SUPPLEMENT USE IN PROFESSIONAL RUGBY LEAGUE

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Abstract

The purpose of this research was to gain a better understanding of sports supplement use in elite Rugby League (RL) though identifying the prevalence of supplement use within elite RL; assessing the knowledge, beliefs and attitudes towards supplements amongst elite RL players; and by examining the knowledge, beliefs and attitudes towards supplements of support staff who have a direct influence on the sports nutrition practices within the elite RL.

A questionnaire was distributed to identify the prevalence of supplement use and assess the knowledge, beliefs and attitudes of supplements amongst 166 elite RL players, across eight English teams competing in the European Super League (ESL). The questionnaire asked each player to report supplement use and type, the input they had, levels of knowledge and source of information, and reasons for use. Frequency analysis and comparison between frequency counts was performed using cross tabulation matrices and Chi^2 analysis to identify any statistical significance. The questionnaire data revealed that 95 percent of elite RL players report the use of supplements. The main reasons for supplement use related to recovery (90%) and building muscle (86%) with the main ingredients reported as protein (100%); creatine (64%); vitamins and minerals (60%); carbohydrate (56%). Other than the players themselves, strength and conditioning coaches (85%) and dieticians or nutritionists (29%) were identified as the most influential individuals when deciding supplements practices. Many respondents (25%) reported having no input into the supplements they consumed with 92 percent acknowledged an awareness of potential risks associated with supplements. However only 56 percent of respondents were aware of the risk minimisation scheme in the UK. This was despite 97 percent of respondent reporting receiving advice relating to safe supplement use with strength and conditioning coaches (87%), dietician or nutritionist (73%) and sport scientist (39%) being identified as the main sources for such advice.

Additionally, semi-structured one-to-one interviews, which were deductively developed to assess the knowledge of and attitudes towards supplements amongst player support staff, were conducted with one member of support staff from eight English teams competing in the ESL. The interviews were transcribed and a systematic, line-by-line process of coding took place to identify different themes and common trends, which later developed into general dimensions. Triangulation was also used to review the findings, provide a check on the selective perception, and illuminate any blind spots or misinterpretations during the initial analysis. The interview data highlighted the lack of qualified nutritionists within RL as only 2 respondents identified themselves as nutritionists. The additional six respondents were strength and conditioning staff. The majority of the respondents agreed that supplements do play a part in sport and identified that the benefits of supplements relate to convenience and the addition of certain dietary demands that were difficult to meet through food alone. However, the majority of participants also stresses the importance of a good diet. All respondents identified sponsorship and the related financial benefits as driving influential factors in supplement brand choice and there are similarities in the way that clubs decide and deliver supplement practices which highlight a possible dependency culture. However, it is reported that the head of strength of conditioning has the ultimate responsibility with respect to supplement use even where clubs have access to a nutritionist. Respondents also stress that there was a lack of educational resources available to both themselves and players and suggest that this could be a factor leading to the perceived lack of knowledge amongst players and support staff in RL.

In conclusion, the current research reports the high prevalence of supplement use in elite RL whilst highlighting the issues concerning a potential lack of nutritional and anti-doping knowledge amongst both players and athlete support staff. These findings suggest that both players and athlete support staff would benefit from further education in relation to the safe use of supplements from an anti-doping perspective and further analysis is needed to assess the levels of dependency within elite RL.

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Finally, thanks to all of the players and support staff who participated in the research, by giving their open and honest opinions about what may have been a rather sensitive subject. It is hoped that the issues raised will help to inform future strategies to tackle inadvertent doping and responsible supplement use within Rugby League.

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CHAPTER ONE

INTRODUCTION

1. Introduction

Rugby League (RL) is a high-intensity collision sport which involves low-intensity, aerobic activities combined with frequent periods of intermittent, intensive anaerobic activities. A game consists of two 40-minute halves (Austin & Kelly, 2013 Twist et al., 2014) with each team being made up of 13 players including six forwards and seven backs. Elite RL players require muscular strength and power to perform game specific movements such as tackling, lifting, leg drives and playing the ball (Meir et al., 2001). To achieve these requirements elite RL player's train five to six days per week (Hodgson-Phillips et al., 1998 and Stephenson et al., 1996) and engage in prolonged periods of structured resistance training (Baker and Newton, 2006; Baker, 2013). In addition to appropriate structured resistance training, it is important that elite RL players optimise their dietary intake by ensuring that both the total calorific intake and the protein targets are met on a daily basis (Bradley et al., 2015a; Bradley et al., 2015b). Training for and playing RL can markedly increase the need for macro- and micronutrients and at a professional level, this increase can be substantial. Although some studies suggest that such increases in other sports, can be covered adequately by dietary management (Burke et al., 2006), there is very limited research relating to RL. With this in mind the primary nutritional strategy to support optimum performance in RL should be the consistent intake of a well-balanced and healthy diet.This may include controlling the quantity and type of foods to meet varying energy needs, selecting the correct food sources to provide adequate carbohydrate, protein, and micronutrients and planning the timing of intake to facilitate recovery from games and training (Hawley et al., 2006; Williams and Serratosa, 2006). However, Tooley et al. (2015) found that a number of elite RL players struggle to meet these

requirements. Given the need for a high lean muscle mass in RL players (Morehen et al., 2015) and reported under-recovery across a playing season (Fletcher et al., 2016), the use of dietary supplements in this group of athletes is unsurprising.

