodied athletes and athletes with spinal cord injury, with the support from our supervisor Dr. Katherine Black. This thesis has been supported by the research of other authors and we have done our best to provide references to these sources.

A friend's family member who had a spinal cord injury and the paucity of nutritional recommendations for athletes with spinal cord injury inspired the topic for this thesis. I hope the completion of this thesis and degree is an initial step towards a successful dietetic career, for which I plan to continue my learning through further research and experience.

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1.0 INTRODUCTION

The use of nutritional supplements has become a temptation for all athletes, including athletes with a disability, who wish to gain an advantage over their competition. Nutritional supplements are products intended to contribute to an individual's dietary intake and may include vitamins, minerals, amino acids and other substances [1]. Some evidence has associated certain health benefits from the use of specific supplements, whereas other supplements have been shown to enhance performance, often termed 'nutritional ergogenic aids' [1, 2]. This has led to the explosion of the nutritional supplement industry, which is continuously developing by providing a wide variety of supplements and sports food to athletes and non-athletes. Even though the evidence supporting the use of some supplements is inconclusive [3], the persuasive marketing campaigns from the supplement industry has increased the popularity and acceptance of these products among all athletes [3].

A growing population of athletes perceives that an optimal diet will not suffice and supplements are an important nutritional factor to enhance their performance. This is also true for athletes with a disability, who often have further physiological and medical complications to consider prior to supplement use since they are susceptible to adverse health outcomes [4, 5]. Despite there being five categories of disability at the Paralympics, those with a spinal cord injury (SCI) are the largest individual group competing and therefore, this thesis will focus on athletes with a SCI.
Previous research has demonstrated that anything from 51% [6] to 99% [7] of able-bodied (AB) athletes are reaching for nutritional supplements. Considerably less evidence is available for the use of supplements among athletes with a disability, however, one

study suggested at least 44% of athletes with SCI currently use supplements [8]. Therefore, it remains clear that the use of supplements is popular among athletes with or without a disability.

Moreover, a number of researchers believe dietary behaviour, such as supplement use, is related to dietary knowledge and attitude, and if provided with education on healthy eating practices and correct supplement use, then they are more likely to reflect this in their behaviour [9, 10]. Therefore, understanding supplementation among athletes, including their reasons for use, expected effects, nutritional knowledge and other factors likely to influence their decision to use nutritional products, may be crucial to improve supplementation practices among groups of athletes.

Current efforts by the Australian Institute of Sport (AIS) have classified supplements and sports food according to their efficacy and safety, accompanied by recommendations for their use in sport and exercise [11]. Other similar classifications exist [1] and therefore, it is often assumed for athletes, especially of elite level, to have the skill and knowledge to select appropriate supplements to effectively compliment their diet in order to meet their nutritional goals. However, the increasing availability and use of supplements that do not possess convincing scientific support for their use in sport and exercise places athletes at risk of supplement misuse, which can lead to positive drug tests, health complications, and poor control of body composition [3, 12]. This risk may be exacerbated when the evidence suggests many populations of athletes, some of elite level, possess only moderate to poor levels of nutrition and supplement knowledge [6, 13-15].

At present, there is limited information on the nutritional supplement knowledge of elite athletes and athletes with SCI, with no evidence comparing the two groups. Additionally, the majority of previous research has used nutrition knowledge questionnaires designed for AB junior athletes, coaches, or for countries other than New Zealand (NZ). Therefore, NZ requires its own questionnaire as the sporting pathways and nutrition education programs for athletes are often country specific. The questionnaire in the present study was designed to investigate the supplement knowledge, practices and reasons for use of elite NZ athletes, with and without SCI. Thereby, answering the research questions;

1) How does the nutritional supplement knowledge and practices of athletes with SCI compare with their able-bodied counterparts?

2) Does nutritional supplement knowledge relate to supplement practices among athletes?

2.0 LITERATURE REVIEW

The growing number and diversity of nutritional supplements and ergogenic aids on the market is tempting for athletes who wish to enhance their performance, or reach their health and dietary goals. Marketing claims are often based on poor scientific evidence, or none at all, and may lead to the misuse of these products by athletes [3]. The physiological alterations and adaptations associated with SCI [5] in combination with the physical demands of exercise creates a unique set of nutritional challenges, for which supplement misuse may exacerbate the risk of poor health outcomes and impaired performance. This emphasises the need to evaluate supplement knowledge and practices not only among AB athletes, but also athletes with SCI, due to the growing popularity and competitiveness of Paralympic sports.

2.1 Athletes with spinal cord injury

2.1.1 The rise of participation in sport

The first international sporting event for individuals with SCI occurred in 1952 at Stoke Mandeville Hospital in England, the home of the National Spinal Injuries Centre. These games were organised based on observations that those injured servicemen who were active had a better prognosis than those who remained bed ridden. The success of these games was built upon and by 1976, the first Olympiad was held for athletes with a disability in Toronto, Canada [16]. More than 1500 athletes from 38 countries participated [16]. The Toronto Olympiad is considered the turning point in the emergence of sports for the physically disabled from a predominantly rehabilitation measure to a respected performance event [16]. Even in non-paralympic sports, athletes with disabilities are achieving amazing accomplishments from swimming the English Channel to completing the Hawaii Ironman Triathlon. The benefits of physical activity for individuals with disabilities are synonymous with AB. Not only are there improvements in mobility, balance, endurance, weight management and strength, but possibly more important is the positive psychological influence diminishing the sense of depression commonly accompanying permanent physical or psychological disability [16]. Sport participation has become a desire for many individuals with disabilities to express their autonomy, mastery and purpose of their own life, as it is ability that counts, not disability [16]. The Paralympics has become the second largest sporting event in the world (the largest being the Olympics) [17] and as many elite Paralympic athletes are now professional, like their AB counterparts, they are seeking out the competitive edge, sometimes through the use of supplements.

2.1.2 What is spinal cord injury?

Spinal cord injury refers to any injury of the spinal cord that is caused by trauma [18]. Mechanical trauma results in the direct compression of neural elements, damaged blood vessels, disrupted axons, and broken neural cell membranes [18]. Symptoms of SCI vary depending on the location and severity of the lesion, and can result in pain, paralysis or incontinence [18]. Determining the level of lesion in the spinal column provides an indication for which specific body parts may be affected by a loss of function or sensation [19]. Figure 2.1.2.1 provides a map of the divisions of the spinal column and their neural output within the body.

Spinal cord injuries can be divided initially into two groups, tetraplegia and paraplegia. Tetraplegia is an impaired function of the arms, trunk, legs and pelvic organs, and results from a disruption or loss of motor and/or sensory function in the cervical segments of the spinal cord [19]. However, athletes with SCI are more likely to have paraplegia as a result of impaired motor and/or sensory function in the thoracic, lumbar, or sacral (not cervical) segments of the spinal cord [19]. With paraplegia, an individual's arm function is retained, however, depending on the location of the injury, the trunk and legs can be affected [19]. Further subdivisions of spinal cord injuries depending on severity are described at various levels of "incomplete", which can range from having no effect on the patient, to a "complete" injury, which means a total loss of function and sensation [19]. The severity of injury has been categorised by the five-level (A-E) American Spinal Cord Injury Association (ASIA) impairment scale, see Table 2.1.2.1 below [18].

Table 2.1.2.1 American Spinal Cord Injury Association impairment scale and description of each grade of impairment.

Grade	Description
A	Complete; no sensory or motor function preserved in the sacral segments (S4-S5).
B	Incomplete; sensory but no motor function preserved below the neurological level and extending through the sacral segment (S4-S5).
C	Incomplete; motor function preserved below the neurological level; most key muscles have a grade <3, which indicates active movement with a full range of motion against gravity.
D	Incomplete; motor function preserved below the neurological level; most key muscles have a grade >3.
E	Normal motor and sensory function

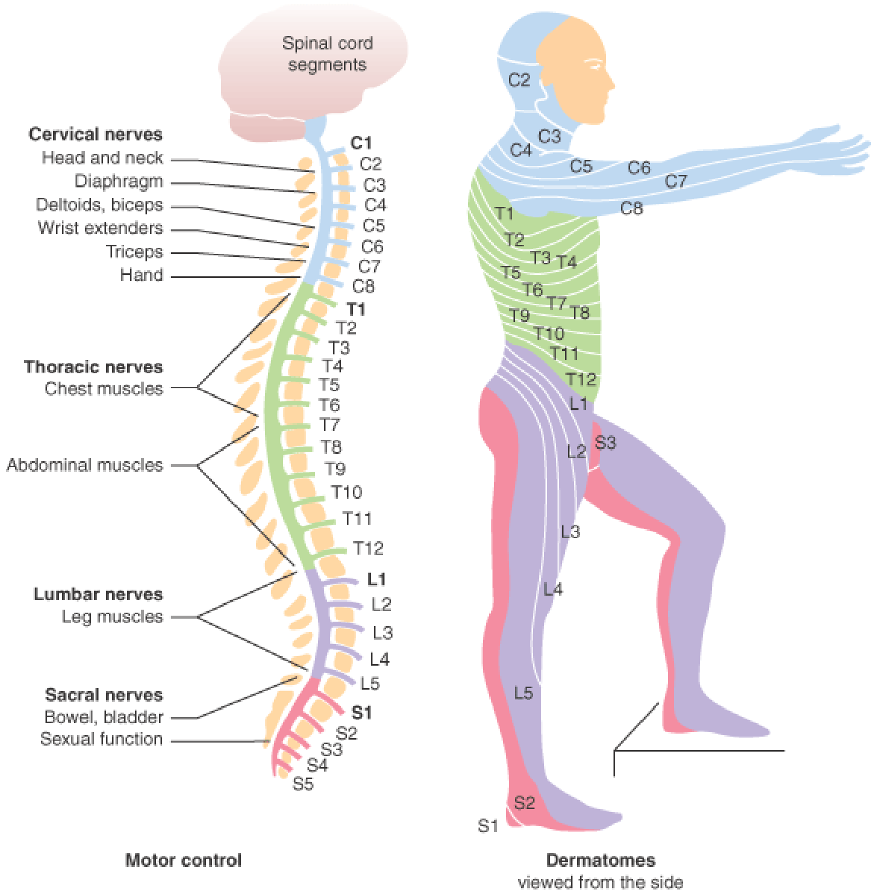


Figure 2.1.2.1. Spinal cord segments and their associated neural output and muscle groups innervated [20].

2.1.3 Common medical problems for athletes with spinal cord injury

The exponential rise in sport participation by athletes with SCI means health professionals need to be knowledgeable and proficient at dealing with health complications specific to this group of athletes [21]. As a population, epidemiological studies have shown athletes with disabilities have similar injury rates and patterns compared to their AB counterparts [22, 23]. However, some injuries and health complications are increasingly prevalent within some disability classifications [22]. Athletes with a SCI are likely to possess health complications that may have implications for sporting performance or are exacerbated by exercise, such as pressure sores, infections, autonomic dysreflexia, thermoregulation, neurogenic bladder and peripheral nerve entrapments [21]. It is important for these existing medical conditions to be effectively managed for an athlete to fulfil their training and competition schedule. Medications and medical support may be necessary to maintain health, quality of life and functionality, however, it is also important to consider how these effect their nutritional requirements and performance.

2.1.4 Dietary considerations for athletes with spinal cord injury

Athletes with SCI train at similar relative intensities, durations and frequencies as their AB counterparts [8]. The increasing popularity and competitiveness of Paralympic sports demands athletes to utilise optimal training strategies, including nutrition, to enhance performance [8]. A recent study investigating the dietary adequacy of athletes with SCI demonstrated micronutrient deficiencies, despite having macronutrient and energy intakes within acceptable ranges [8]. Other studies have reported the dietary intake of athletes with SCI is similar to non-athletes with SCI [24-26], which suggests this athletic population may not be consuming an optimal diet to enhance performance.

For athletes with SCI in NZ, many receive nutrition education during the rehabilitation period, however, long term nutritional support from qualified professionals is variable and may be lacking [27]. This may be because a considerable amount of research has been invested into the development of nutritional recommendations for AB athletes that may not be appropriate for athletes with SCI and at present, alternative recommendations are unavailable. Athletes with SCI have changes to their cardiorespiratory, metabolic, neuromuscular and thermoregulatory systems compared to AB athletes that reduce their overall physiological capacity and need to be evaluated prior to nutrition intervention [5, 8]. These nutritional considerations exist in conjunction with some evidence suggesting that athletes with

SCI are likely to have inadequate intakes for some nutrients [8] (as discussed in the following sections) and may have different nutritional requirements compared to their AB counterparts [5, 28-30]. This is predominantly based on physiological studies evaluating the changes in fluid regulation, nutrient metabolism and body composition, often by measuring specific physiological or metabolic processes, such as sweat rate [5, 28], nitrogen balance [30], respiratory exchange ratio [31-33], resting metabolic rate [5] or muscle and fat mass [5]. The following is a summary of nutritional complications associated with athletes with SCI.

2.1.4.1 Energy balance and macronutrient intake

Balancing energy intake with energy expenditure is increasingly difficult for athletes with SCI compared to AB athletes [30]. A study by Krempien & Barr [8] demonstrated energy intakes of Canadian athletes with SCI were 2,156 ± 431 kcal for men and 1,991 ± 510 kcal for women, which is similar to those for non-athletes with SCI [8]. Furthermore, macronutrient intakes were within acceptable macronutrient distribution ranges (AMDR) (54.2% carbohydrate, 17.6% protein, 28.7% fat), with no significant differences based on gender, sport, or training environment [8]. However, AMDR's are designed for AB adults who are not athletes and are not specific to athletes with SCI [8]. Despite their high activity levels, athletes with SCI often have energy intakes lower than estimated energy requirements for sedentary AB individuals of similar size [8]. This is likely due to the reduced energy expenditure associated with lower resting metabolic rates as a result of their lower lean muscle mass and reduced active tissue [8, 29, 34]. A consequence of this is weight gain, and an increased susceptibility to becoming overweight or obese, which is evident as many individuals with SCI struggle to control their body weight [30].

2.1.4.2. Micronutrient intake

Athletes with SCI need to consume a nutrient dense diet as they try to meet their micronutrient needs while consuming a diet lower in energy compared to an AB population. For non-athletes with SCI, intakes of several vitamins and minerals including calcium, vitamin D, folate, zinc and iron have been found to be below recommendations [24-26, 35]. Additionally, in the study by Krempien & Barr [8], more than 25% of male athletes with SCI were reported to have intakes below the estimated average requirement (EAR) for calcium, magnesium, zinc, riboflavin, folate, vitamin B12, and vitamin D, and more than 25% of female athletes with SCI had intakes below the EAR for calcium, magnesium, folate and vitamin D [8]. Although vitamin and mineral supplementation increased male intakes of micronutrients, it had no effect on the prevalence of male athletes reaching nutrient recommendations (i.e. EAR), and even less effect on female athletes, suggesting that athletes with the poorest diets were less likely to use supplements because of the failure of supplements to improve dietary adequacy (i.e. meet the EAR) [8].

2.1.4.3. Hydration and thermoregulation

There are physiological and practical complications for managing the hydration status and thermoregulation among athletes with SCI [5, 30]. The neurological interruption within the spinal cord impairs the autonomic and somatic nervous system, which disrupts the control of skin blood flow and diminishes the sweating response to areas innervated below the spinal cord lesion, thus impairing the thermoregulatory system [5, 36]. The consequence of a reduced vascular control over a large portion of the skin lowers the capacity of heat dissipation and elevates core body temperature at rest and during exercise, which increases the risk of hyperthermia and may impair performance in a similar way to AB athletes [5, 37]. It has been demonstrated that the thermoregulation impairment of athletes with SCI causes an elevation in core body temperature similar to AB athletes during exercise, despite a lower metabolic rate (due to a lower muscle mass) [38]. Therefore, it is mainly when exercising in the heat where hyperthermia is of greatest concern, as heat has been shown that the lower limbs act as heat skin and thereby heat is gained from the environment [39]. Furthermore, a diminished sweating response means athletes with SCI may have lower fluid requirements compared to their AB counterparts during exercise. Despite the reduced fluid loss from sweat appearing to benefit dehydration, it contributes to the negative effects of the thermoregulatory capacity and further increases the risk of hyperthermia [5, 28]. As with AB athletes, it is recommended for athletes with SCI to estimate their fluid requirements from sweat rates to develop appropriate hydration strategies [28]. Other factors athletes with SCI need to consider are their access to toilet and water facilities and potentially the use of urine collection bags as bladder control can be impaired [40]. Athletes using catheter bags have an increased risk of urinary tract infection, which can be prevented by increasing fluid consumption [41]. However, this needs to be well managed in order to prevent the onset of hyponatremia, which is seen among the SCI population at greater rates than within the general population. This is possibly due to a resetting of the osmostat to lower levels, a phenomenon which has previously been described within the SCI population [42].

2.1.4.4. Nutritional Supplements

The use of nutritional supplements in athletes with SCI is determined with a similar approach to AB athletes. The quality of an athlete’s diet, health status, nutrition goals, and the risk of under-nutrition or malnutrition all need to be evaluated before supplements are recommended, ideally by a qualified sports nutritionist or dietitian [1].

Furthermore, medications may compromise the metabolism of some nutrients, producing acute or chronic dietary deficiencies, dependent on the type, dose and duration of the medication [43]. Therefore, athletes and health professionals must be prudent with supplement choice to avoid possible nutrition complications.

In general, it can be assumed the benefits of supplementation are similar in AB athletes and athletes with SCI. However, all supplements and sports food need to be evaluated for efficacy, effectiveness, side-effects, and risk for inadvertent doping prior to use [1, 44].

2.2 Nutritional Supplements

2.2.1 What are nutritional supplemements?

There is no single definition for what constitutes a “nutritional supplement”, although many attempts have been made. Within the supplement industry, nutritional supplements have many terms – dietary supplement, nutritional ergogenic aid, sports food and therapeutic nutritional supplement. Each definition has failed to encompass the full scope for ‘what are nutritional supplements’, ‘reason for use’ and the ‘context for which they are to be used’. The US Congress, for example, in framing the 1994 Dietary Supplements Health and Education Act (DSHEA), defined supplements as follows...

...”*A dietary supplement is a product taken by mouth that contains a "dietary ingredient" intended to supplement the diet. The "dietary ingredients" in these products may include: vitamins, minerals, herbs or other botanicals, amino acids, and* *substances such as enzymes, organ tissues, glandulars, and metabolites. Dietary supplements can also be extracts or concentrates, and may be found in many forms such as tablets, capsules, soft gels, gel caps, liquids, or powders. They can also be in other forms, such as a bar, but if they are, information on their label must not represent the product as a conventional food or a sole item of a meal or diet. Whatever their form may be, DSHEA places dietary supplements in a special category under the general umbrella of "foods," not drugs, and requires that every supplement be labelled a dietary supplement"...* [1].

The International Olympic Committee (IOC) states, "*the use of supplements does not compensate for poor food choices and an inadequate diet, but supplements that provide essential nutrients may be a short-term option when food intake or food choices are restricted due to travel or other factors*" [44]. The New Zealand Dietetic Association's Position Stand on Sports Nutrition discourages the use of supplements [45]. However, consistent with the IOC, supplements may be used to ameliorate medical conditions, for example iron supplementation for the treatment of iron deficiency anaemia [45].

Some countries classify a nutritional supplement as a food, while in other countries they are classified as drugs [3]. In most countries, products regulated under the food law must not claim to treat or cure an illness or disease [3]. However, if supplement manufacturers represent or claim their product to have such benefits, these must be substantiated by adequate evidence to show that they are not false, misleading or deceiving [1]. Such claims are reserved primarily for pharmaceuticals - not dietary supplements, however, a supplement manufacturer may wish to market their product as both, nutritional supplement and pharmaceutical, as long as they meet the conditions of each regulatory framework [3]. Overall, supplements have nested into a vital area of nutrition particularly for health and performance, and if used in accordance with current research and guidelines, nutrition experts have shown some supplements to ameliorate health and performance [44].

Nutritional ergogenic aids are substances that claim to increase exercise performance capacity and/or enhance training adaptations [1]. This includes substances which help prepare an athlete for exercise, improve the efficiency of exercise, or aid recovery post exercise, and are either nutrients, metabolic by-products of nutrients, food (plant) extracts, or substances commonly found in the diet that are supplied in concentrations higher than commonly found in the natural food supply [1]. Differentiating nutritional ergogenic aids from supplements is their beneficial effect on performance, which is often based on theoretical support and lacks convincing scientific evidence [1]. Caffeine, creatine and buffering agents such as bicarbonate are the only ergogenic aids with sufficient evidence to be considered of benefit to an athlete's performance when used in accordance with current evidence and under the guidance of a qualified health or sport professional [1]. However, there is some debate over what qualifies supplements, sports food and even nutritional practices as ergogenic since many of these can benefit performance in multiple sporting situations [1].