According to the UK Anti-Doping (UKAD) programme, rugby has one of the highest rates of anti-doping rule violations (ADRVs) in the UK with 47 ADRVs across both codes (Rugby League and Rugby Union) between 2012 and 2016. However, figures from 2012 indicate that approximately 44 percent of positive tests in the UK during that year were linked to inadvertent doping (UKAD, 2015) through the presence of prohibited substances in supplements.

Research highlights the anti-doping risks posed to athletes in relation to supplement use (Delbeke et al.,2002; Van Poucke et al.,2007; De Cock et al., 2001; Geyer et al.,2011). Given that it is almost impossible to prove whether doping is intentional or inadvertent, the contamination or adulteration of a supplement is not an acceptable excuse for an anti-doping violation (Burke, 2000b; Yonamine et al., 2004). The UKAD figures from 2012 could suggest that there may have been a lack of awareness amongst professional athletes concerning anti-doping risks.

There are many studies which report athletes using supplements without full understanding or evaluation of the potential benefits and risks associated with their use; without consultation with a qualified practitioner (Maughan, 2005; Maughan et al., 2007; Waddington et al., 2005; Petróczi et al.,2007); and without

knowing the possible side effects (Giraldia et al., 2015; O'Dea 2003). Dascombe et al. (2010) also suggested that among athletes who used supplements, many did not know the active ingredients, any potential side effects or even the reported mechanisms of action of the supplement.

Although sports science and sports nutrition are now a given in professional sports (Wolinsky, 1998), many athletes do not have access to qualified practitioners. It is often a member of support staff who takes responsibility for advising on nutrition practices (Juzwiak and Ancona-Lopez, 2004; Torres-McGehee et al.,2012; Cockburn et al., 2014). However, there is limited research that actually investigates the nutritional knowledge of support staff. The research that has been conducted in this area (Smith-Rockwell et al., 2001; Juzwiak and Ancona-Lopez, 2004; Zinn et al., 2006; Torres-McGehee et al., 2012; Cockburn et al., 2014) suggests that the majority of support staff have inadequate levels of knowledge pertaining to nutrition. This perceived lack of knowledge extends further as Mazanov et al. (2014) found that athlete support staff had very poor knowledge of anti-doping rules.

In light of these issues and the current lack of research in this area, the prevalence of supplement use; and the knowledge attitudes and beliefs towards supplement use by those participating in, and setting supplement practice in elite RL, has been the primary focus of this research.

1.1 Aims and objectives of the research

RL has been identified as a sport with a particularly high number of athletes sanctioned for ADRVs. Based on the nature of the substances detected, many of the ADRVs could be due to inadvertent doping through supplement use. The main aim of the research will be to gain a better understanding of sports supplement use in elite RL. To achieve this aim there are three key objectives:

i. to identify the prevalence of supplement use within elite RL;
ii. to assess knowledge, beliefs and attitudes towards supplements amongst elite RL players;
iii. to examine the knowledge, beliefs and attitudes towards supplements of support staff who have a direct influence on the sports nutrition practices within the elite RL.

CHAPTER TWO

REVIEW OF LITERATURE

2. Review of Literature

2.1 Rugby League

2.1.1 Introduction to Rugby League

RL is a contact team sport played professionally in the United Kingdom, Australia and New Zealand and semi-professionally in other nations (e.g. France; Papua New Guinea; Canada and the United States). In the UK, the elite competition is the European Super League (ESL), which - as of the 2017 season - included twelve teams, eleven of which were from England. A typical season spans eight months, with these twelve teams competing over a maximum of 32 matches. There is also the potential for teams to play an additional four matches in the major knockout competition (Challenge Cup). In Australia and New Zealand, the elite competition is the National Rugby League (NRL), which follows a similar structure as the ESL.

RL is a high-intensity collision sport which involves low-intensity, aerobic activities (e.g. standing, walking and jogging) combined with frequent periods of intermittent, intensive anaerobic activities (e.g. sprinting, side stepping, passing and collisions), played over two 40-minute halves (Austin & Kelly, 2013 Twist et al., 2014). A team consists of 13 players, which includes six forwards (loose forward, second-row, prop-forward, and hooker) and seven backs (fullback, wingers, centres and half-backs). In comparison to backs, forwards cover the shortest distance (~4000 cf. 7000 m), are involved in more physical collisions (1.0 cf. 0.6 per minute), and have the shortest playing time (55 cf. 80 min) (Gabbett et al., 2012; Waldron, et al., 2011; Oxendale, et al., 2016; Twist, et al., 2012). Despite differences in total distance

covered and playing time, the relative distance covered during a match is similar for both positional groups (~90–95 m·min^{-1}; Gabbett et al., 2012; Waldron et al., 2011).