2.2.2 Classification of nutritional supplements

There is a variety of approaches used to classify nutritional supplements; in reference to their function, form, or availability of scientific merit. The AIS devised a system dividing supplements into classifications according to their effectiveness and safety [11]. Supplements are grouped from A to D, representing supplements supported for the use in specific sporting situations, through to supplements with no supporting evidence or are banned due to a high risk of contamination [11]. The International Society of Sports Nutrition has taken a similar approach by dividing supplements into classifications from ‘apparently effective’ to ‘apparently ineffective’ [1]. The AIS have classified supplements such as sports drinks, whey protein, sports bars, calcium supplements, iron supplements, multivitamins, vitamin D, electrolyte replacements, caffeine, creatine and bicarbonate within group A; a convenient source of energy and nutrients, or containing sufficient scientific evidence indicating a performance enhancement [11]. Group B supplements have received some scientific attention and suggest possible benefits to performance and Group C supplements have no or little scientific evidence for performance benefits. Group D supplements include stimulants and hormone/pro-hormone boosters such as Ephedrine, DHEA, Androstenedione, 19-norandrostenedione, erythropoietin and Tribulus terrestris, which are unsafe and/or banned by the World Anti Doping agency (WADA) [11]. The World Anti Doping agency have developed a list of prohibited substances and practices for use in-competition, out-of-competition, and in particular sports [46]. Substances and practices are classified in seven categories: anabolics, stimulants, diuretics, narcotic analgesics, hormones and analogues, and physical manipulates [46]. Prohibited substances by WADA are placed in the Group D category by the AIS [11].

2.2.3 Regulation of nutritional supplements

The regulation of nutritional supplements is a contentious area and encompasses issues of manufacture, labelling and marketing. Among athletic populations, there are concerns for the efficacy, safety, risk of inadvertent doping, and the proliferation of unsupported marketing claims, which have combined to create a conundrum for athletes regarding supplement choice [1, 3, 11, 12, 47]. The WADA code expresses extreme caution regarding supplement use, and state...

... "*The use of dietary supplements by athletes is a concern because in many countries the manufacturing and labelling of supplements may not follow strict rules, which may lead to a supplement containing an undeclared substance that is prohibited under anti-doping regulations. A significant number of positive tests have been attributed to the misuse of supplements and taking a poorly labelled dietary supplement is not an adequate defence in a doping hearing*"... [46]

There is no universal system for the regulation of supplements as countries differ in their approach. For example, government bodies may regulate supplement use and availability, with other agencies or programs providing anti-doping education and drug testing for prohibited substances [47]. As a result of some countries failing to enforce the regulation of supplements and sports food, many become contaminated with substances that could cause positive doping tests or endanger individuals' health [12].

2.2.4 Safety and Risks of nutritional supplements

Most nutritional supplements are likely to be safe as health and wellbeing are the primary concerns for manufacturers [3]. Nevertheless, cases of toxicity and side effects including allergic reactions, overexposure due to self-medication and poisoning from contaminants have been reported [48-50]. Studies have shown some products do not contain measurable amounts of substances stated on the label, while others may contain up to 150% of the quantity identified on the label [51-53]. In some cases, the undeclared substances found in supplements overlap with substances prohibited by the Anti-Doping Code of the International Olympic Committee (IOC) and WADA [12]. These include the stimulants ephedrine and sibutramine, and anabolic-androgenic steroids [54], with the consumption of these pro-hormone substances through supplements has becoming a frequent source of unintentional doping [47]. Results from an IOC study on non-hormonal nutritional supplements (from 13 countries) showed that 94 of 634 samples (14.8%) contained prohormones not listed on the label [54]. Forty-nine (7.7%) of the supplements contained one steroid, with 45 (7.1%) containing more than one steroid product, and eight (1.3%) containing five or more different steroid products [54].

The innocent ingestion of prohibited substances is not an acceptable excuse for a positive WADA doping test, as athletes are 100% liable for positive results and should enquire at anti-doping agencies within their countries for advice on the risks associated with specific supplements prior to their use [55].

2.2.5 Prevalence of nutritional supplement Use

Current research suggests the majority of athletes value the use of nutritional supplements and ergogenic aids as indicated by their popular use (Table 2.2.5.1). The available literature suggests anything from half [6] to almost all AB athletes [7] are using or have used some type of supplement, compared to 44% of athletes with SCI [8]. Of the research investigating athletes supplement practices, several studies have evaluated the supplement use in athletes 18 years and older of mixed sports (studies must be representative of 3 or more sports) competing at a minimum of university, college, state (if American) or national level published since 2000 (table 2.2.5.1). These criteria were used to restrict the inclusion of studies to those athletes most representative of the AB athlete population in the present study. Two other studies were included; one study investigating athletes with SCI [8] and one study investigating athletes with disabilities [56] (table 2.2.5.1).

The highest use of supplements was found in a study by Kristiansen (2005), who investigated the supplement practices among 247 Canadian university AB athletes from 17 different sports teams (table 2.2.5.1) [7]. Ninety-nine percent of this group reported using some type of supplement, which was compared to a control group of non-athletes, of which 94.3% used supplements [7]. Others studies have also found high levels of supplement use among AB athletes, each reporting over 80% of the athletes in the sample population were using or have used some type of supplement [14, 57, 58]. However, the group of athletes in Kristiansen's study was considered to be of non-elite level, for which the majority of research investigating supplement practices in athletes has evaluated. These include studies by Burns et al [57], Froiland et al [58], Herbold et al [59], Jacobson et al [60], Striegel et al[61], and Tian et al [62], who have all reported the popular use of supplements and nutritional products among athletes (Table 2.2.5.1).

In comparison, a Norwegian study of elite athletes by Sundgot-Burgon (2003) investigated supplement practices in 1,620 (960 male and 660 female) athletes of different competitive levels [6]. From the studies shown in table 2.2.5.1, Sundgot-Burgon reported the lowest rates of supplement use, as demonstrated by only 52.6% of the athletic sample population reporting the use of one or more products [6]. This study compared results with a sample of the general population, and showed the prevalence of use was similar in female athletes and female controls, however, significantly more male athletes used supplements (51.4%), compared to male controls (32.4%) [6]. Although, there was no significant difference between male (51.4%) and female athletes (54.1%), females of higher ranking and experience were less likely to use supplements compared to their lower ranked counterparts [6], suggesting supplements are not necessary for performance.

Slater (2003) investigated another group of elite athletes, this time in Singapore, and reported 77% have used one or more supplements within the previous 12 months, which is considerably higher than their Norwegian counterparts [15]. The difference in the prevalence of use between groups of elite athletes in different countries is not solely a result from the characteristics of the study methodology and differences in supplement classification, but also from the unique nutritional education programs and sporting pathways for elite athletes within different countries. A total of 59 different supplements were reported to be used in the study, with each athlete reporting the consumption of 3.6 ± 3.8 different products within the previous year [15]. Of those athletes reporting supplement use, 89% used more than one product, 40% used 5 or more products, and 9% used 10 or more products [15]. The use of more than one supplement, commonly termed “polypharmacy”, has been reported in other studies [14, 57, 62]. One of these was a recent study by Dascombe (2010), who reported 87.5% of elite athletes from the AIS took at least one nutritional supplement [14], with the highest use reported by kayakers using an average of six supplements and swimmers using an average of four supplements [14].

Additionally, a study by Striegel (2006) examined 598 Master athletes from five different European countries participating at the World Masters Athletic Indoor Championships 2004 [61]. Athletes in this study were significantly older compared to other studies, with an mean age of 50 for females and 54 for males [61]. Within this population, 60.5% reported to previously using supplements, from which, 93.8% reported to be currently using [61], which demonstrates aging athletes continue to perceive supplements as an important nutritional factor in competitive sport.

It is important to consider the recommendations for the use of specific supplements to enhance performance are dependent on the nutritional requirements of the athlete and the characteristics of their chosen sport or event. The marketable versatility of sports drinks have led to their ubiquitous use in sports and have been reported as the most popular supplement for many athletes, which was demonstrated by Kristiansen et al[7], as 76.5% of Canadian university athletes reported to consume some type of sports drink, a practice also reported by Froiland et al [58]and Tian et al [58, 62]. However, various studies have shown prevalences for the use of specific supplements to be variable between athletic populations, which are likely due to a difference in study methodology and the characteristics of the athletes participating (Table 2.2.5.1).

Creatine was the most popular supplement among athletes from an American university, which was consumed by 28.6% of the athletes, with men (38.9%) significantly more likely to take creatine than women (9.8%) [60], a trend reported in several other studies [6, 7, 15, 60]. A male's preference for creatine is probably due to its association with improved performance and increases in muscle mass and strength, which are desirable attributes for many male dominated sports [1]. Furthermore, 18.9% of the athletes used vitamin and mineral supplements, which was more common in females (29.3%) than males (13.2%), potentially because of its association with health and wellbeing [60]. Other studies have reported the use of vitamin and mineral supplements in approximately 40% of athletes, with a higher use among females [6, 7, 14, 57, 58, 62].

The single study reporting supplement use in athletes with SCI by Krempien et al only investigated the use of vitamin and mineral supplements [8]. Among these athletes who were considered of elite level, who were predominantly competing in wheelchair rugby, 43.8% reported the consumption of vitamin or mineral supplements [8]. In another study by Tsitsimpikou et al who investigated athletes with a disability participating in the 2004 Athens Paralympics, 42.1% reported the use of supplements [56]. However, Tsitsimpikou et al did not separately analyse the different categories of disabilities, nor mention which supplements were used. Nevertheless, the results from these two studies indicate that supplement use remains high among this athletic population, although it is likely to be not as popular as within AB athletes.

Table 2.2.5.1. Prevalence of supplement use and demographic characteristics reported by studies published since 2000 investigating supplement practices of athletes 18 years and older of mixed sports (studies must be representative of 3 or more sports) competing at a minimum of university or college, state (if American) or national level.

Reference	**N (gender)**	**Sport, level**	**Country**	**Age (years)**	**Prevalence of use**	**Most common supplements**
Jacobson et al, 2001[60]	330 (F 125, M 205)	Mixed, Tertiary	America	N/A	F 65%, M 79%	Creatine (28.6%), Vitamin/Mineral supplements (18.9%), Carbohydrate drink (16%)
Slater et al, 2003 [15]	160 (F 75, M 85)	Mixed, Elite	Singapore	<15 to > 35, predominantly 15 to 25	77%	Sports Drinks (39%), Caffeine (37%), Vitamin C (33%)
Sundgot-Burgon et al, 2003 [6]	1222 (F 556, M 666)	Mixed, Elite	Norway	M 23.2 ± 4.7, F 21.4 ± 4.6	F 54%, M 51%	Energy Supplements (M 65%, F 53%), Vitamins (M 70%, F 82%), Minerals (M 26%, F 43%), Omega 3 (M 36%, F 37%)
Burns et al , 2004 [57]	236 (F 118, M 118)	Mixed, Tertiary	America	20 ± 1.1	88%	Vitamins/Minerals (73.3%), Calorie Replacement Drinks (47.0%), Protein supplements (40.3%)
Froiland et al, 2004 [58]	203 (F 88, M 115)	Mixed, Tertiary	America	19 & older	89%	Sports Drinks (73%), Calorie Replacement Drinks (61.4%), Multivitamin (47.3%)
Herbold et al, 2004 [59]	162 (F)	Mixed, Tertiary	America	19.5 ± 1.2	65.40%	Vitamins and minerals (36.0%), Herbal/botanical supplements (17.0%), Protein supplements (12.0%)

Tsitsimpikou et al, 2004 [56]	680	Mixed, Elite, Athletes with a disability	Various	34.3 ± 7.8	42.10%	N/A
Kristiansen et al, 2005 [7]	209 (F 89, M 120)	Mixed, Tertiary	Canada	F 20.7 ± 1.6, M21.3 ± 2.0	98.60%	Sports Drinks (76.5%), Caffeine (75.5%), Carbohydrate bars (64.1%)
Striegel et al, 2006 [61]	598 (F 184, M 414)	Mixed, Elite/Masters	Various	F 50.0 ± 10.6, M 54.1 ± 11.9	60.50%	Minerals (29.9%) Vitamins (35.4%) Proteins (10.6%)
Tian et al, 2009 [62]	82 (F 47, M 35)	Mixed, Tertiary	Singapore	21.9 ± 2.5	76.80%	Sports Drinks (90.4%) Vitamin C (49.2%) Multivitamins (30.2%)
Dascombe et al, 2010 [14]	72 (F 36, M 36)	Mixed, Elite	Australia	21.9 ± 3.9	87.50%	Minerals (45.8%), Vitamins (43.1%), Iron (30.6%)
Krempien & Barr, 2011 [8]	32 (F 8, M 24)	Mixed, Elite, Athletes with SCI	Canada	30.6 ± 6.2	F 62.5%, M 37.5% (Vitamin/Mineral supplements only)	Vitamin/Mineral supplements (43.7%)

N/A = Not available

2.2.6 Reasons for Nutritional Supplement Use

Previous research has provided numerous reasons for supplement use among AB athletes, with the most common reasons summarised in Table 2.2.6.1, however, the current review could not ascertain any research investigating the reasons for supplement use among athletes with SCI. Recommendations for nutritional supplementation or the use of sports food aim to provide,

- a practical and convenient source of nutrients to meet daily requirements to optimise training and competition performance, or
- a source of nutrients in large quantities to treat a known nutritional deficiency, or
- a source of nutrients or other components in quantities that are scientifically supported to directly enhance sport performance or maintain/restore health and immune function [1, 2].

It is likely male and female athletes differ in their reasoning for supplement use. Studies investigating athletes' supplement practices have reported females tend to use supplements because of an inadequate diet, preventing illness, or increasing energy [14, 58]. Alternatively, male athletes tend to use supplements to improve speed and agility, increase strength and power, or for weight and muscle gain [58]. [1, 2, 14].

However, an incongruence between evidence based reasoning for the use of specific supplements and an athlete's motives for or their desired effect from the use of the same supplement has been reported among both males and females. In a Canadian study of university athletes, males and females were reported to consume creatine in order to ‘strengthen bones’, caffeine to ‘to provide energy and meet nutrient needs’, and vitamins to ‘provide more energy’ [7], for which these supplements are unlikely to achieve because they are either not associated with the desired effect or provide no benefit in addition to an optimal diet [1, 2]. Another study specifically investigating UK based elite and non-elite athletes’ performance-related reasoning and their use of certain supplements demonstrated similar incongruences [63]. Vitamin C was the exception, which was associated, but not strongly, with preventing illness [63]. No other supplement and rationale for use showed a strong or intermediate association [63]. It is possible some athletes may be using supplements as a placebo effect, although many of the discrepancies between an athlete’s supplement use and their supporting reasons suggests athletes have an inadequate level of nutritional supplement knowledge, which will be discussed in the proceeding sections.

It is clear, long-term training, optimal nutrition, adequate sleep and recovery, state-of-the-art equipment, superior genetics and other factors that determine successful performance cannot be replaced by the use of supplements [1, 3]. Athletes can be distracted from these true elements of success with the enticing and emotive claims offered by nutritional products and sports food. Therefore, athletes failing to address the basic elements of good training and lifestyle need to be investigated by sport and health professionals for their reasoning prior to their use of supplements. Additionally, it may be important to evaluate an athlete’s reasons for use in conjunction with psychological factors such as unattainable goals and the belief supplements can provide the pathway to becoming a world class athlete, as these will need to be addressed [55].

Table 2.2.6.1 Reasons for supplement use reported by studies published since 2000 investigating athletes 18 years and older of mixed sports (studies must be representative of 3 or more sports) competing at a minimum of university or college, state (if American) or national level.

Reference	**Gender**	**Population**
		Health and Wellbeing
Slater et al, 2003 [15]	Both	Athletes categorized under the Sports Excellence Scheme of the Singapore Sports Council
Froiland, 2004 [58]	Both	College Athletes (American Division 1)
Herbold et al, 2004 [59]	Female	Undergraduate Female Athletes of an American University
Kristiansen et al,2005[7]	Both	Athletes of a Canadian University
Striegel et al, 2006 [61]	Both	Masters athletes at the 2004 World Masters Athletic Championships Indoors
Tian et al, 2009 [62]	Both	Athletes of a Singaporean University
Dascombe et al,2010[14]	Both	Athletes from Australian State Based Sports Institutes
		Improving Sport and Athletic Performance
Slater et al, 2003 [15]	Both	Athletes categorized under the Sports Excellence Scheme of the Singapore Sports Council
Sundgot-Burgon et al, 2003[6]	Both	Elite Athletes in Norwegian National Teams
Froiland et al, 2004 [58]	Both	College Athletes (American Division 1)
Herbold et al, 2004 [59]	Female	Undergraduate Female Athletes of an American University
Kristiansen et al,2005[7]	Both	Athletes of a Canadian University
Striegel et al, 2006 [61]	Both	Masters athletes at the 2004 World Masters Athletic Championships Indoors
Tian et al, 2009 [62]	Both	Athletes of a Singaporean University
Dascombe et al,2010[14]	Both	Athletes from Australian State Based Sports Institutes
		Increase Muscle Size and Strength
Slater et al, 2003[15]	Both	Athletes categorized under the Sports Excellence Scheme of the Singapore Sports Council
Froiland et al, 2004 [58]	Both	College Athletes (American Division 1)
Herbold et al, 2004 [59]	Female	Undergraduate Female Athletes of an American University
Kristiansen et al,2005[7]	Both	Athletes of a Canadian University
Striegel et al, 2006 [61]	Both	Masters athletes at the 2004 World Masters Athletic Championships Indoors
Tian et al, 2009 [62]	Both	Athletes of a Singaporean University

Dascombe et al,2010[14]	Both	Athletes from Australian State Based Sports Institutes
		Increase Energy
Slater et al, 2003 [15]	Both	Athletes categorized under the Sports Excellence Scheme of the Singapore Sports Council
Froiland et al, 2004 [58]	Both	College Athletes (American Division 1)
Kristiansen et al,2005[7]	Both	Athletes of a Canadian University
Striegel et al, 2006 [61]	Both	Masters athletes at the 2004 World Masters Athletic Championships Indoors
Tian et al, 2009 [62]	Both	Athletes of a Singaporean University
Dascombe et al,2010[14]	Both	Athletes from Australian State Based Sports Institutes
		Boost Immunity and Prevent Illness
Slater et al, 2003 [15]	Both	Athletes categorized under the Sports Excellence Scheme of the Singapore Sports Council
Froiland et al, 2004 [58]	Both	College Athletes (American Division 1)
Kristiansen et al,2005[7]	Both	Athletes of a Canadian University
Tian et al, 2009 [62]	Both	Athletes of a Singaporean University
Dascombe et al,2010[14]	Both	Athletes from Australian State Based Sports Institutes
		Improve an inadequate Diet
Sundgot-Burgon et al, 2003[6]	Both	Elite Athletes in Norwegian National Teams
Froiland et al, 2004 [58]	Both	College Athletes (American Division 1)
Kristiansen et al,2005[7]	Both	Athletes of a Canadian University
		Reduce Fatigue
Slater et al, 2003 [15]	Both	Athletes categorized under the Sports Excellence Scheme of the Singapore Sports Council
Kristiansen et al,2005[7]	Both	Athletes of a Canadian University
Tian et al, 2009 [62]	Both	Athletes of a Singaporean University
Dascombe et al,2010[14]	Both	Athletes from Australian State Based Sports Institutes

2.3 Nutritional supplement knowledge

2.3.1 An introduction to nutrition and supplement knowledge

Many athletes appear to have inadequate knowledge regarding nutrition and supplements [3], and unfortunately for the many athletes using nutritional supplements and ergogenic aids, research suggests they possess misconceived reasons for their use [3]. Currently, only one study has investigated the nutrition knowledge of athletes with a disability and reported this group had similar nutrition knowledge levels with their AB counterparts [64]. This does not imply athletes with a disability have adequate nutrition knowledge, but are more likely to be a victim of poor nutrition education and persuasive marketing as are AB athletes.

Knowledge regarding nutritional supplements can be categorized into two types [10],

- *"Declarative knowledge is the knowledge of what is, awareness of things and processes"*. For example, sports drinks provide a source of fluid, electrolytes and carbohydrates or milk is a good source of calcium.
- *"Procedural knowledge is the knowledge regarding how to do things"*. For example, how to prepare a sports drink from powder to meet the recommendations for electrolyte and carbohydrate content or how to choose what supplement will compliment nutritional and training goals.

Interestingly, some knowledge is ignored in preference for other knowledge which holds higher value to the individual [10]. Despite some knowledge being 'scientifically proven', prior beliefs or experiences influence how important new information is perceived. This led to the emergence of the 'cognitive dissonance theory', in which individuals may hold conflicting ideas, beliefs and values [10]. Individuals acquire 'cognitive consistency' by manipulating these ideas, beliefs and values in accordance with true fact, or contrary to this, individuals or companies may manipulate true facts in accordance with current beliefs [10]. As a result, not only athletes, but also any individual who does not critically evaluate supplements based on scientific merit is susceptible to misinformation and poor knowledge.

2.3.2 Knowledge of Nutritional Supplements

Many athletes demonstrate a poor to moderate level of knowledge regarding nutritional supplements. However, nutritional knowledge is complex and often difficult to measure, especially in athletic populations, due to the variability of nutritional requirements for each sporting discipline and the nutritional goals of the athlete. With this in mind, an athlete may only be knowledgeable about a specific supplement or sports food they are currently using or have used in the past [10]. Additionally, misconceptions of specific nutrients may influence their knowledge of a particular supplement, therefore, evaluating an athlete's knowledge of nutrients such as protein, carbohydrate, vitamins and minerals – which all contribute to some types of supplement – can help gauge the level of an athletes supplement knowledge.

A paucity of literature exists which directly investigates an athlete's knowledge of nutritional supplements, therefore, the following studies have been used (table 2.3.2.1) as they are relevant to supplement knowledge either by evaluating an athlete's perceived level of knowledge [6, 7, 14, 15, 62], their knowledge of specific nutrients that are available as nutritional supplements [60, 65, 66] or their reasons for supplement use (previously in section 1.2.6.), in addition to investigating the knowledge of supplement function and efficacy [58, 67]. Despite, the majority of the current research being representative of AB university athletes, it remains evident that regardless of an athlete's age, sex, sporting level or country, their knowledge of nutritional supplements appears is suboptimal.

2.3.2.1 Self-reported knowledge

Various studies investigating athletes supplement practices have evaluated their "self reported" or "perceived" level of knowledge of nutritional supplements [6, 7, 14, 15, 62]. In a Canadian study of university athletes by Kristiansen et al [7], only 37% of athletes felt they knew enough about nutritional supplements, with 46% reporting they had insufficient knowledge. This is a common trend within many athletic groups [6, 7, 14, 15, 62] and may be reflective of the nutrition education provided to athletes as they progress from junior to elite level. Although this athletic group was of non-elite level, the results are comparable to a study of elite athletes by Sundgot-Borgen et al [6], who reported among those currently using supplements, only 41% of males and 37% of females believed they were well informed about nutrition and supplements. However, this study only evaluated Norwegian athletes and may not be representative of the beliefs of elite athletes from other countries as the athlete development programs and nutrition education system are likely to differ.

In another study of elite athletes, Slater et al recruited participants from the Sports Excellence Scheme of the Singapore Sports Council and evaluated their perceived level of supplement knowledge. Sixty percent of this group self-reported no or limited knowledge of supplements, with only 10% reporting a good or excellent level of knowledge [15]. There was no relationship between supplement use and knowledge ($p=0.09$), however, athletes who were grouped into those reporting good and excellent levels of knowledge were more likely to use supplements than those reporting nil, limited or average levels of knowledge ($p=0.02$) [15], a result supported in a later study by Tian et al [62].

Similar to Kristiansen et al [7] and Slater et al [15], Dascombe et al investigated elite athletes from the Australian Institute of Sport [14]. Despite the majority of these athletes self-reporting a limited level of supplement knowledge, they had a desire to learn more [14], which is a trend supported by other studies by Kristiansen et al [7], Tian et al [62] and Nieper at al [68]. One of these was by Tian et al, who investigated athletes of a Singaporean university [62]. More than one third (36.3%) of supplement users reported no or limited knowledge of the supplement they were using, however, 81% of males and 52% of females reported to research a nutrition product before use. Interestingly, despite 54% stating they were concerned about the risks and safety of supplement use, 86.4% were not aware supplements could adversely affect health and 29.5% did not realise they are a possible cause for inadvertent doping [62]. Therefore, an athlete's low perceived level of knowledge may be exacerbated by their lack of understanding of the safety and probably, the efficacy and effectiveness of some supplements.

2.3.2.2. Knowledge of supplement function

A recent study by Jessri (2010) investigated the nutrition knowledge of Iranian college basketball and football players. The questionnaire comprised of four subcategories evaluating the athlete's knowledge of specific nutrients, fluid and hydration, weight control, and supplements [67]. Among these athletes, the supplement knowledge category contributed the least to their overall nutrition score and received the highest amount of unsure responses. This may be an outcome of the numerous nutritional messages and marketing claims offered by the supplement industry, which are often unsupported by scientific evidence and conflict with best practice guidelines [3]. Furthermore, almost two thirds of this group stated that athletes should routinely take vitamin supplements [67], which does not coincide with current recommendations that clearly state an optimal diet can supply adequate amounts of vitamins and minerals for athletic performance [1]. However, there are some nutritional supplements and ergogenic aids that are associated with performance enhancing effects in additional to an optimal diet when used correctly and in specific sporting situations [1, 2]. It is possible some athletes are not aware of these performance benefits, which was demonstrated in a study by Froiland et al who asked athletes attending an American university to define a "nutritional supplement" [58]. Only 34% of the responses contained all or part of the following statement; a product that helps to increase performance, strength, muscle, and enhance recovery [58]. Contrary to this statement, the Dietary Supplement Health and Education Act's definition of nutritional supplements does not include any performance-related effects [1], which may account for this result. It is also probable for the marketing from the supplement industry claiming to enhance performance or health from the use of specific supplements, which are often unsupported by the scientific literature, may lead to misconceptions regarding the efficacy of some supplements, which has already been reported in athletes of elite and non-elite level [7, 14, 63].

2.3.2.3. Protein knowledge

A high protein diet has had a long history in sport and is often thought to augment muscle size and strength [3]. Various athletic groups continue to possess misconceptions regarding protein, particularly its role in energy metabolism and muscle growth. A study by Jacobson et al, reported 54.4% of American university athletes correctly agreed with protein “aids in tissue maintenance”, however, the remaining 45.6% believed either the following; protein “provides immediate energy” or “increases muscle size” or “increases muscle strength” or “used for weight gain” [60]. Jonnalagadda et al also reported common misconceptions among American college athletes were “protein is the primary source of energy for muscles” and “protein supplements are needed in addition to diet for muscle growth and development”. A year later, Rosenbloom et al, examined American university athletes’ knowledge of nutrients and supplements, and reported 34.7% of athletes believed protein supplements were necessary for performance [66]. These misconceptions contrast to best practice guidelines, which clearly state that protein requirements can be reached through an optimal diet without the use of protein supplements [1, 2]. Additionally, there is no evidence for increases in muscle size or strength if dietary protein intake exceeds requirements in conjunction with a diet providing adequate energy [1, 2]. Nevertheless, protein supplements can provide some benefit to athletes when food availability is limited as they supply a convenient source of protein, and often carbohydrate [1, 2].

2.3.2.4. Vitamin and mineral knowledge

Vitamins and minerals are also susceptible to misconceptions regarding their effect on performance and health. In the same study by Jacobson et al, 14.7% of the athletes stated vitamins “increase muscle strength” and “aid in weight gain”, and 30.3% stated vitamins “provide immediate energy”, with only 37.0% correctly reporting vitamins role in the regulation of cellular metabolism [60]. An athlete’s belief for the role of vitamins and minerals for increasing perceived energy levels has been reported in various studies, one of these was by Rosenbloom et al, who reported 63.1% of athletes to agree with this concept [66]. Additionally, Kristiansen et al and Jonalagadda et al both reported athletes used supplements in order to "provide more energy" [7, 65]. Despite the importance of vitamins and minerals in energy metabolism [1], best practice guidelines clearly state an optimal diet will all the nutrients an athlete requires, with vitamin and mineral supplements only being of benefit to an athlete when their diet is deficient [1, 2].

2.3.2.5. Hydration, carbohydrate and sports drink knowledge

The importance of consuming adequate amounts of fluid and maintaining hydration for optimal performance has been well documented [1, 2]. This was demonstrated in the responses of athletes in the same study by Jonnalagadda et al, with the majority of athletes correctly agreeing with "fluids should be replaced before, during, and after athletic events" and "dehydration decreases athletic performance", and correctly disagreeing with "athletes can rely on thirst to ensure fluid replacement during and after competition" [65]. Additionally, the importance of consuming adequate amounts of carbohydrate was also reported by Jonnalagadda et al, as the majority of athletes correctly agreed with "carbohydrates and fats are the main source of energy for muscles" and disagreed with "eating carbohydrates makes you fat" [65]. A diet supplying optimal amounts of carbohydrate is essential for performance to augment muscle glycogen depletion during endurance and high-intensity type exercise [1, 2]. For these reasons, sports drinks have become a popular supplement in many athletic groups [3] as they supply not only a source of fluid, but also a convenient source of carbohydrate and electrolytes [1, 2]. In the study by Rosenbloom et al, 21.6% of athletes agreed with "sports drinks are better than water" [66]. This is a contentious topic as sports drinks are associated with performance benefits in specific sporting situations, however, for many situations such as medium intensity exercise lasting less than an hour, sports drinks provide no further benefit compared to water [1, 2].

2.3.2.6. Athletes with a disability

Only one study has investigated the nutritional knowledge and attitudes of athletes with a disability [64]. A total of 72 athletes who had previously competed in the Seoul, Barcelona, Atlanta, or Sydney Paralympic Games were randomised to either the control group or intervention group, which received nutrition education. There was no difference in the knowledge scores between the two groups at baseline, however, the intervention group scored significantly higher after being provided with nutrition education, although only moderate scores were recorded for each group [64]. The lowest post-test scores for the intervention group were reported for fat, protein, vitamins and minerals, health benefits of food, hydration, and nutrition for athletes with a disability [64]. Similar to the previous studies investigating AB athletes, a common misconception was an athlete's higher requirement for protein, which was demonstrated in a pre-test measure by the entire intervention group agreeing with "a higher protein intake is necessary for disabled athletes' [64]. Additionally, these athletes indicated poor knowledge regarding the specific nutritional issues of athletes with a disability such as healthy fats, disabled athletes' requirement for different nutrition and nutrition education, and their requirements for calcium, iron and fibre [64]. Many of these nutrients athletes demonstrated an inadequate level of knowledge for are marketed and sold as nutritional supplements, which suggests athletes with disabilities, similar to their AB counterparts, may not possess sufficient supplement knowledge and require further nutritional education.

Table 2.3.2.1. Demographic characteristics and either nutritional supplement knowledge, self-reported nutritional supplement knowledge or knowledge of specific nutrients associated with dietary supplements reported by studies published after 2000 investigating elite able-bodied athletes and athletes with spinal-cord injury competing at a minimum of either university or college, state (if American) or national level.

Reference	**N (gender)**	**Sport, level**	**Country**	**Age (years)**	**Type of knowledge**	**Knowledge Level**
Jacobson et al, 2001 [60]	330 (F 125, M 205)	Mixed, Tertiary	America	N/A	SNK (Recommendations for PRO, FAT, CHO, and functions of vitamins and protein)	Percentage of athletes correctly identifying recommendations; CHO 29%; PRO 3%; and FAT 11.7%. Percentage of athletes identifying; correct function of vitamins M 35.1% and F 40.2%; correct function of protein M 52.0% and F 58.4%.
Jonnalagadda et al , 2001 [65]	M 31	American Football, Tertiary	America	18.2 ± 0.5	SNK	Mean percentage of correct responses was 50.45%.
Rosenbloom et al, 2002 [66]	328 (F 91, M 237)	Mixed, High School & Tertiary	America	F 19 ± 1.3, M 19 ± 2.7	SNK	Mean percentage of correct responses; total 52.7%; M 53.6%; F 51.8%.
Slater et al, 2003 [15]	160 (F 75, M 85)	Mixed, Elite	Singapore	<15 to > 35, majority 15 to 25	SRK	60% reported no or limited knowledge, 10% reported good or excellent knowledge

Sundgot-Borgen et al, 2003 [6]	1222 (F 556, M 666)	Mixed, Elite	Norway	M 23.2 ± 4.7, F 21.4 ± 4.6	SRK	Elite athletes; M 41% and F 37% felt they were well informed about nutrition and nutritional supplements; Controls; M 56% and F 61%.
Froiland et al, 2004 [58]	203 (F 88, M 115)	Mixed, Tertiary	America	19 & older	SD	34% responded with all or parts of the following: a supplement is a product that helps to increase performance, strength, muscle, and enhance recovery. Other popular definitions included; a multivitamin, something that improved health or the body, additional nutrition added to the diet, pills, anything other than food, or something that helps you gain or lose weight.
Kristiansen et al, 2005 [7]	209 (F 89, M 120)	Mixed, Tertiary	Canada	F 20.7 ± 1.6, M21.3 ± 2.0	SRK	37% believed they knew enough about supplements, 46% did not, 16% were unsure. 37% would like to know more about supplements, 56% would not, 7% were not sure.
Nieper, 2005 [68]	32 (F 12, M 20)	Track, Elite junior	Britain	18 (average)	SRK	48% believed they had an average knowledge of supplements. 75% would like to know more about supplements.
Petroczi et al, 2007 [63]	874 (F 296, M 580)	Mixed, Elite	United Kingdom	<19 to 39, majority 19 to 29	SK (Reasons for use)	Only strong association was between vitamin C and the prevention of illness.

Rastamanesh et al, 2007 [64]	72; two age- and sex-matched groups (Intervention 42, Control 30)	Mixed, Elite, Athletes with a physical disability	Various	30 ± 7.6	SNK	Nutrition education significantly increased the nutrient knowledge in the intervention group compared to control group, correct responses were 81.3% vs. 43.1% respectively.
Dascombe et al, 2010 [14]	72 (F 36, M 36)	Mixed, Elite	Australia	21.9 ± 3.9	SRK	>50% of athletes using supplements had an in depth (more than active ingredient) knowledge on their chosen supplement. 36% remain uneducated regarding their supplement routine.
Jessri et al, 2010 [67]	207 (F 98, M 109)	Basketball and Football, Tertiary	Iran	21.8 ± 1.3	SK, SNK (Nutrients)	Mean percentage of correct responses for; supplement knowledge was M 25.4% and F 35.3%; nutrient quantity and type M 30.9% and F 42.6 %.
Tian et al, 2010 [62]	82 (F 47, M 35)	Mixed, Tertiary	Singapore	21.9 ± 2.5	SRK	36.3% reported no or limited knowledge about the product they consumed.

SRK = self-reported knowledge; SD = supplement definition; SNK = supplement nutrient knowledge; SK = supplement knowledge; N/A = Not available

2.3.3 Sources of Nutritional Supplement Information

Common sources of supplement information for athletes are family members (32.4%), fellow athletes (31.9%), athletic trainer (30.0%), registered dietitian (28.5%), friend (28.5%), their strength coach (28.0%), and coach (28.0) [58]. In addition to these sources, magazines and the internet have been reported by athletes from a variety of countries [14, 15, 57, 60, 63, 64]. Many of these are not guaranteed sources of accurate information and if an athlete is not under the guidance of a qualified health professional, then they are susceptible to misinformation and supplement misuse [60].

2.3.4 Supplement Knowledge and Usage

Numerous studies have investigated the influence of nutritional knowledge on dietary behaviour [69-73], however, this research has been unsuccessful in reaching a conclusive association. Categorising athletes by sex, age, level of competition, type of sport and sources of nutritional information has also failed to explain such discrepancies. There is some evidence suggesting an inverse relationship between an athlete's nutrition knowledge and their supplement use [74-76]. However, recent research by Slater suggests a positive relationship [15]. Therefore, it is likely factors other than nutrition knowledge are influential on dietary behaviour.

Theories and models have been developed to explain dietary behaviour, with many of these being applicable to explain supplement use [77, 78]. As with dietary behaviour, supplement use is not entirely determined by an individual's requirement for nutrients to optimise physiological processes [78]. The hedonic values of supplements and sports food such as taste, smell and texture may have an initial influence on behaviour [78]. Additionally, positive experiences associated with specific nutritional products may lead to further use. These choices can be reinforced by demographic, social, cultural, religious, economic and marketing factors [78].

Common factors have emerged showing knowledge is only one influencing factor in a myriad of possibilities [79]. These have been summarised by Worsley (2002),

- *Perceived consequences* - these can be positive or negative, likely or unlikely.
- *Attitudes* and *beliefs* about the behaviour.
- *Skills* and *knowledge* relating to the behaviour.
- The *context* within which the behaviour occurs, as influenced by the social and physical, internal and external environments.
- *Motivators* - these can include social influences, environmental rewards (reinforcers), biological needs, psychogenic needs, and personal and cultural values [10].

It has also been suggested nutrition knowledge shapes an individual's attitude, beliefs, perceptions and values relating to a specific food or dietary behaviour [10]. It is possible that nutrition education strategies aiming to optimise the health or performance of athletes are likely to be interpreted to satisfy and shape their own aspirations, belief system or perceptions [10]. This phenomenon has been previously described as the "cognitive dissonance theory" which occurs when individuals attempt to achieve 'cognitive consistency'.

2.3.5 Evaluation of the methodology of nutritional supplement studies

Many of the studies investigating an athlete's prevalence of use, reasons for use and knowledge of nutritional supplements vary in methodology and participant characteristics. As a result, comparisons between studies may be limited or inaccurate.

The research populations differed between studies in regards to sample size, age of participants, country, sporting discipline and level of competition. It has been reported, studies with larger sample sizes show lower rates of supplement use compared to smaller sample sizes 14, 62.This is demonstrated by Sundgot-Borgen et al 6 who investigated a large sample of 1620 athletes and reported only 54% of females and 51% of males used supplements 6. Similarly, Striegel et al 61 used a moderately large sample size of 598 athletes and reported a slightly higher prevalence rate of 60.5%. Conversely, Burns et al 57,Froiland et al [58]and Kristiansen et al [7] each used smaller sample sizes of 200-300 athletes and reported higher prevalence rates between 80-99% [7, 57, 58]. Additionally, studies by Dascombe et al [14] and Tian et al [62] who used 72 and 82 athletes respectively, reported high prevalence rates of 87.5% and 76.8% [14, 62]. It is important to note, the influence on results a response has in a small sample is considerably larger than if it were in a larger sample size, for example, a difference of 10 would be 50% in a sample of 20, but only 10% in a sample of 100.

Age is probably another factor influencing an athlete’s knowledge and use of supplements. It can be assumed the longer an athlete is involved in competitive sport and has access to qualified health professionals, their knowledge of nutrition and supplements will increase. It is also possible, the younger an athlete is the less likely they would use supplements as they have less control over their dietary practices [80]. Other possible reasons include, less exposure to marketing claims, less money to purchase supplements and less pressure to perform [80]. In this review, studies were restricted to athletes over the age of 18 years, which also included one sample of masters athletes with an age range of 35-87 years. However, it is likely in some studies for athletes to be under the age of 18 years as ambiguous age ranges were reported. Froiland et al [58] reported an age range of 19 years and older, Slater et al [15] reported an age range from younger than 15 to 35 and older, Petrosczi et al [63] reported an age ranging from less than 19 to 39 years, and Jacobson et al [60] did not state any age range. Despite the variable ages, athletes predominantly represented 20-30 year olds, which is an optimal age range for athletes to reach their potential in many sports.

Furthermore, the sporting disciplines and competitive levels varied between studies. Studies included athletes from universities and colleges [7, 58-60, 62, 65-67], with some not reporting the level competition. This could mean athletes represented levels from recreational to elite. It is possible for this to increase the reliability of the investigations, however, it may prevent comparisons to elite athletes.

Moreover, the lack of clarity regarding the definition of nutritional supplements in the questionnaires could have affected the results, either over- or under-estimating supplement use. Some questionnaires allowed participants to produce information about supplements in a blank space, whereas other questionnaires asked questions about specific products or nutritional topics. Additionally, the nutrients or supplements investigated were not consistent between studies, which make direct comparisons impossible. However, a simple measure of supplement knowledge was to measure an athlete’s perceived level of knowledge [6, 7, 14, 15]. This is important, as an athlete’s knowledge may be specific to their nutritional goals and use of specific supplements, and cannot be accurately measured in a study investigating a diverse athletic population consuming a variety of supplements.

Another factor likely to affect the results was the method for distributing the questionnaires. Some questionnaires were filled out during a team meeting with time being designated for this purpose [14, 58, 59, 61]. This allowed athletes to focus on providing accurate answers without being hurried. However, the presence of their coach may have restrained them from reporting the use of some supplements, despite anonymity being assured. Some studies [7, 14, 62] distributed questionnaires to athletes before or after training, when the athlete may not be expecting such approach. This may have caused the athlete to provide inaccurate answers if their time was limited or if they were pre-occupied by other commitments. Whereas, studies allowing athletes to take the questionnaires home [7, 62] or mailed to athletes [6, 14, 15, 60] provided them time to accurately respond to each question, but also allowed answers to be researched to improve their nutrition and supplement knowledge prior to answering.

2.4 Conclusion

It is clear that athletes with and without SCI have nutritional requirements for health and performance [1, 2]. There is some evidence reporting athletes with SCI are not meeting recommended nutrient intakes and are consuming a diet similar to non-athletes with SCI [8], which suggests they are not consuming an optimal diet to enhance their performance. To compensate for an inadequate diet and to enhance performance and health, nutritional supplements have become a popular nutritional strategy for many athletes with SCI, like their AB counterparts.

Many athletes have reported moderate levels of nutrition knowledge and possess various misconceptions [13]. Athletes with SCI have demonstrated similar levels of nutrition knowledge to AB athletes' [64], although this does not imply their knowledge is adequate. Furthermore, athletes self-reported levels of knowledge have been poor [6, 7, 14, 15, 62] and suggest the education strategies within many sporting organisations are not effectively providing athletes with accurate supplement information. Additionally, many athletes are receiving nutrition advice from various sources, with many of these considered as not being guaranteed sources of accurate information [58]. Therefore, athletes are at risk of nutritional misinformation, which may impair performance and health.

Furthermore, it has become less clear whether an athlete's knowledge of nutrition and supplements are likely to influence their dietary behaviour and use of supplements, since many other factors have been proposed to influence what an athlete consumes [10]. This is especially important for athletes with SCI due to their secondary health complications, which can be exacerbated by poor dietary habits and the misuse of supplements [5, 30].

Unfortunately, there is a paucity of literature evaluating the nutrition knowledge and practices of athletes with SCI. The majority of research has focused on AB athletes in countries other than New Zealand, therefore, it seems prudent to investigate the nutritional supplement knowledge and practices of athletes within this country. Understanding how athletes with SCI compare to their AB counterparts would provide a basis to generate more comprehensive nutrition education strategies for this group and with these factors in mind, the present study has the following aims,

1) Evaluate the nutritional supplement knowledge of athletes with SCI in New Zealand.
2) Ascertain whether the nutritional supplement knowledge of athletes with SCI differs from their AB counterparts, and
3) Identify any association between nutritional supplement knowledge and use.

3.0 METHODS

3.1 Subjects

Emails were sent to national and local sporting organisations describing the study and asking if they would give permission for their athletes who met the entry criteria to participate. Sporting organisations included athletes with a disability who compete or have competed at national or international level, and elite or carded AB athletes.

One sporting organisation for athletes with a disability agreed to take part in the study – Parafed Auckland, New Zealand. Parafed Auckland is an organisation for local athletes with a variety of disabilities participating from a recreational to elite level. A meeting was held with the Parafed Auckland general manager on the 28th March to explain the aim of the study and confirm the participation of their athletes who met the study's entry criteria. The entry criteria for athletes with a disability included athletes over the age of 18 years at the time of participation and previous or current competition at national or international level in either an individual or team sport.

Able-bodied athletes were recruited from the Millennium Institute of Sport and Health (MISH) and local sporting organisations within New Zealand. Athletes were required to be of elite level and participate in either an individual or team sport. To be considered of elite level, the athlete must be carded or part of a high performance academy or group. A carded athlete is an athlete that is provided with support from Sport New Zealand and is deemed to be of elite level. Able-bodied athletes were also required to be over the age of 18 years at the time of participation.

3.2 Ethical approval

The study was given ethical approval by the Department of Human Nutrition and the University of Otago Human Ethics Committee.

3.3 Focus Group

A focus group was held with four athletes with a SCI participating in wheelchair rugby within the Parafed Auckland organisation. The discussion was led by two student researchers and consisted of 6 questions over a period of 30 minutes. The questions were specific to the nutritional issues relating to athletes with disabilities and were considered to be a priority to the development of the questionnaire, these are shown with the participants' responses in appendix 1. The participants were encouraged to voice their opinion and provide examples. The focus group was recorded by a recording device and later transcribed by the student researchers.

3.4 Questionnaire development

The questionnaire (appendix 2) was developed to evaluate the nutritional supplement knowledge and practices of athletes with a disability and elite AB athletes.

The questionnaire was divided into 6 sections;

Section 1A – Demographic data

Section 1B – Disabled athletes (specific questions)

Section 2 – Supplement knowledge

Section 3 – Supplement practices

Section 4 – Nutritional supplement attitude

Section 5 – Nutritional supplement education and information

Questions and sections were either modified from previous studies investigating the nutrition knowledge and practices of athletes [7, 81, 82] or developed to ascertain information on specific areas of nutritional supplements, nutritional requirements for athletes or the nutritional and physiological differences for athletes with a disability. Responses from the focus group were used to ensure questions were appropriate for both athletes with a disability and AB athletes.

3.5 Online survey

The questionnaire was transferred to an online format using SurveyMonkey (SurveyMonkey, Palo Alto, California, USA). Auckland regional dietitians and a performance psychologist with research experience screened the questionnaire. The psychologist has an extensive background in questionnaire development and experience working with elite athletes, making her a reputable source to screen the questionnaire to minimise bias and ambiguous questions. A pilot trial of the questionnaire was conducted among two groups; local recreational athletes and dietitians. Based on the results and feedback of the pilot trial, changes were made to questions that were ambiguous or misinterpreted. Validity and reliability tests were unable to be performed due to time constraints. To identify those athletes who had correct knowledge as opposed to those who had incorrect knowledge and those who did not have any knowledge, the questionnaire used ‘yes’, ‘no’, and ‘unsure’ answers, with some questions using a multichoice system. A copy of the questionnaire is shown in appendix 2.

Parafed was asked to email their athletes who met the inclusion criteria a brief description of the study (appendix 3) and a link for an online survey, for which they were encouraged to complete. At the same time, the student researchers emailed AB athletes a brief description of the study and a link for the online survey. The survey was online for 60 days, allowing athletes to complete it during their own time and environment. Athletes were encouraged not to use external sources of information when answering any questions. One week after the initial email, a second email was sent as a reminder for athletes to participate in the study. Results from SurveyMonkey were downloaded and collated for analysis.

3.6 Data Analysis

As the majority of the disabled athletes were athletes with SCI, this will be the main focus of the study. Therefore, the participants with other disabilities were excluded from the analysis. Data was downloaded from the online survey into Microsoft Excel for Mac (Microsoft Corporation™, United States of America). Data is presented as percentages where the answer was ‘yes’, ‘no ‘or ‘unsure’, these were calculated in Microsoft Excel (Microsoft Corporation™, United States of America). Differences between athletes identifying as having SCI and those who did not declare any disability were analysed by chi-squared analysis using STATA 11C (StataCorp, Texas, USA). Significance was set $P \leq 0.05$.

The main outcomes to be defined were

- The percentage of correct answers for nutritional supplement knowledge.
- The beliefs athletes have about nutritional supplements.
- The nutritional supplement practices of athletes.
- Athletes’ perception about nutrition supplement education.
- The preferred source of nutritional information for athletes.

- How AB athletes and athletes with SCI differ in their nutritional supplement knowledge, beliefs and practices.

3.7 Dissemination of results

After the collation of data and analysis of results the student researchers will use this information, in collaboration with the current literature to provide nutrition recommendations specific to athletes with a disability. These will be sent to Parafed Auckland with permission to pass them on to other Parafed branches around New Zealand

4.0 RESULTS

A total of 29 athletes (11 able-bodied, 18 with SCI) started the questionnaire with 26 (11 able-bodied, 15 with SCI) completing the nutritional supplement knowledge and practices sections.

4.1 Demographics

Table 4.1.1.1 Mean (SD) age (y), weight (kg), height (cm), and BMI, and ethnicity, tertiary qualification and previous nutrition education for AB athletes and athletes with a SCI.

		Total sample (n=29)	**AB (n=11)**	**SCI (n=18)**
Age (y)		33.6 (12.1)	22.8 (1.1)	40.1[a] (11.0)
Sex (%)	Male	72.4	63.6	77.8
	Female	27.6	36.4	22.2
Weight (kg)		80.4 (11.2)	77.0 (10.7)	82.6 (10.9)
Height (cm)		181.0 (9.4)	180.5 (6.3)	181.3 (10.9)
BMI		24.6	23.6	25.1
Ethnicity (%)	NZ European	82.8	90.9	77.8
	Maori	10.3	9.1	11.1
	Niuean	3.4	0.0	5.6
	Indian	3.4	0.0	5.6
Tertiary qualification (%)	Yes	72.4	81.8	66.7
	No	10.3	9.1	11.1
Received previous nutrition education (%)	Yes	58.6	81.8	44.4
	No	34.5	9.1	50.0
	Unsure	6.9	9.1	5.6

[a] significant difference between groups p-value <0.05

4.1.1. Participant characteristics

Table 4.1.1.1 shows the demographics for the AB and SCI groups. The age of the AB group ranged between 21 and 25 years and was significantly lower than the SCI group (p=0.001), which ranged from 22 to 63 years. The demographics for sex, weight, height and BMI did not significantly differ between the two groups. No athlete was a current smoker in either group, however, four were ex-smokers in the SCI group. The majority of the athletes classed themselves as NZ European (10 AB and 14 with SCI), although there was no overall difference between the two groups for ethnicity (p=0.307). The athletes were well educated, with nine AB and twelve with SCI having attended or graduated university or polytec, which was not significantly different between the two groups (p=0.199). However, athletes with SCI tended to report having less nutrition education compared to their AB counterparts (p=0.062).

4.2 Supplement Knowledge

4.2.1 Nutritional supplement definition

There was no significant difference between the two groups when asked to choose the best definition of a nutritional supplement (Q14) (p=0.384), with 81.8% and 93.3% of the AB and SCI groups respectively choosing "a preparation intended to supply nutrients, such as vitamins, minerals, fatty acids or amino acids that are uncommon or not found in sufficient quantity in a person's diet."

4.2.2 Nutritional supplement classification

There was no significant difference between the two groups in their overall ability to classify nutritional supplements (Q15) (p=0.496), see figure 4.2.2.1. However, athletes with SCI tended to be more likely to correctly choose "calorie replacement drinks or weight loss drinks" to be a nutritional supplement (p=0.098).

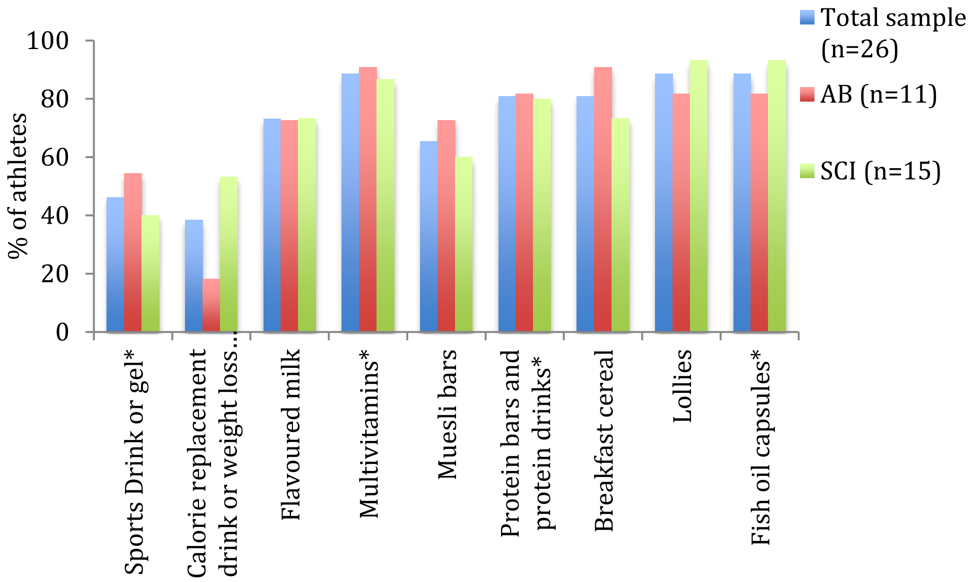


Figure 4.2.2.1. Percentage (%) of athletes correctly classifying each item.

*Classified as a nutritional supplement

4.2.3 Overall nutritional supplement knowledge

There was no overall difference in the supplement knowledge of the AB and SCI groups (p=0.466), with a mean correct score of 64.8% and 57.5% respectively, see figure 4.2.3.1. A total of 16 questions were divided into two sections; athlete's general supplement knowledge (Q16) and their beliefs for the efficacy of commonly used supplements (Q17). After questions were excluded regarding the nutritional supplements not currently in use by the athletes (i.e. HMB and bicarbonate), the mean correct score for the AB and SCI groups increased to 70.1% and 64.8% respectively. Of interest, the SCI group (53.3%) tended to be more likely than the AB group (27.3%) to believe "nutritional supplements should only be consumed when recommended by a medical doctor or dietitian" (p=0.074). Whereas, the AB group (81.8%) had a higher tendency than the SCI group (46.7%) to correctly disagree with "iron supplements improve performance when athletes have adequate iron levels" (p=0.074). Similarly, only 53.8% of the total sample correctly disagreed with "multivitamins maximise body stores of all vitamins and minerals beyond normal levels to improve performance".

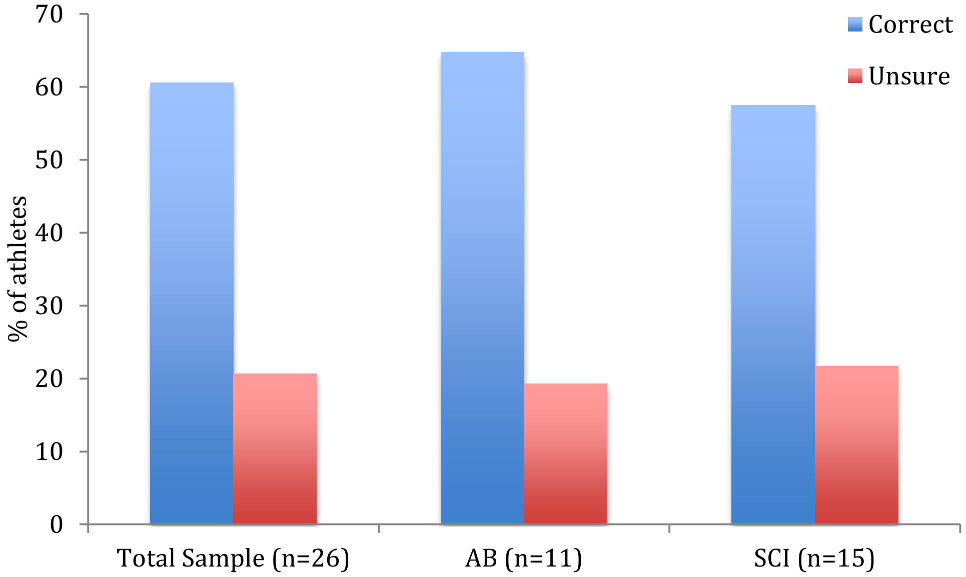
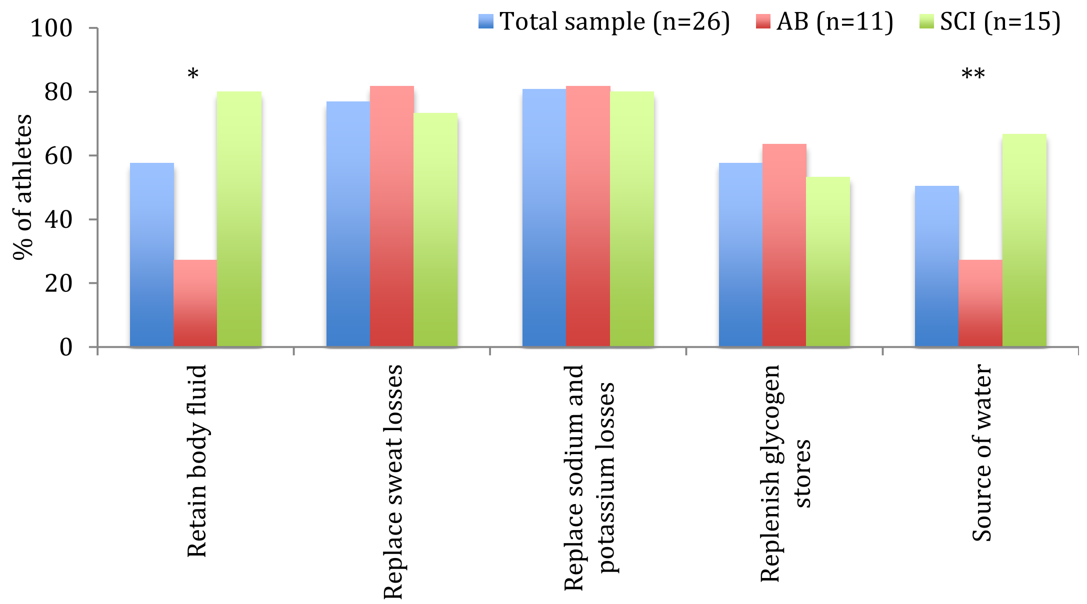


Figure 4.2.3.1. Percentage (%) of athletes responding as correct or unsure for overall nutritional supplement knowledge.

Nearly 40% of all athletes were 'unsure' when asked to agree or disagree with the following statements; caffeine, creatine and bicarbonate supplements are all considered ergogenic aids; carbohydrate drinks and gels help replace liver and muscle glycogen stores during recovery; and, caffeine is a central nervous system stimulant and is thought to improve endurance. An increasing prevalence of uncertainty (92.3% and 69.2% respectively) was reported for; HMB (hydroxyl methyl butyrate) improves endurance rather than increasing muscle strength; and, bicarbonate acts as a buffer to lactic acid produced during high intensity exercise.

4.2.4 Sports drink knowledge

Athletes with SCI had a tendency to be more knowledgeable of a sports drink function than their AB counterparts (Q18) (p=0.0845). The mean percentage of athletes correctly choosing the functions of a sports drink was 70.7% of the SCI group and 56.4% of the AB group. Figure 4.2.4.1 shows the correct functions of sports drinks and the percentage of the two groups selecting each option. Incorrect options were ‘replaces protein losses’, which was selected by 9.1% AB and 13.3% with SCI, and ‘helps to burn fat’, which no athlete selected from either group. Significantly more athletes with SCI correctly chose functions of a sports drink to “retain body fluid” (p=0.016) and there was a higher tendency correctly identifying sports drinks as a “source of water” (p=0.077).



* p = 0.016, **p=0.077

Figure 4.2.4.1. Percentage (%) of athletes responding to the correct functions of a sports drink.

4.2.5 Sports nutrition knowledge

There was no significant difference in overall sports nutrition knowledge between the two groups (Q19, Q20, Q21) (p=0.920). Figure 4.2.5.1 shows the participants beliefs regarding the performance benefits of protein and carbohydrate consumption before and during exercise tended to be different (p=0.078). Despite almost double the percent of SCI compared to AB agreeing that protein before exercise improves performance (36.4% AB vs. 68.8 SCI), there was no significant difference (p=0.102). Every AB athlete correctly believed the optimal time to eat after exercise is within 30 minutes, however, only 36.4% of the AB group identified the correct quantity of carbohydrate to consume after exercise. Conversely, significantly less of the SCI group (56.3%) believed the optimal time to eat after exercise was within 30 minutes (p=0.008) and only 12.5% knew of the correct quantity of carbohydrate to consume after exercise, however, this was not significantly different (p=0.150).

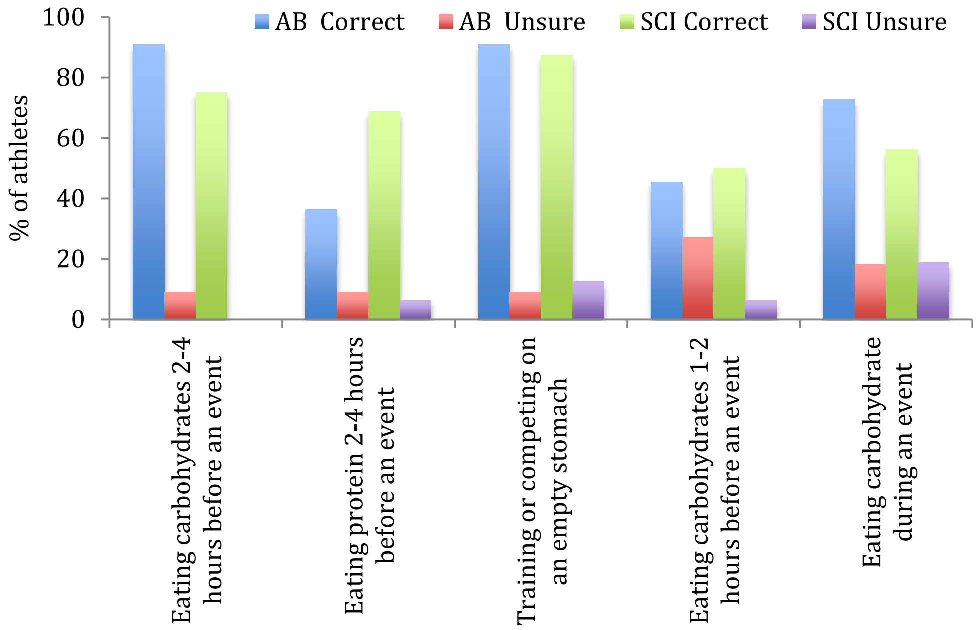


Figure 4.2.5.1 Percentage (%) of athletes reporting their beliefs regarding the performance effects of carbohydrate and protein consumption.

4.3 Nutritional supplement practices

4.3.1 Prevalence of nutritional supplement use

Seventy-five percent of the total sample used some type of nutritional supplement, with 85.0% of the AB group and 66.7% of the SCI group stating they either purchase or get provided with supplements (Q26), with no significant difference between the two groups (p=0.535). Although, when athletes were asked for the frequency they use supplements, 30.8% of the total sample, including 36.4% of the AB group and 26.7% of the SCI group reported to never use supplements (Q23). However, this difference was not significant (p=0.243). This is not consistent with the previous result or with the list of supplements athletes reported to use (Q22), shown in table 4.3.1.1, which suggests a much higher use. Nevertheless, sports drinks were the most frequently used supplement, consumed by 63.6% of the AB group and 50% of the SCI group.

Closer examination of the different supplements revealed significantly more athletes with SCI were supplementing with Vitamin C (p=0.05) and creatine (p=0.012). However, there was no significant difference between the two groups for the consumption of protein supplements (p=0.558), carbohydrate supplements (p=0.526) or vitamin/mineral supplements (p=0.290), see Figure 4.3.1.1.

Table 4.3.1.1. Prevalence (%) of nutritional supplement use by athlete groups.

	Total sample (n=25)	**AB (n=11)**	**SCI (n=14)**
Sports drinks	56.0	63.6	50.0
Vitamin C	32.0	18.2	42.9[a]
Protein powder	32.0	27.3	35.7
Creatine	20.0	9.1	28.6[b]
Caffeine	16.0	27.3	7.1
Multivitamin	12.0	9.1	14.3

Protein bars	12.0	0.0	21.4
Carbohydrate gels	8.0	9.1	7.1
Amino acids	4.0	9.1	0.0
Bicarbonate	4.0	9.1	0.0
Carbohydrate drinks*	4.0	0.0	7.1
Glutamine	4.0	0.0	7.1
B-complex vitamin	4.0	0.0	7.1
Glucosamine	4.0	0.0	7.1
Probiotic	4.0	0.0	7.1
Fish Oil	4.0	0.0	7.1

*Does not include sports drinks
[a] significant difference between groups p=0.05
[b] significant difference between groups p<0.05

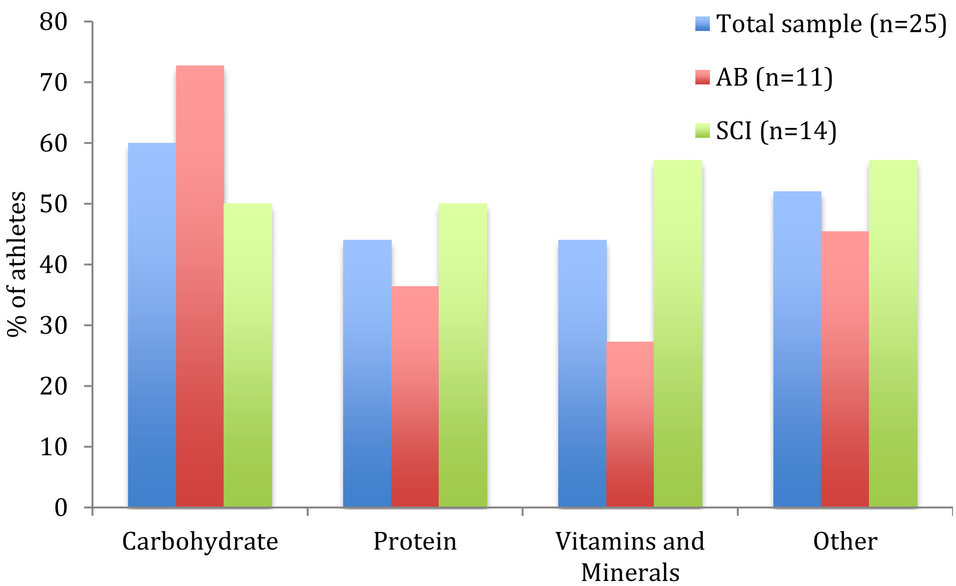


Figure 4.3.1.1. Percentage (%) of athletes using nutritional supplements according to supplement type.

4.3.2 Number of nutritional supplements used

There was no difference between the two groups regarding the total number of nutritional supplements they reported currently using (p=0.729). However, athletes with SCI were using slightly more nutritional supplements, with a mean of 2.4 per person (SD 2.1) compared to 1.8 per person (SD 1.8) for AB athletes.

4.3.3 Frequency of nutritional supplement use

There was no difference between the two groups in terms of the frequency of nutritional supplement use (Q23) (p=0.763), see figure 4.3.3.1. Sixty-seven percent of the SCI group reported using a nutritional supplement less than once a week or never (meaning 33% reported more frequent use), compared to 54.6% of the AB group reporting supplement use less than once a week or never.

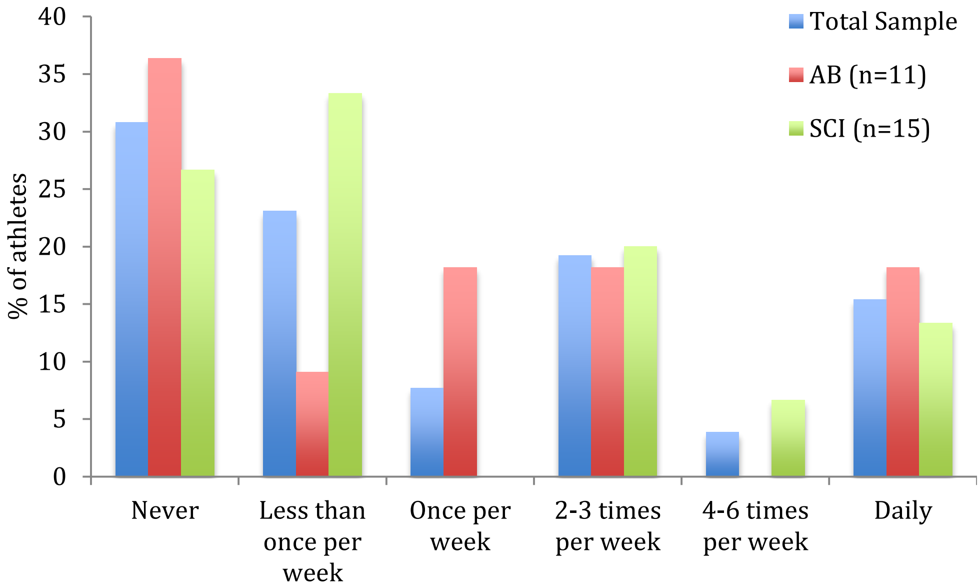
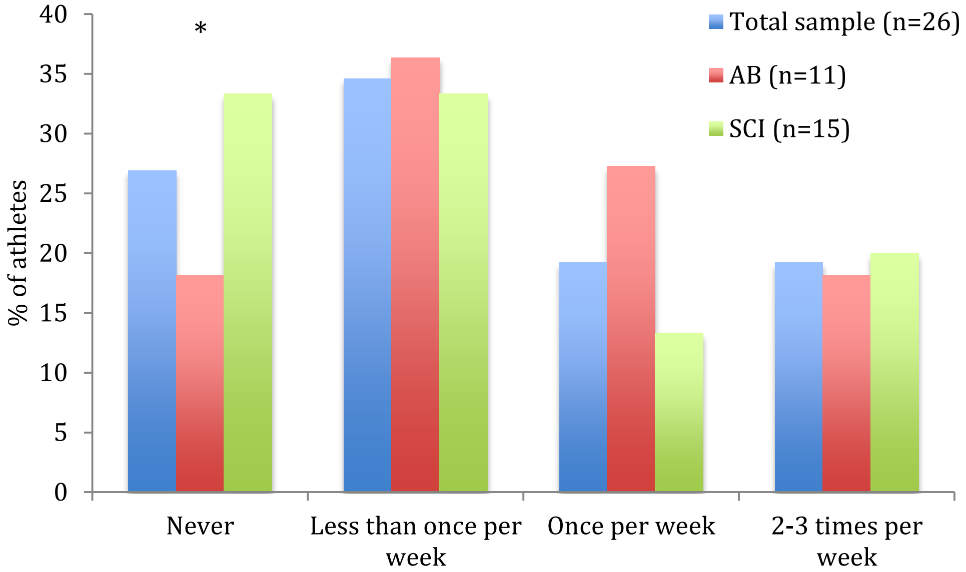


Figure 4.3.3.1. Percentage (%) of athletes reporting their frequency of supplement use.

4.3.4 Frequency of sports drink use

Able-bodied athletes reported a more frequent use of sports drinks compared to athletes with SCI (Q24), see figure 4.3.4.1. Only 18.2% of the AB group reported never consuming a sports drink, compared to 33.3% of the SCI group (p=0.03). No athlete consumed sports drink more than 2-3 times per week.

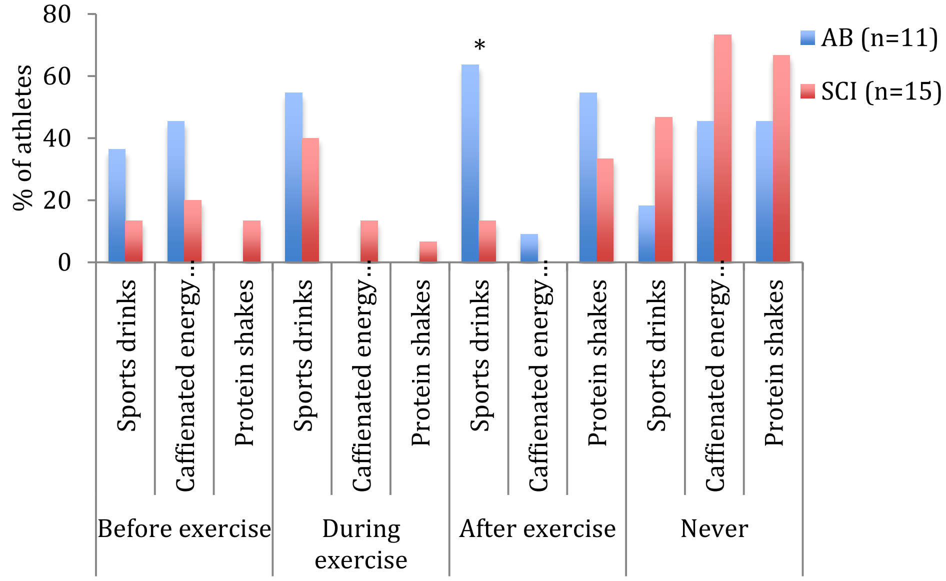


*p<0.05

Figure 4.3.4.1. Percentage (%) of athletes reporting their frequency of sports drink use.

4.3.5 Time of drink consumption

There was no overall difference between the two groups for when they consumed drinks (Q25), see figure 4.3.5.1. However, significantly more AB athletes than athletes with SCI would consume sports drinks after exercise (63.6% AB vs. 13.3% SCI) (p=0.007). The proportion of athletes stating 'never' for sports drinks and protein shakes differed compared to previous questions, suggesting athlete responses are either inconsistent or they were consuming these drinks at times other than around exercise.

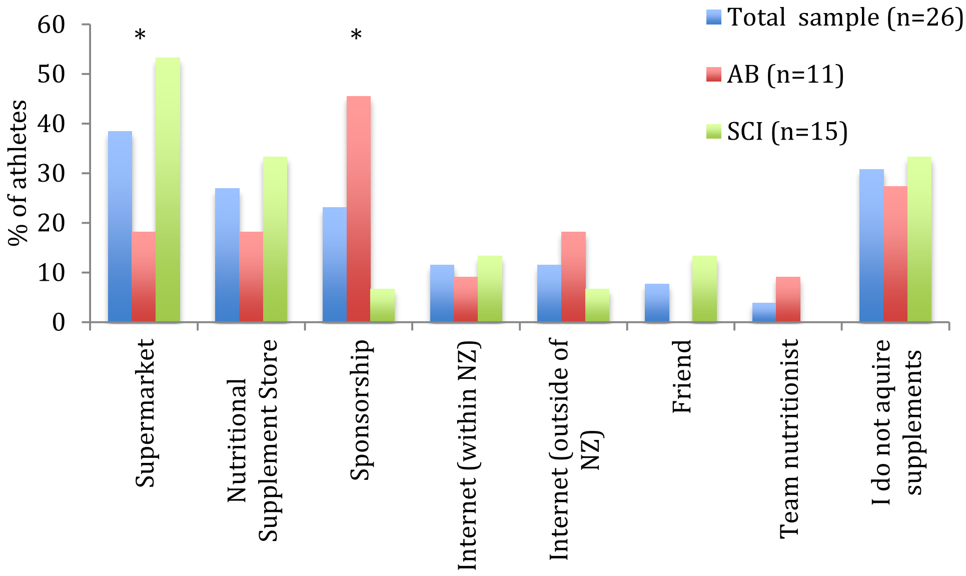


* p<0.05

Figure 4.3.5.1. Percentage (%) of athletes reporting the time when they consume nutritional supplement drinks.

4.3.6 Acquiring nutritional supplements

Athletes' methods for acquiring nutritional supplements showed a significant difference (Q26). The AB group was more likely to acquire supplements from sponsorship (45.5% AB vs. 6.7% SCI) (p=0.039), where as significantly more of the SCI group acquired their supplements from supermarkets (53.3% SCI vs. 18.2% AB) (p=0.016). More of the SCI group acquired supplements from nutritional supplement stores (33.3% SCI vs. 18.2% AB), however, this was not significant (p=0.399), see figure 4.3.6.1.



*p<0.05

Figure 4.3.6.1. Percentage (%) of athletes reporting their methods for acquiring nutritional supplements.

4.3.7 Side effects

Three athletes from the total sample (11.5%) experienced negative side effects after using nutritional supplements (Q27). Reported side effects were; developing a stitch after using a carbohydrate gel during a marathon, sore tummy with flatulence and bloating, weight gain, diarrhoea, and sleeplessness.

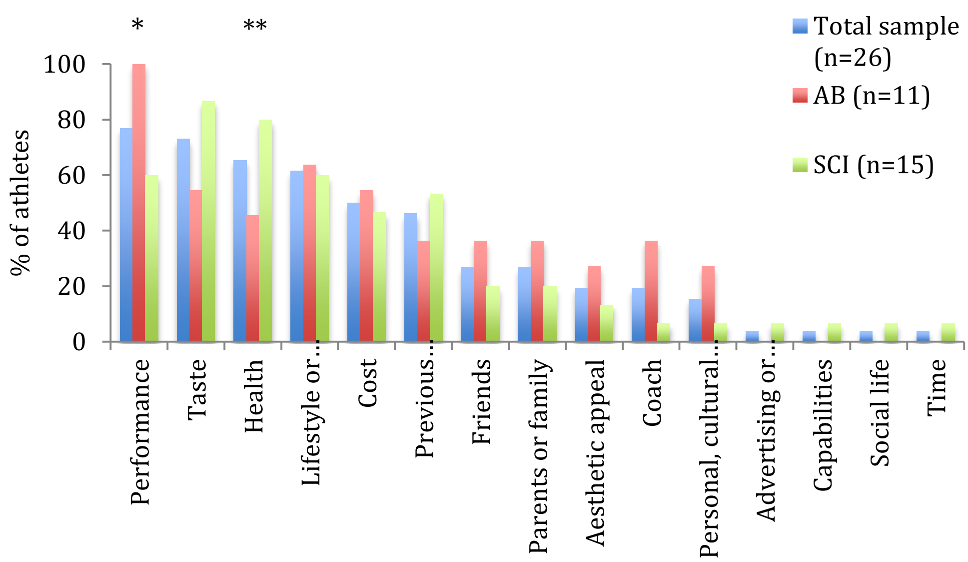
4.3.8 Money spent on nutritional supplements

The mean amount of money spent on nutritional supplements per month (Q28) did not differ between the AB group ($21.82 ± 39.20) and the SCI group ($18.93 ± 21.05) (p=0.815). The money spent on nutritional supplements ranged from nothing to $100 a month and included the expenses for athletes who acquired free or discounted products from sponsorship. A closer examination showed there was a negative association between an athlete's knowledge of the nutritional requirements surrounding exercise and the amount of money spent on supplements per month (p=0.05, r=0.158). There was also a strong correlation between the number of supplements reported being used and the amount of money spent of supplements (p=0.0006, r=0.6384).

4.4 Nutritional supplement beliefs and education

4.4.1 Important influences on dietary habits

There was a tendency for health to be influential on dietary habits of the SCI group (80%) compared to the AB group (45.5%) (Q29) (p=0.07), see figure 4.4.1.1. In contrast, significantly more of the AB group (100%), compared to the SCI group (60%), reported performance to be influential on their dietary habits (p=0.019). Other important influences for both groups were lifestyle and convenience, taste, previous experience with certain foods and cost.



* p<0.05, ** p=0.07

Figure 4.4.1.1. Percentage (%) of athletes reporting important influences on their dietary habits

4.4.2 Perceived performance benefits

There was no overall significant difference between the two groups in their belief that nutritional supplements are beneficial for performance (Q30) (p=0.244). However, when responses were combined, significantly more of the AB group (90.9%) compared to the SCI group (60%) agreed or strongly agreed with supplements being important for performance (p=0.019), see figure 4.4.2.1.

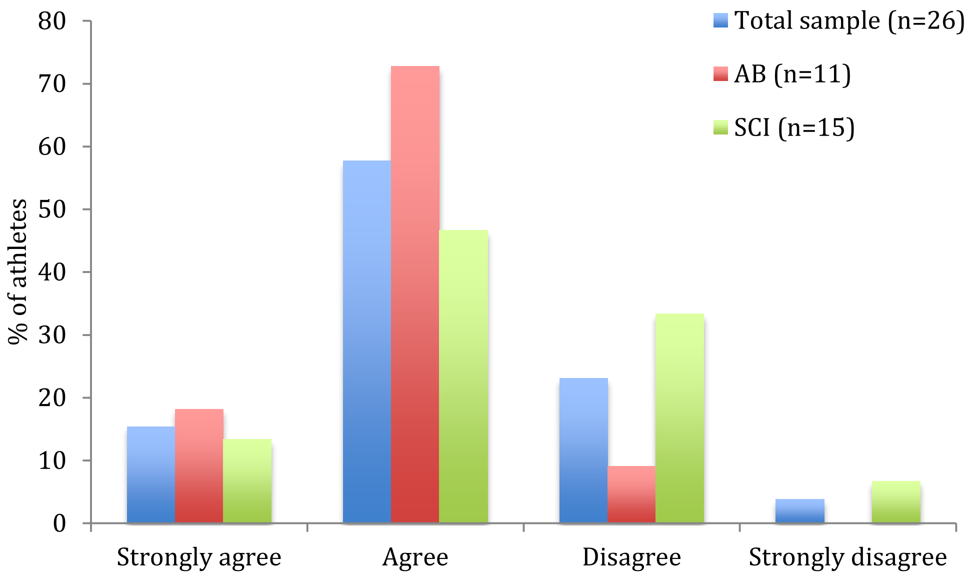
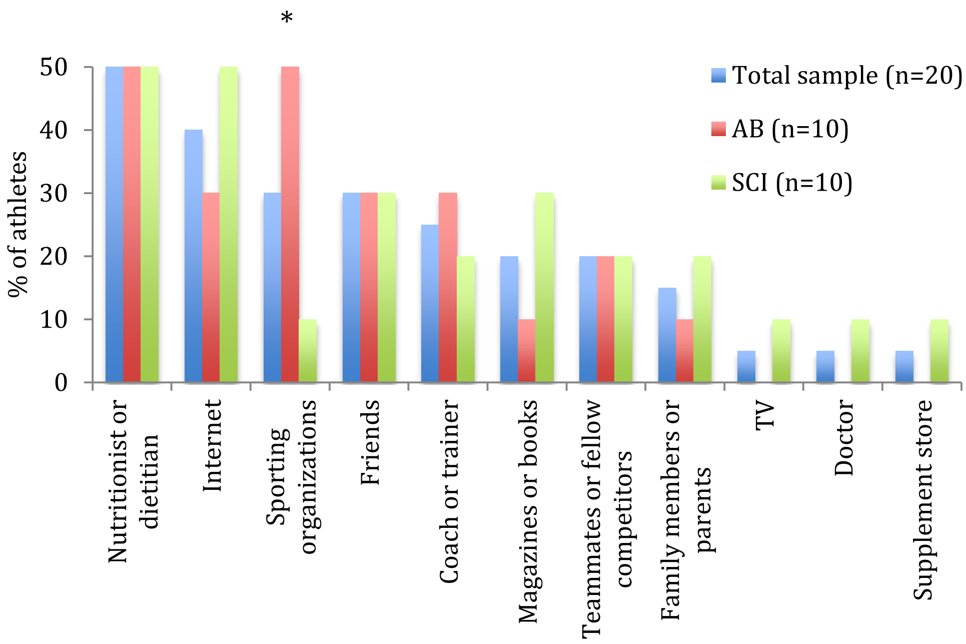


Figure 4.4.2.1. Percentage (%) of athletes reporting their belief regarding nutritional supplements importance on performance.

4.4.3 Source of information

Nutritionists, dietitians and the internet were the most popular sources of nutritional supplement information (Q31), see figure 4.4.3.1. Significantly more AB athletes received their nutritional supplement advice through their sporting organisations (50%) compared to athletes with SCI (10%) (p=0.05).



*p=0.05

Figure 4.4.3.1. Percentage (%) of athletes reporting their sources of nutritional supplement information.

4.4.4 Adequacy of information

There was no difference between the two groups regarding the adequacy of their previous nutritional supplement education (81.8% AB vs. 50.0% SCI) (Q32) (p=0.234), see figure 4.4.4.1.

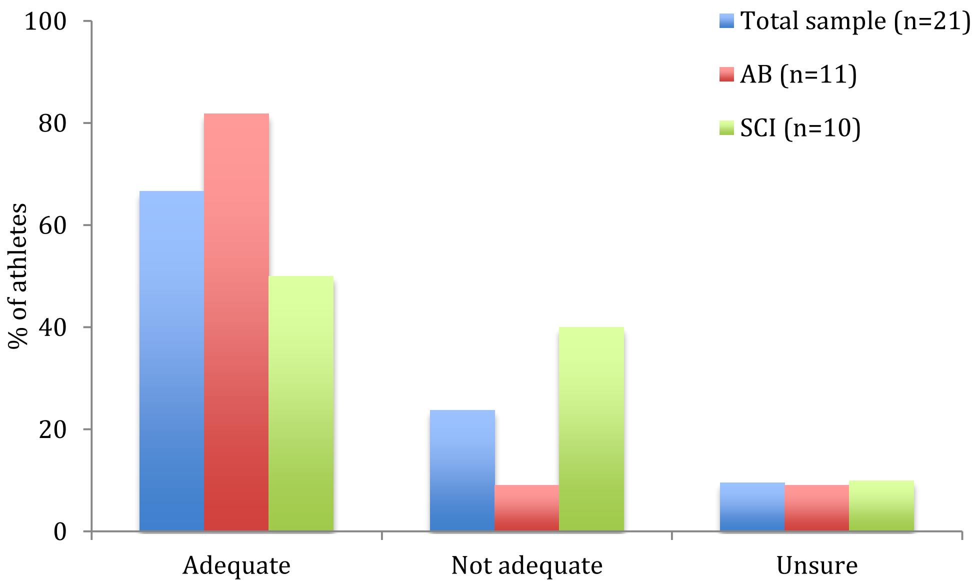


Figure 4.4.4.1. Percentage (%) of athletes reporting their belief regarding the adequacy of nutritional supplement information.

4.4.5 Further information

There was no overall difference between the two groups for seeking further information on nutritional supplements prior to use (Q33) (p=0.324), see figure 4.4.5.1. There remained no significant difference between the two groups when the responses to 'always' and 'most times' were combined (p=0.243).

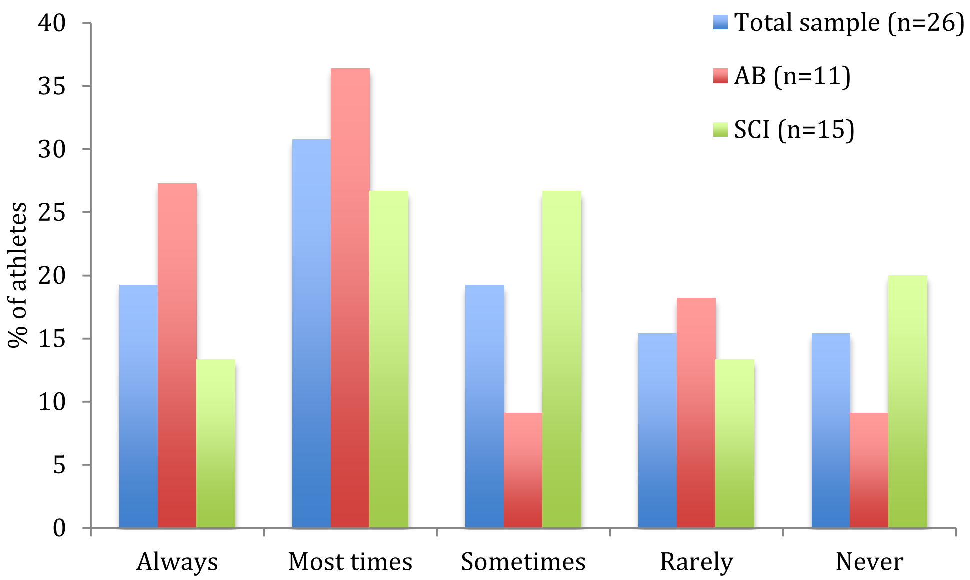


Figure 4.4.5.1. Percentage (%) of athletes reporting their frequency they would seek further information before consuming nutritional supplements.

4.4.6 Areas of interest

For those athletes seeking further advice, the 'performance' and 'health benefits' of nutritional supplements were the most popular areas of interest (Q34), see figure 4.4.6.1.

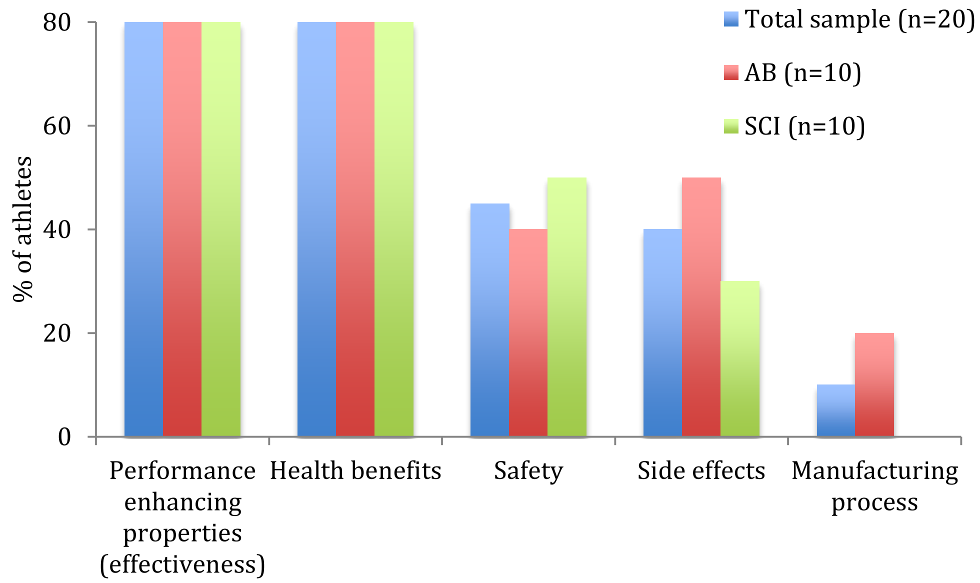
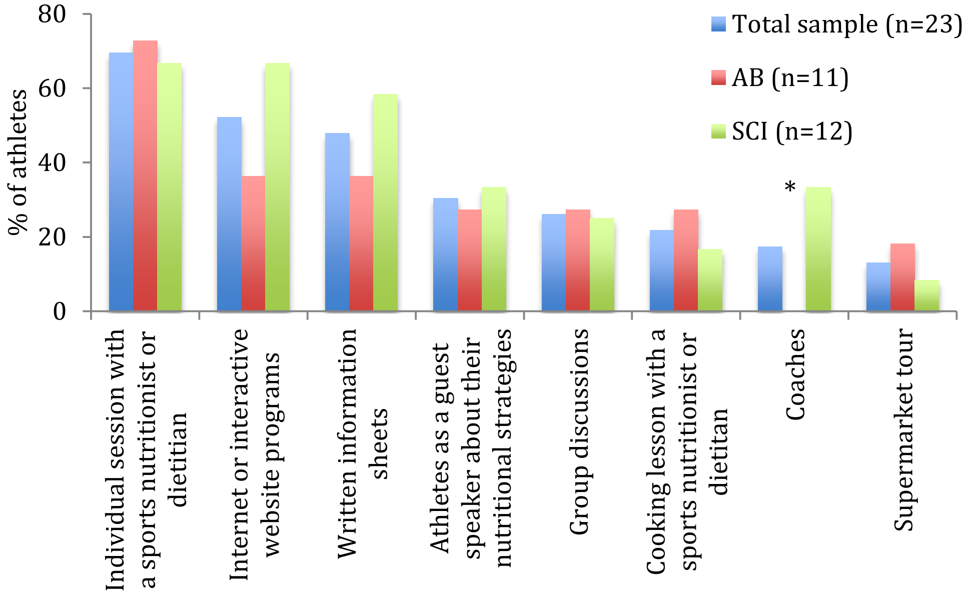


Figure 4.4.6.1. Percentage (%) of athletes reporting their preferred topics for nutritional supplement information.

4.4.7 Methods of delivery

There was a tendency for more athletes with SCI (33.3%), compared to AB athletes (0%) to prefer information to be delivered by their coach ($p=0.077$). There were no other differences between the AB and SCI groups ($p>0.05$) (Q35), see figure 4.4.7.1.



*p=0.077

Figure 4.4.7.1. Percentage (%) of athletes reporting their preferred method for the delivery of nutritional information.

5.0 DISCUSSION

A recent review of the available literature suggests the present study is the first in NZ to compare the nutritional supplement knowledge and practices of athletes with SCI to their AB counterparts. A questionnaire investigated the prevalence of athletes using supplements, types of supplements taken, their knowledge of supplements and reasons for their use. AB athletes and athletes with SCI demonstrated similar supplement practices and levels of knowledge. However, when examined more closely, the SCI group reported behaviour and beliefs reflecting the implications manifesting from the physiological and physical differences associated with SCI.

Athletes are influential figures within NZ as the nation takes pride in its sporting success. For this reason, nutritional supplements and ergogenic aids have become a temptation for AB athletes [6, 7, 14, 15, 58] and athletes with SCI [8, 56], who wish to gain an advantage over their competition. In NZ, many of the Paralympic athletes attend two sporting organisations within NZ – Millennium Institute of Sport and Health and Parafed Auckland - who contributed the majority of participants to the present study. The results provided by these athletes will be discussed with relevance to supplement practices, supplement knowledge, beliefs and attitude, and information and education.

5.1 Nutritional supplement practices

5.1.1 Prevalence of use

An athlete's ability to sustain consistent training and competition without succumbing to symptoms of over-training, chronic fatigue, injury and illness is not only influenced

by the types of food consumed, but also the amount and timing of food intake [1, 2]. Many athletes believe a normal diet will not suffice for optimum performance and resort to the use of nutritional supplements and ergogenic aids [3].
This has been demonstrated by previous studies reporting the popular use of supplements and ergogenic aids for male and female athletes of all ages, sporting disciplines and competition levels [6, 7, 14, 15, 58].

In the present study, 75% of the athletes reported using some type of supplement, with no difference shown between the AB and the SCI groups (p=0.535).
The prevalence of supplement use in the AB group (85%) was similar to other studies investigating supplement practices of elite athletes in Australia [14] and Singapore [15], who demonstrated the prevalence of use to be 88% and 77% respectively. This is in contrast to a study investigating elite Norwegian athletes which reported the use of supplements to be as low as 51% in males and 54% in females [6]. Whereas, the prevalence of supplement use in the SCI group (67%) was considerably higher than other studies in elite athletes with SCI (44%) [8] and elite athletes with a disability (42%) [56]. Therefore, it would appear that reported supplement use in NZ athletes is comparable to their international competitors. However, given the unreliability of some athletes to report accurate supplement practices [83], it is possible that the actual prevalence of use is higher than was reported. Although, it is also possible any under-reporting was minimised as the present study followed an online format and assured athletes' anonymity.

The increasing popularity of supplements may be the result of either scientific investigations showing performance benefits [57], the increased acceptance of supplement use by athletes [3], or the recent changes in the World Anti-doping Agency's (WADA) prohibited list [46]. This trend may also reflect the continual development of the commercial supplement industry and the sponsorship of influential sports teams and athletes by nutritional supplement companies, which is likely to influence athletes in two ways. Firstly, the sponsorship of many athletes from the supplement industry, particularly elite AB athletes, due to their marketability and extensive media coverage provides this group with monetary benefits from the use of their products. In contrast, the second route is by non-sponsored athletes becoming influenced by viewing their more successful peers marketing supplements and resort to the use of these products in an attempt to match their success. These differences in sponsorship opportunities are shown in the present study by nearly half of the AB athletes (46% AB vs. 7% SCI) reporting to receive free or discounted products (p=0.039).

Supplement manufacturers and retailers market their products to enhance multiple areas of health and performance. Athletes are often persuaded by these claims and in hope for further benefits will use a variety of supplements simultaneously, a practice termed 'dietary supplement polypharmacy' [84]. Polypharmacy has been demonstrated in groups of elite athletes [14, 15], with one study showing 9% of elite Singaporean athletes to have used over 10 types of supplements within the previous year [15]. In the same group of Singaporean athletes, 89% supplemented with more than one product, with an average of 3.6±3.8 products being consumed [15]. In the present study, 55% and 53% of each group respectively consuming more than one supplement, with AB athletes supplementing with an average of 2.4 products and an average of 1.8 products for athletes with SCI, suggesting polypharmacy occurs in NZ athletes with and without SCI.

Interestingly, athletes with SCI reported using nutritional supplements less frequently than AB athletes, despite their use of a wider variety of products. Sixty-seven percent of the SCI group reported using supplements less than once a week or never, compared to 55% of the AB group (Q23). It is possible for athletes with SCI to have refrained from the frequent use of supplements due to the nutritional complications associated with their disability, possibly because there is potential for the misuse of these products to exacerbate nutritional issues such as weight gain, hyponatremia, gastrointestinal discomfort or frequent urination [5, 30, 84]. Many nutritional supplements do possess value for the athlete in specific situations [3], however, it is recommended athletes who are at risk of nutritional complications to seek advice from a qualified professional prior to use and are monitored throughout supplementation to evaluate whether there is a benefit to their performance [1, 3]. The importance of this was reflected in the present study, as athletes with SCI were nearly twice as likely than AB athletes (53% vs. 27%) to agree with only using nutritional supplements recommended by a medical doctor or dietitian (Q16) (p=0.074), which will be discussed in the proceeding knowledge sections of this report.

5.1.2 Sports drinks

Sports drinks have been reported as the most popular nutritional supplement within many athletic populations [7, 15, 58, 62] and it was also the supplement that was most commonly consumed in the present study. Sixty-four percent of the AB group reported consuming sports drinks, which is similar to research by Froiland et al [58] and Kristiansen et al [7], who reported sports drink consumption in 74% of athletes attending an American university [58] and 77% of athletes attending a Canadian university [7]. Furthermore, a report by Tian et al [62] estimated 90% of athletes attending a university in Singapore supplemented with sports drinks [62]. Other studies have reported the popular consumption of sports drinks but with a lower prevalence of use [15, 57, 60], which is likely due to a difference in athletes participating and the studies methodology, as these predominantly utilized a questionnaire evaluation of dietary habits, with the questions and format remaining unpublished. It is not surprising that sports drinks are the most popular sports supplement as they are one of the most researched nutritional products, with the majority of research showing beneficial effects of carbohydrate-electrolyte drinks (sports drinks) on exercise performance when the duration is greater than one hour [1, 2]. Although some would fault the design of these studies, it is beyond the scope of this thesis to critique the research on sports drinks, but for a recent review, see 'The truth about sports drinks' by Deborah Cohen. Further; enticing athletes to consume sports drinks is the multi-million dollar industry that promotes their use, with expensive and persuasive marketing campaigns and sponsorship deals [85].

Athletes with SCI often possess thermoregulation and hydration complications that can be affected by the amount and type of fluid consumed [5, 28], therefore, the consumption of fluid needs to be effectively managed to prevent further complications. A diminished sweating response is a common outcome from SCI, which reduces an individual's fluid requirements [5] and is a possible reason for the slightly less prevalent use of sports drinks among the SCI group (50%) than the AB group (64%). In cases where an excessive amount of fluid is consumed, adverse outcomes for athletes with SCI may include gastrointestinal intolerances, frequent urination, or hyponatremia [5, 28]. Hyponatremia is classified as serum sodium levels below 135mmol/L, which has the potential to lead to irreversible brain damage, exacerbation of neurological symptoms and death in extreme cases [86]. The high incidence of hyponatremia among the SCI population is probably multifactorial. In addition to the consumption of large volumes of fluid, factors may include impaired fluid excretion due to higher circulating anti-diuretic hormone (ADH) and an increased renal sensitivity to ADH, often referred to as resetting of the osmostat [42].

It has been previously demonstrated one of the flaws with using a survey design is that responses are not always accurate and reliable [81]. Validating and pre-testing questionnaires can help to minimise these discrepancies, however, some inaccurate responses often remain. This was seen in the present study when responses to the frequency of use for sports drinks were not consistent with previous answers. Eighteen percent of the AB group and 33% of the SCI group reported to "never" consume a sports drink (Q24), whereas, in a previous response to the type of supplements consumed, 36% and 50% of the AB and SCI groups respectively reported to not use these products (Q22).

Nevertheless, for those athletes consuming sports drinks, the majority would drink these during and after exercise, and less than once per week (Q25). This corresponds with the scientific literature supporting their use, whereby consumption of carbohydrate during exercise improves performance by limiting muscle glycogen losses and maintaining blood glucose concentrations [1, 2]. These benefits are important, as exercise intensity has to decrease when carbohydrate is not the fuel source [2]. Sports drinks have also shown to benefit muscle and liver glycogen resynthesis post-exercise, and are more effective than water for rehydration due to the sodium content that assists with water absorption and retention within the body [1, 2]. With this in mind, their use by many elite athletes is understandable since this group is frequently exposed to periods of moderate to heavy training loads, involving large sweat losses and are in need of beverages that enable fast and effective fluid replacement.

Additionally, elite athletes often require a higher carbohydrate diet compared to recreational athletes who may only train 3-4 times per week for 30-60 minutes per session. The general consensus in the scientific literature is the body can oxidise 1-1.1g of carbohydrate per minute or about 60 grams per hour [1]. The American College of Sports Medicine (ACSM) recommends 0.7g/kg/hour of carbohydrate should be consumed during prolonged exercise of more than 60-90minutes [2]. This is equivalent to a 70kg athlete consuming just over 150ml of a 6-8% carbohydrate sports drink every 15 minutes. In contrast, athletes with SCI are likely to use less carbohydrate during exercise due to their reduced active muscle mass and lower overall caloric requirements [5, 30], suggesting the use of sports drinks in this group may be of minimal benefit and will only contribute to their total energy intake.

5.1.3 Creatine

Creatine phosphate is an important energy source in high-intensity exercise, especially during the periods of rapid recovery between multiple sprints [87]. There is substantial evidence to show creatine supplementation can increase the amount of creatine and creatine phosphate in the muscles, increase muscle mass and improve performance in strength and power events [1, 2, 87]. This has led to creatine being considered as one of the most beneficial supplements available to athletes [1] and its inclusion by the Australian Institute of Sport (AIS) into group A of their supplement classification system [11].

Spinal cord injury is associated with an obligatory loss of lean muscle tissue and strength [5]. As a compensatory strategy, athletes with SCI may be tempted to supplement with creatine, which was demonstrated in the present study as significantly more athletes with SCI (29%) compared to their AB counterparts (9%) reported to use creatine (p=0.012). Other studies have reported similar results among AB athletes, with 16% of elite Singaporean athletes [15], 13% of elite Australian athletes [14] and 12% of elite male Norwegian athletes [6] using creatine supplements. The highest prevalence of use was in a study by Froiland (2004), showing 37% of athletes from an American university were using creatine supplements [58]. Froiland continued to report that males were significantly more likely than females to use creatine, 34.5% compared to 3.4% respectively [58], a trend demonstrated in other studies investigating supplement use in athletes [6, 7, 15, 60], probably due the perceived muscle mass gained with use.

5.1.4 Protein

There is considerable debate regarding the optimal amount of dietary protein for athletes, particularly as protein metabolism during and following exercise is affected by sex, age, intensity, duration, and type of exercise, energy intake and carbohydrate availability [1, 2]. Current literature indicates that athletes undergoing intense training may require additional protein (1.4-2.0g/kg/day) in comparison to the general population (0.8-1.0g/kg/day) [1]. Consuming adequate amounts of dietary protein is important to an athlete for the repair and regeneration of exercise induced muscle fibre damage that leads to the training adaptations required for optimal performance [88]. Inadequate consumption of dietary protein may impair recovery and training adaptations [1]. Protein supplements have been included in group A of the AIS classification system as they offer a convenient method to ensure athletes consume quality protein in their diet and are meeting their protein needs without major changes to their eating habits [11]. Considering the timing of protein ingestion is of great importance, especially post-exercise [88]. Supplementing with protein shakes or bars means protein can be ingested immediately, particularly when food availability is limited.

In the present study, half of the SCI group compared to a third of the AB group consumed protein supplements (p=0.558), which included protein powder, shakes, bars and amino acids. Protein supplements are often associated with 'building muscle' or 'bulking up', therefore, it is not surprising the use of these products is more popular in the SCI group as these athletes attempt to prevent the obligatory loss of muscle size and strength.

Other studies have reported considerably less use of protein supplements among elite athletes participating in various sports [6, 14, 15]. It is possible this is a result from the formatting of the questionnaire, as the present study had pre-listed a variety of protein supplements and required athletes to select the products they used, whereas other studies may have requested athletes to state the supplements they consumed or only investigated a specific criteria of protein supplements, as in the case of Sundgot-Burgon (2003) who only reported the use of amino acids.

Accumulating evidence suggests protein supplements are not necessary to meet dietary requirements when consuming a well balanced diet [1, 2]. Ingesting protein beyond requirements does not appear to promote additional gains in strength and muscle mass [1]. Instead, excess protein contributes to the overall energy intake and may lead to weight gain in susceptible individuals, particularly athletes with SCI who generally have lower energy requirements than their AB counterparts [30]. Therefore, athletes consuming adequate amounts of protein should focus on the timing and quality of protein consumption [1, 2]. Although the convenience of supplements provides athletes with the opportunity to ingest protein within the optimal timeframe post exercise when food availability is limited and was demonstrated in the present study with the majority of athletes consuming protein shakes reported to use these after exercise.

5.1.5 Vitamins and Minerals

Vitamins and minerals are essential for the regulation of metabolic processes such as energy synthesis, production of enzymes and hormones, and neurological processes [1]. Current literature suggests certain vitamins and mineral supplements possess some health benefits, however, very few have been reported to provide direct ergogenic value for the athlete [1, 2]. In the present study, 57% of athletes with SCI and 27% of AB athletes consumed some type of vitamin or mineral supplement, however there was no significant difference between the two groups (p=0.290). Other studies combining the prevalence of use for vitamin and mineral supplements have shown that vitamin and mineral supplementation varies considerably, with a range reported between 19% and 73% [57, 60]. Where as, vitamin (not mineral) supplementation remained consistently popular among various athlete groups [6, 14, 58]. For example, 43.1 % of Australian elite athletes [14], 47.3% of athletes at an American university [58], 70% of male and 82% of female Norwegian elite athletes [6], have reported to use some type of vitamin supplement.

Athletes with SCI were more than twice as likely to supplement with vitamin C compared to AB athletes in the present study (43% SCI vs. 18% AB) (p=0.05). Vitamin C is involved in a variety of metabolic processes in the body including the synthesis of epinephrine, iron absorption, and as an antioxidant [1]. Individuals with SCI are susceptible to infection [89] and may be tempted to supplement with vitamin C as a prevention measure. Theoretically, it could benefit performance by improving metabolism and enhancing immunity, thereby maintaining and increasing training loads by attenuating the occurrence of infections [1, 2]. There is also some evidence suggesting vitamin C supplementation of approximately 500mg/day following intense exercise may decrease the incidence of upper respiratory tract infections [1].

The popularity of vitamin and mineral supplementation coinciding with a paucity of evidence supporting its use to enhance performance suggests many athletes are wasting time and money on these products. Although the few cases supplementation can be of benefit to the athlete does not imply supplements should be viewed as a substitute for good food choice. A well-chosen diet that contains a variety of foods in sufficient amounts to meet the energy and nutrient demands of training and competition should be the nutritional focus of all athletes [1-3, 44].

5.2 Nutritional supplement knowledge

5.2.1 General supplement knowledge

Studies investigating nutritional supplement practices report an athlete's knowledge on this area of nutrition to be variable and often poor, which was demonstrated in the present study. Nutrition and supplement knowledge is difficult to measure and has led to the use of a variety of methods, with some of the current literature reporting athletes' self-perceived knowledge of supplements [6, 7, 14, 15, 62], knowledge of nutrient function [60, 64-66] and the reasons for supplement use [7, 14, 15, 58, 59, 61-63]. Within these studies, the majority of athletes self-report limited or no nutritional supplement knowledge, or state a lack of education in this area [6, 7, 14, 15, 62], a trend present in many athletic populations throughout the world, irrespective of an athlete's sex, age or sport.

In the present study, the majority of athletes (82% SCI and 93% AB) were aware nutritional supplements are preparations intended to supply nutrients (Q14), such as vitamins, minerals, fatty acids or amino acids that are uncommon or not found in sufficient quantity in a person's diet. In comparison, Froiland (2004) required athletes to state their own definition of nutritional supplements and reported 34% of participants responded with all or parts of the following; a supplement is a product that helps to increase performance, strength, muscle, and enhance recovery [58], which is indicative of the function of ergogenic aids. Other commonly reported definitions by Froiland (2004) included a 'multivitamin' or 'pill', 'something that improves health or the body', 'anything other than food', or 'something that helps you gain or lose weight' [58]. In the present study, the questions were multi-choice and did not investigate an athlete's knowledge of the definition of nutritional ergogenic aids. Therefore, it could not be determined whether athletes could distinguish between nutritional products designed to improve health or those with performance enhancing properties.

The nutritional supplement knowledge section consisted of two parts; athletes' general supplement knowledge (Q16) and their beliefs for the efficacy of commonly used supplements (Q17). No significant difference in the level of knowledge between the two groups was evident (p=0.466), however, the mean percentage of correct responses was only moderate, 65% and 58% respectively. This lack of knowledge is concerning for athletes with pre-existing medical conditions who choose to supplement, such as athletes with SCI, as the misuse of these products can cause further harm to their health [1, 2, 12].

Not surprisingly, the SCI group's moderate level of knowledge was reflected in their belief regarding the adequacy of the information they have previously received on supplements, with only 50% stating they had been given sufficient information. Despite possessing a similar level of knowledge, 82% of the AB group believed the information they had received was adequate, which may reflect the increased support from government and sporting organisations. Nevertheless, this does not necessarily mean AB athletes are being provided with sufficient nutrition education to improve their knowledge about supplements.

When examined closer, athletes with SCI tended to be more likely than AB athletes (53% SCI vs. 27% AB) to agree with only using nutritional supplements recommended by a medical doctor or dietitian (p=0.074). This is important for athletes with pre-existing health complications as advice from qualified health professionals prior to use may be required to prevent the exacerbation of these issues. However, this can be controversial as the nutrition knowledge of some health professionals and dietitians can be limited in regards to sport and performance since this is not their specific field of training, experience or research [90]. With sport nutritionists and dietitians who are competent in managing specific medical issues an athlete may possess being a more reliable source of advice [90].

Nutritional knowledge is dynamic and can be specific to an athlete's use of certain supplements. Therefore, it was understandable the responses to two questions regarding supplements not in use by either group (HMB and bicarbonate) exhibited extremely high levels of uncertainty. When these two questions were excluded, the average correct score for the AB and SCI groups increased to 70% and 65%. It is also interesting to note there was a lack of knowledge for the ergogenic value of creatine, caffeine and bicarbonate, especially as these supplements have been proven to enhance performance in certain sporting situations and are widely used among various sporting disciplines [3]. Similarly, many athletes were not aware of the role carbohydrate has during recovery, despite 35% of athletes consuming carbohydrate containing sports drinks after exercise.

Misconceptions regarding the role of vitamins and minerals, and their effect on performance were common among athletes in this study. Over a quarter of the total sample falsely believed "multivitamins maximise body stores of all vitamins and minerals beyond normal levels to improve performance", with only 54% correctly disagreeing with this statement. Athletes with SCI were twice as likely (20% vs 9%) to falsely believe "iron supplements improve performance when athletes have adequate iron levels", for which the AB group (81.8%) demonstrated a higher tendency than the SCI group (46.7%) to correctly disagree with this statement ($p=0.074$). These beliefs are not consistent with current literature, which clearly states vitamin and mineral supplements will provide no further benefit to performance when supplied in adequate amounts through the diet [1, 2].

Moreover, this contradiction to current guidelines did not influence their supplement choice, as no athlete in this study supplemented with iron and there was not a significant difference between the two groups for their overall use of vitamin and mineral supplements, with an exception for the SCI group's increased use of vitamin C. Unfortunately, the design of this questionnaire makes it difficult to compare with other studies. Nevertheless, it is apparent many athletes possess poor knowledge of nutritional supplements despite their popular use.

5.2.2 Sports drink knowledge

Sports drinks have now become a regular addition to many athletes' diets, from recreational to elite level. Not only do they provide a source of carbohydrate, fluid and electrolytes, additional nutrients are being added such as caffeine, vitamins and minerals [91] and has led to the explosion of the sports drink industry [85].

In the current study there was a tendency for athletes with SCI to be more knowledgeable about the functions of a sports drinks (Q18) (p=0.0845). When examined more closely, the SCI group demonstrated a higher level of knowledge relating to sports drinks' effects on hydration and body fluid regulation. This was evident by a larger proportion of athletes with SCI correctly choosing functions of a sport drinks to "retain body fluid" (p=0.016) and identifying sports drinks as a "source of water" (p=0.077).

It is likely athletes with SCI are more knowledgeable about the functions of sports drinks as a result of managing the hydration and thermoregulatory complications associated with SCI. As earlier discussed, individuals with SCI often have a diminished sweating response which can reduce their fluid requirements and increase their risk of hyperthermia and hyponatremia [5, 36]. Therefore, alternative thermoregulatory strategies in preference to the consumption of fluids are required to prevent over-heating [36]. Conversely, athletes with SCI are susceptible to urinary tract infection, which can be attenuated by increasing fluid consumption, however, the volume of fluid consumed needs to be well managed to prevent hyponatremia [92].

5.2.3 Sports Nutrition Knowledge

An optimal diet to enhance performance, promote training adaptations, and improve recovery not only requires sufficient amounts of certain nutrients, but also the correct timing and composition of meals and snacks [1]. Dietary preparation is essential for performance during prolonged events (more than 60-90 minutes) as substrate utilisation often depletes muscle and liver glycogen, and circulating blood glucose [1]. Current literature recommends eating a high carbohydrate meal 3-4 hours before exercise followed by a light carbohydrate and protein snack (50g carbohydrate and 5-10g protein) 30-60 minutes before exercise to increase the availability of carbohydrate and amino acids during intense exercise and delay the depletion of substrate stores [1].

In this study, the beliefs of either group regarding dietary strategies before and during exercise did not significantly differ. The majority of the athletes were aware of the importance of consuming carbohydrate, which was demonstrated by 91% of the AB group and 75% of the SCI group correctly agreeing with ‘consuming carbohydrates 2-4 hours before exercise can influence performance (Q19), however, considerably less athletes (46% AB vs. 50% SCI) believed carbohydrate should be consumed 1-2 two hours before an event. Twice as many in the AB group, compared with the SCI group (69% SCI vs 36% AB) believed consuming protein 2-4 hours before an event was beneficial to performance, although this was not significant (p=0.102). It is recommended athletes consume protein before exercise, however, the supporting reasons are indicative of improving recovery rather than directly enhancing performance during the period of exercise [1]. Protein consumed beforehand before exercise increases the amino acid availability during exercise and ameliorates exercise-induced catabolism of muscle protein [1]. Therefore, one may argue consuming protein before exercise indirectly improves performance in subsequent bouts of exercise because of an improved recovery from exercise.

Current literature suggests that athletes should consume approximately 1g/kg of carbohydrate and 0.5g/kg of protein within 30 minutes following intense exercise, in addition to a high carbohydrate meal within two hours following exercise [1]. In the present study, every AB athlete knew they should eat within 30 minutes following exercise, however, only 36% knew what they consumed should contain an amount of carbohydrate equivalent to 1g/kg of their bodyweight. This uncertainty is a possible outcome for the various nutritional recommendations associated with different sporting disciplines. For example, a post-training snack in addition to a meal may not be required in some situations, particularly in the case of skill based trainings or sports where athletes do not expend considerable amounts of energy.

Additionally, the nutritional requirements for athletes with SCI must accommodate their unique physiological status and the type, duration and intensity of their chosen sport. Previous research suggests carbohydrate requirements for athletes with SCI are likely to be lower due to an increase in fat oxidation as evident by a reduced respiratory exchange ratio during prolonged exercise and lower overall energy requirements [5]. It is likely these influencing factors caused uncertainty among athletes with SCI in the current study, as only 56% of the SCI group believed they should eat within 30 minutes after exercise and 13% stating the food consumed should contain carbohydrate equivalent to 1g/kg of their bodyweight.

Overall, athletes reporting higher levels of sports nutrition knowledge spent less on nutritional supplements. This is possibly because with increasing knowledge, athletes become more aware of appropriate foods to eat surrounding exercise. In contrast, athletes with less knowledge resort to the consumption of supplements as a compensatory strategy for poor food choice.

5.3 Beliefs and Attitude

It is important to recognise the information on the efficacy and safety of many nutritional supplements and ergogenic aids athletes use is limited and in some cases completely absent [3]. To consider a supplement effective, whether for performance or health, it must be evaluated in a controlled and unbiased manner. Importantly, if a supplement's efficacy for use has not been evaluated, it is unlikely there will be any evidence for the safety of the product. Supplements may not possess benefits for all athletes, with the current literature suggesting athletes respond differently to some products [1, 2]. Nonetheless, the evidence supporting the use or refraining from the use of supplements often has to compete with an athlete's beliefs and attitude towards these products. It has been reported that individuals can either manipulate or ignore the nutrition information they receive in accordance with their current beliefs, termed the 'cognitive dissonance theory' for which athletes aim to reach 'cognitive consistency' [10].

Athletes in the current study reported 'performance' to be the most influential factor on dietary habits. Interestingly, only 60% of the SCI group stated performance benefits to have an influence over what they consumed, compared to 100% of the AB group (p=0.019). This is likely due to a more prevalent belief among AB athletes (91% AB vs. 60% SCI) that nutritional supplements are important for performance. In similar studies, ‘improving performance’ and performance measures such as ‘strength’, ‘power’, ‘muscle mass’ and ‘energy’, have also been reported as reasons for supplement use by many elite and university AB athletes [14, 15, 58].

In contrast, athletes with SCI reported ‘taste’, ‘health’, ‘lifestyle’ and ‘convenience’ to have equal or more influence than performance on dietary habits. This is suggestive that improving the quality of life (QOL) for an athlete with SCI through the amelioration of nutritional limitations is of more benefit to performance, than if the focus were on consuming products directly associated with enhancing performance (i.e. ergogenic aids). The QOL associated with SCI was investigated by Mortenson et al [93] who evaluated the influence of several factors at three and 15 months after discharge in a group of 93 non-athletic individuals with SCI [93]. Mortenson et al reported health competence, family support and mood state, such as optimism and self-efficacy, to be the most influential factors on QOL [93]. In comparison, physical barriers and daily activities were considered to be of less importance [93], which suggests the participation in sport and exercise is not a main priority for the SCI population. Furthermore, some supplements may provide benefit to athletes with SCI who report the importance of convenience and lifestyle. Convenience supplements currently represent the largest segment of the nutritional supplement industry and are typically fortified with vitamins and minerals, and differ on the amount of carbohydrate, protein and fat they contain [1]. The AIS have listed many of these supplements within group A as they are of benefit to the athlete in specific sporting situations, which in addition to several others, include sports drinks, protein powder, protein bars, and carbohydrate gels. However, the AIS supplement list was developed for AB athletes and may not be appropriate for some athletes with SCI, thus emphasising the importance of seeking advice from a qualified health professional prior to use.

The varying influence of several factors in the present study did not produce significant differences in the type of supplements consumed between the two groups, apart from the SCI group's more prevalent use of creatine (p=0.012), and vitamin C (p=0.05). However, whether this group's health or performance will benefit from the supplementation with these products is unknown and requires additional investigation.

It is clear the relationship between an athlete's dietary habits and their nutrition knowledge, beliefs and attitude is complex, and presents many problems when attempting to identify possible associations. Therefore, further research is required to clarify these factors and if an athlete will improve their dietary habits if provided with nutritional education [9].

5.4 Information and education

Athletes rely on accessible sources of information, with coaches, family, friends, and fellow athletes often being reported by athletes in several countries as a primary contact for advice [14, 15, 57, 58, 60, 64]. Unfortunately, conflicting nutritional messages coinciding with the continuous expansion of the nutritional supplement market has made it difficult for clear nutrition recommendations to translate at a population level

[3, 94]. Therefore, relying on unqualified individuals for advice may not translate into optimal nutritional practices.

In the present study, half of the AB and SCI groups reported receiving nutritional supplement information from nutritionists and dietitians, who were the most common source of advice for these athletes (Q31). However, the AB group received significantly more information from sporting organisations compared to the SCI group (p=0.05). This is understandable as the majority of the AB athletes in this study attended the MISH, which provides specialist high performance training facilities and nutritional support to New Zealand's top athletes. In contrast, the majority of the athletes with SCI attended Parafed Auckland, a local sporting organisation for athletes with physical disabilities aiming to progress towards training at the MISH. Nutritional support at Parafed Auckland is less accessible, as only one dietitian is employed on a part-time basis, compared to nearly every team and athlete at MISH having a dietitian or nutritionist assigned to them. As a result, the internet, magazines, books, family and television tended to provide the SCI group with more supplement information.

Despite the present study not ascertaining whether individuals who provide athletes with nutritional advice have had previous nutrition education, such as friends, family, coaches and parents, it remains possible they are not guaranteed sources of accurate information. These individuals in addition to supplement manufacturers are likely to not rigorously evaluate a nutritional product for its safety, efficacy, potency and legality before delivering nutritional information and advice [1, 12]. Therefore, qualified health professionals who obtain information from peer-reviewed scientific publications and have experience in high performance sport are likely to be the best source of unbiased information for athletes who are choosing to use supplements.

Furthermore, a higher percentage of athletes with SCI than AB athletes (40% SCI vs. 64% AB) reported to seek further advice prior to supplement use (Q33), although this was not significant (0.243). The reasons for this were not investigated, however, as athletes with SCI were nearly twice as likely than AB athletes to agree with only using supplements recommended by a medical doctor or dietitian (54% SCI vs. 27% AB), they may believe further education on the use of a particular supplement is not necessary and refrain from seeking additional information, such as the supplementation protocol for a specific product. However, athletes with SCI were more likely to believe the information provided to them is inadequate (Q32), although this difference was insignificant (p=0.324), therefore, it is concerning athletes with only moderate levels of knowledge would not educate themselves further on supplements prior to their use. Without proper knowledge, athletes who use supplements face several risks from ineffective products to impaired performance. Furthermore, athletes can be susceptible to unintentional doping, which can and does happen, even when athletes are ensured the products are safe [1, 12].

Even with the risk of unintentional doping, the proportion of athletes reporting further education on the safety (45%) and side effects (40%) of supplements were considered to be of less importance than their performance enhancing effects (80%) and health benefits (80%). This may be of concern as some athletic populations are not aware supplements can adversely affect health and be a cause of unintentional doping [62]. However, a similar study demonstrated that 56% of athletes from a Canadian university stated they did not want to know more about supplements [7], which reflects the positive attitude of New Zealand athletes to learn more.

If this is the case, for informed professionals to effectively educate athletes and be influential in their supplement practices, then easily accessible mediums to disseminate accurate information such as the internet, television, magazines and newspapers should be utilized. In particular, nutrition education needs to extend to those in direct contact with athletes such as coaches, trainers, parents and family. In this study, both groups indicated that an individual session with a sports nutritionist or dietitian is their preferred source of nutrition information, although, this is not cost-effective and it is unlikely there is sufficient resources within NZ to accomplish this.

5.5 Limitations

The present study was limited by several factors relating to the questionnaire, sample population, methodology and analysis.

The questionnaire was based on the current literature relating to nutritional supplements, nutrition requirements for athletes and nutrition for individuals with SCI. Questions were either adapted from other studies investigating supplement knowledge and practices, or created to ascertain information on specific nutrition areas. As time was limited, the questionnaire could not be validated. The validity of nutrition knowledge measures can be evaluated according to three categories; content, construct and criterion [81]. Assessing content validity refers to how well the questions assess the targeted measure and can be influenced by the response format, layout and interpretability [81]. Whereas, the construct validity can be measured by providing the questionnaire to two groups with known differences in knowledge, i.e. sports dietitians and recreational athletes, and criterion validity which is determined by comparing to other measures of nutrition knowledge, however, due to the variability of questions in many questionnaires, this is often difficult [81]. A small test-retest reliability correlation was performed which showed good reliability $r = 0.811$, $p<0.001$. However, due to the small number of participants involved in this, the true reliability of the test cannot be confirmed. Furthermore, the terminology used was relatively simple, however, some words may be foreign to the athletes such as 'ergogenic aids' and 'electrolytes'. The majority of the questionnaire utilised a multi-choice format, for which the responses may not be representative of the athlete's true knowledge, especially if the question was misinterpreted, and allows the athlete to answer questions superficially. The questionnaire also didn't evaluate an athlete's reasoning for some responses, and it is unknown whether they were lying or cheating.

The questionnaire was completed online, and within the athlete's own time and environment. Therefore, there is potential for athletes to research questions they were unsure of. Despite anonymity being assured, athletes may have felt obliged to respond with answers we felt were correct in preference to their true beliefs or practices, which may bias some answers towards current nutritional recommendations.

The sample population was relatively small and consisted of 11 AB athletes and 18 athletes with SCI. Recruiting athletes with SCI who are considered to be of elite level is difficult because of the poor accessibility to this population, particularly due to their low number and it being a Paralympic year. Therefore, athletes with SCI were sourced from Parafed Auckland, a lower level-sporting organisation for athletes with disabilities. Athletes were only recruited from NZ, which limits the application of results to similar populations since the athlete development programs are unique to each country.

The participation of AB athletes and athletes with SCI was voluntary, which possibly biased results towards individuals with higher levels of supplement knowledge and use. Furthermore, several athletes failed to answer each question for unknown reasons, allowing those responding to have a larger influence on the results. This means two responses in a sample of 10 SCI increases the prevalence by 20%, whereas if all athletes with SCI to answer (18 SCI), the prevalence would only increase by 11.2%. The small sample could not produce a statistically significant difference for many questions, despite a clear difference in knowledge being apparent.

The analysis of results included minimal correlations between sections and questions of the questionnaire. Due to the small sample population, the study did not possess the power to provide significant correlations between knowledge, beliefs and practices. Despite ascertaining the sports athletes participated in, we did not display these in our results, nor did we differentiate between the level of knowledge or supplement practices and the different sporting disciplines, as further sub-division would have decreased the power of the study. Furthermore, this study did not differentiate the level of knowledge between female and male athletes.

6.0 CONCLUSION

Nutritional supplements have become a popular dietary strategy for many athletes wishing to enhance their performance. Despite many supplements claiming to improve health or performance without conclusive scientific support, athletes continue to use these products, with many consuming more than one simultaneously. The type of supplement used by athletes is variable and should theoretically relate to their nutritional goals and the requirements of their sport, however, this is often not the case. However, it was evident among athletes with SCI in the present study this does not always occur, as they tended to use supplements associated with enhanced muscle mass and strength, and the prevention of illness, despite the possibility for many of these supplements being of no benefit.

Moreover, the level of nutritional supplement knowledge exhibited by athletes with SCI in the present study was similar to their AB counterparts. This does not imply athletes with SCI possess an adequate level of knowledge, especially as it may not be relevant to the products the athlete supplements with, nor with the health issues of the athlete and the characteristics of their chosen sport. An athlete's lack of knowledge for specific areas of nutrition may be compounded by misconceptions regarding supplements or certain nutrients, and the delivery of misinformation from a variety of misinformed sources. Therefore, athletes need to be educated from an early age on the importance of good nutritional habits prior to supplement use, for which only some products may provide a benefit to performance and should only be used when advised by a qualified professional.

7.0 PRACTICAL APPLICATIONS

The first step should be to ensure all athletes make good food choices appropriate to their nutritional targets. Accurate nutritional educational messages, consistent with evidence-based practice, should be passed onto athletes directly or through coaches, sports institutes and health professionals. The dissemination of nutritional information needs to utilise accessible mediums in order to effectively reach these groups. Although, the passing on of nutritional information may not be sufficient for some athletes, who may also require continual support to reinforce good food choices at home, as well as at training and competition events. Health professionals need to be aware of an athlete's prior nutrition education and their current beliefs or misconceptions, and correct these if necessary. Additionally, they must understand athletes' goals and the desired effects for the use for any products being supplemented with.

Although considerable research has been done to serve as a basis for nutrition recommendations for AB athletes, these standards may not be appropriate for athletes with SCI and comparable standards are not available [8]. Therefore, the nutritional knowledge of athletes with SCI cannot be compared to population-specific nutritional recommendations, as they do not exist. This emphasises the importance of further research to investigate the nutritional requirements for this group of individuals and how participation in sport and exercise may influence their nutrient metabolism and whether they become at further at risk of secondary health complications.

Nevertheless, the availability of nutrition information to AB athletes does not mean they possess adequate amounts of knowledge regarding their nutritional requirements and practices. Therefore, validated tools to assess athletes' nutrition knowledge and behaviour will help health professionals evaluate these, and allow the effectiveness of nutrition interventions to be monitored.

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9.0 APPENDICES

Appendix 1. Focus group transcription

This is a summary of the focus group conducted on the 11/4/12 including four wheelchair rugby athletes with spinal cord injuries.

1. Student Researcher: Do you think nutrition education for athletes with a disability is adequate?

Subject A: No, it is often left up to other experienced athletes and un-tailored to the physical training requirements and health needs of each athlete.
Subject B: No, not really
Subject C: No, I know the basics but that is just from my coach and I don't know how he knows what he does.
Subject D: No, we usually just have to find out for ourselves. Sometimes the doctor tells me about what foods to eat because it can affect my medications. We don't get told about sports nutrition though.

2. Student researcher: What dietary challenges do you currently experience, if any?

Subject A: Food requirements with antibiotics either with or without food requirements, and loss of appetite.
Subject B: Weight gain. Or sometimes I just don't feel like eating.
Subject C: I'm not sure what food to eat and drink for training – before, during and after.
Subject D: Weight gain. And keeping properly hydrated, not drinking too much fluid, particularly because with spinal cord injury our sweating response is disrupted.

3. Student researcher: How do you manage fluid and hydration?

Subject A: Chilled water in a sealed container in the refrigerator, I try to always drink 1 glass with meals, and during exercise I use Horley's replace. I was told to start consumption after 15 minutes of exercise and have a maximum of 750ml.
Subject B: Yeah, cold water. I don't drink at least 3 hours before bed because it means I need to get up in the night for the toilet.
Subject C: I try to drink lots of water and always have a water bottle on me.
Subject D: I don't drink water by itself; I don't like the taste so I usually have juice/tea/coffee. I drink Powerade or replace whenever I train.

4. Student researcher: Do you use nutritional supplements?

Subject A: Yes, to support energy during long trainings. I use a zinc/magnesium/B6 combination instead of carbohydrates to support energy production and not to consume too much sugar. As an older athlete, I use CoQ10 to support energy also, and fish oil to support brain and nervous system, and to aid concentration, usually for two weeks into competition. And, creatine monohydrate for the week before competition and during.

Subject B: I use protein before and after the gym, and Horley's replace during training. I also take fish oil.
Subject C: I don't take anything really, just a multivitamin.
Subject D: I have caffeine gel shots if I go on really long pushes and Horley's replace.

5. Student researcher: Do you think your knowledge regarding diet and nutritional supplements is adequate?

Subject A: I am always looking to improve performance and refine my diet for performance, so I think my knowledge is adequate for national level of competition, but not for international level. I realise that as research knowledge has improved my diet can also be improved.
Subject B: I could definitely learn more about supplements. I don't know that much. I know about protein and creatine though.
Subject C: I don't use supplements, although I take a multivitamin because my partner takes one as well. I don't know a lot about supplements.
Subject D: My coach recommended the gel shots and a lot of us use replace for hydration but other than I don't really know very much about any other supplements.

6. Student researcher: What areas of diet and nutrition do you believe your knowledge is inadequate?

Subject A: Fast recovery strategies and important trace elements, and use of anti-oxidant foods during competition.
Subject B: Supplements, what foods cause weight gain, what foods to avoid if trying to lose weight?
Subject C: Foods that will help me train better and recover faster. I don't really know what and how much food to have during training. I usually just eat whatever is easiest.
Subject D: Lots of different things – weight loss would be the most helpful for me. I would like to know what foods are actually bad for me. Also, I'd like to know the guidelines for hydration for people like me.

Appendix 2. Questionnaire

<u>Section 1A - Demographics</u>

1. **What is your age?**

2. **What is your gender? (please select one)**

	Male
	Female

3. **What is your weight (kg) and height (m)?**

	Weight (kg)
	Height (m)

4. **Do you smoke?**

	Yes		No		Ex-smoker

5. **What is the highest qualification you possess?**

	High school
	Tertiary education (University/Polytec)
	Postgraduate study
	Trade qualification/apprenticeship e.g. builder or electrician

6. **Have you previously received nutrition or sports nutrition education?**

	Yes
	No
	Unsure

7. **Which ethnic group do you belong to?**
   (tick the box or boxes which apply to you)

	New Zealand European
	Maori
	Samoan
	Cook Island Maori
	Tongan
	Niuean
	Chinese
	Indian
	Other (such as Dutch, Japanese) Please state:

8. **What is your main sport or event?**

9. **What is the highest level you have competed in for your main sport?**

	International
	National
	Regional
	Recreational/Social

10. **<u>How many hours a week</u> do you spend training for your main sport (including sport specific and gym training)?**

	hours

Section 1B – Disabled Athletes (only)

11. What disability do you have?

	Amputee
	Cerebral Palsy
	Spina Bifida
	Spinal Cord Injury
	Visual Impairment
	Intellectual Impairment
	Les Autres (Other)

12. Does your disability affect your nutritional requirements?

	Yes
	No

13. If yes, how does it affect your nutritional requirements?

	Impaired immune response e.g. increased risk of infection
	Gastrointestinal problems/upsets e.g. bloating, acid reflux, diarrhoea
	Bladder/urinary tract complications e.g. urinary tract infections, bladder control
	Cardiovascular complications e.g. atherosclerosis
	Altered fluid requirements e.g. decreased sweat rate, impaired ability to regulate body temperature
	Susceptible to inadequate oral intake e.g. difficulty swallowing, poor access to food
	Body composition e.g. weight issues, muscle deterioration
	Other (please specify)

Section 2 - Nutritional Supplement Knowledge

14. What is the best description of a "nutritional supplement"? (tick one box only)

	A nutrient which can increase your capacity for physical or mental work.
	A food which must be eaten in pill, capsule or powder form.
	A nutrient which has been shown to increase performance.
	A preparation intended to supply nutrients, such as vitamins, minerals, fatty acids or amino acids that are uncommon or not found in sufficient quantity in a person's diet.

15. Are these classified as "nutritional supplements"?

	Yes	No	Unsure
Sports drink or gel			
Calorie replacement or weight loss drinks			
Flavoured milk			
Multivitamins			
Muesli bars			
Protein bars and protein drinks			
Breakfast cereal			
Lollies			
Fish Oil Capsules			

16. Do you agree or disagree with the following statements regarding nutritional supplements?

	Agree	Disagree	Unsure
All supplement claims are scientifically proven			
Caffeine, creatine and bicarbonate supplements are			

all considered ergogenic aids i.e. increase work output			
Only take supplements recommended by a medical doctor or dietitian			
Excess consumption of supplements can have negative effects on health.			
Supplements can be compared according to their effectiveness and safety			
All supplements have been proven safe for short and long term consumption			
Some supplements can cause positive doping tests			

17. Would you agree or disagree with the following statements?

	Agree	Disagree	Unsure
Protein bars and shakes are <u>essential</u> to increase muscle size and strength			
Carbohydrate drinks and gels help replace liver and muscle glycogen stores during recovery			
Iron supplements improve performance when athletes have adequate iron levels			
Calcium supplements support bone health in those consuming inadequate dietary calcium			
Multivitamins maximize body stores of all vitamins and minerals beyond normal levels to improve performance			
Caffeine is a central nervous system stimulant and is thought to improve endurance			
Creatine increases muscle strength and explosive power only in some individuals			
HMB (hydroxyl methyl butyrate) improves endurance rather than increasing muscle strength			
Bicarbonate acts as a buffer to lactic acid produced during high intensity exercise			

18. Which of these are the <u>main</u> functions of sports drink? (tick as many as appropriate)

	Sports drinks help the body retain fluid
	Sports drinks help burn fat
	Sports drinks help replace sweat losses
	Sports drinks taste better than water
	Sports drinks replace sodium and potassium losses
	Sports drinks help replenish glycogen stores
	Sports drinks help replace protein losses
	Sports drinks are a source of water

19. Do the following improve sports performance?

	Yes	No	Unsure
Eating carbohydrate 2-4 hours before an event			
Eating protein 2-4 hours before an event			
Training or competing on an empty stomach			
Eating carbohydrates 1-2 hours before an event			
Eating protein 1-2 hours before an event			
Eating carbohydrate during an event			

20. **What is the recommended carbohydrate guideline for the recovery snack/meal in athletes?**

	0.1kg of carbohydrate per kg of bodyweight
	0.5g of carbohydrate per 2kgs of body weight
	1g of carbohydrate per kg of bodyweight
	5g of carbohydrate per kg of body weight
	Unsure of the recommended amount

21. **The optimal time for an athlete to eat after exercise is: (select one)**

	Within 30 minutes
	Within 45minutes
	Within 1 hour
	Between 2-3 hours
	Unsure

Section 3- Nutritional Supplement Practices

22. **Please select (tick the box) the nutritional supplements you are currently using. State any further supplements you are using which have not been mentioned.**

Supplement	**Tick ONLY if Currently Using**
Sport drinks	
Carbohydrate drinks (not including sports drinks)	
Carbohydrate gels	
Creatine	
Caffeine	
Protein powder	
Protein drinks (pre-made and packaged)	
Protein bars	
Amino acids	
Weight gainers	
Glutamine	
HMB	
Multivitamin	
Vitamin C	
Vitamin D	
Vitamin B-12	
B-complex vitamin	
Folic acid	
Calcium	
Iron	
Ginseng	
Guarana	
Bicarbonate	
Fat burner	
Glucosamine	
Please state any further nutritional supplements you are currently using	

23. How often do you use nutritional supplements? (Tick one box only)

	Never
	Less than once a week
	Once a week
	2-3 times per week
	4-6 times per week
	Daily
	2-3 times a day
	4 or more times a day

24. How often do you consume sports drinks e.g. Powerade, Horleys Replace (Tick one box only)

	Never
	Less than once a week
	Once a week
	2-3 times per week
	4-6 times per week
	Daily
	2-3 times a day
	4 or more times a day

25. With regards to training and competition, when would you consume these drinks? (you may tick more than one for each drink)

	Before Exercise	During Exercise	After Exercise	Never/not at all
Water				
Fruit drink i.e. from sachet or cordial				
Soft drinks				
Diet soft drinks				
Pure fruit juice				
Sports drinks				
Caffeinated energy drinks				
Protein shakes				
Milk				

26. How do you acquire nutritional supplements? Select all appropriate answers

	Sponsorship i.e. free or discounted supplements
	Nutritional Supplement Store
	Supermarket
	Gym store
	Internet (within NZ)
	Internet (outside of NZ)
	Mail order
	Friend
	Other (please specify)
	I don’t purchase or get provided with supplements

27. Have you ever experienced negative side-effects from using supplements? If you have, please state which supplement(s).

	Yes (Please Specify)…
	No
	Unsure

28. Roughly how much money do you spend on nutritional supplements a month?

$

<u>Section 4 - Nutritional Supplement Attitude</u>

29. What are the <u>most important influences</u> on your dietary habits? (tick all the options which apply to you)

	Performance
	Aesthetic appeal
	Friends
	Parents or family
	Coach
	Personal, cultural or religious beliefs
	Advertising or media
	Lifestyle or convenience
	Taste
	Previous experience within certain foods
	Health
	Cost
	Other (please specify)

30. I think using nutritional supplements are important for performance

	Strongly agree
	Agree
	Disagree
	Strongly disagree

Section 5 – Nutritional Supplement Education and Information

31. **If you have received advice regarding nutritional supplement use, where did you get this from? (please specify)**

	Magazines or books
	Internet
	Sporting organizations
	Friends
	Teammates or fellow competitors
	Family members or parents
	Coach or trainer
	Nutritionist or dietitian
	TV
	Doctor
	Supplement store
	Other (please specify)

32. **Do you think the dietary/nutritional advice you have received is adequate with regards to**

	Yes	No	Unsure
Nutritional supplements and their use			

33. **Do you seek further information of nutritional supplements before using them?**

	Always
	Most times
	Sometimes
	Rarely
	Never

34. **With regard to nutritional supplements, what would you like to learn more about? (Tick all boxes that apply)**

	Performance enhancing properties (effectiveness)
	Health benefits
	Side effects
	Safety
	Manufacturing process
	Other, please specify

35. **How would you like information to be delivered?**

	Written information sheets
	Internet or interactive website programs
	Individual session with a sports nutritionist or dietitian
	Cooking lesson with a sports nutritionist or dietitian
	Group discussions
	Coaches
	Supermarket tour
	Athlete as a guest speaker about their nutritional strategies
	Other (please specify)

Thank you for completing this questionnaire, your effort is much appreciated.

Appendix 3. Email of survey description

Dear athlete,

We are currently completing our Masters in Dietetics to become dietitians through the University of Otago. Our research aims to investigate the nutritional supplement knowledge, nutrition knowledge and dietary practices of both abled-bodied athletes and athletes with a disability, and how they may differ. We are asking for your participation in this study, which only involves following the link below and completing a 30-minute online survey. In return for your effort, we will provide monetary and education incentives. The questionnaire is easy to fill out, which makes an easily earned $20! So get in quick!

If you are interested or know of anyone who would like to participate in this study, please get in touch with us via email or the mobile number below.

We look forward to your response.

Kind regards

Dave Shaw and Jessica Moulds
University of Otago