2.1.2 Physiological demands of Rugby League

Current research provides a limited insight into the physiological match demands of competitive RL. However, a study by Morehen et al. (2016), reported the average weekly total energy expenditure values of professional RL players as 22.5 MJ. These are higher than reported previously in Rugby Union players (Bradley et al., 2015a; Bradley et al., 2015b).

The ability to generate high muscular force rapidly is an important attribute of RL players. Players are required to have high muscular strength to perform game specific movements such as tackling, lifting, pushing and pulling effectively (Meir et al., 2001). In addition, high muscular strength and power are required for fast play-the-ball speeds and effective leg drives in tackle situations. Elite RL player's train five to six days per week (Hodgson-Phillips et al., 1998 and Stephenson et al., 1996) often performing multiple training sessions each day (Gabbett, 2002) and engaging in prolonged periods of structured resistance training (Baker and Newton, 2006; Baker, 2013) that aim to enhance muscle qualities (Gabbett & Seibold, 2013; Speranza, et al., 2016). Accordingly, such training loads have led to elite rugby players possessing higher maximal muscle strength and power than lower standard players (Baker, 2001).

Research suggests that enhancements in muscle qualities could aid improvements in fundamental rugby skills. Gabbett and Seibold (2013), highlight the importance of lower-body and upper-body strength, endurance, and prolonged high-intensity intermittent running ability in semi-professional RL. Furthermore, they suggest that well-developed lower-body strength contributes to effective physical match performance in semi-professional RL players. Another study by Speranza, et al., (2016) demonstrates how the enhancement of lower-body muscular strength, and to a lesser extent muscular power, contribute to improvements in tackling ability in semi-professional RL players.

A longitudinal study by Baker and Newton (2006), observed the changes in maximal upper-body strength and power in twelve professional RL players. They found that by regularly performing combined maximal strength and power training across a 4-year period, significant increases in strength occurred with a 14.3 percent increase in one repetition maximum (1 RM) bench press and power with a 14 percent increase in bench press throws. This was supported by further research conducted by Baker (2013), who examined changes in upper body strength and power in elite professional RL players over a ten-year period. Increases in strength and power in the order of 22.3 percent and 23 percent were found following ten years of training; with most progress being made within the first three years of training. This was despite the initial strength levels of these athletes exceeding the previously reported average for professional RL players (Meir et al. 2001). However, due to the longitudinal nature of this study, participant numbers were low with only six professional RL players recruited.

A study by Appleby et al. (2012) included twenty professional rugby union players and documented the long-term adaptations to resistance training. They found that maximal upper and lower body strength was increased by 6.5 to 11.5 percent after two years of training. They also found that the magnitude of improvement in maximal strength was positively related to the change in the lean mass. The physical demands of the sport require players to maximise lean body mass while also maintaining low body fat. Typical body fat percentages for professional RL players being 15 and 12 percent for forward and backs, respectively (Morehen et al., 2015; Till et al., 2014). Throughout the development of an elite player over numerous seasons, a major aim may be to progressively increase lean mass. Appleby et al. (2012) reported increases in lean mass of 6 to 13 percent in elite rugby union players over two seasons. Typical values for elite RL players have been reported as 60 to 100 kg and 55 to 88 kg for forwards and backs, respectively (Morehen et al., 2015). These values are typically higher than lean mass reported in other team sports, such as soccer (~65 kg) (Milsom et al., 2015).

However, there is also evidence to suggest that the physiological capacities of players may deteriorate as the season progresses. Gabbett, (2005) reported reductions in muscular and maximal aerobic power alongside increases in skinfold thickness occurring towards the end of the RL season. Gabbett, (2005) offered an explanation for such deteriorating measures suggesting they may be linked to limited recover time, residual fatigue and increases in injury rates in the latter half of the season. A Study by Fletcher et al. (2016) also highlights issues relating to under-recovery as they report that elite RL players perceived to be constantly sore

throughout a season and that muscle soreness was still apparent four days after a match.

2.1.3 Nutritional demands of Rugby League

In addition to appropriate structured resistance training tailored towards maximising gains in lean muscle mass, it is imperative that players' diets are optimised. More specifically, players should ensure that both the total calorific intake and the protein targets are met on a daily basis (Bradley et al., 2015a; Bradley et al., 2015b). During a four-day dietary analysis study, Lundy et al. (2006) proposed that the nutrient intake observed in Australian RL players were adequate to meet the demands of generic sports and public health guidelines. However, given that the energy expenditure was not measured or estimated by Lundy et al. (2006) the dietary intake data lacks contextualisation in relation to the energy cost of the activities that were performed during the same time-period in which nutritional intake was assessed. Research by Bradley et al. (2016) recently reported that a competitive RL match can result in ~40% muscle glycogen depletion. This study manipulating energy in the form of carbohydrates by splitting players into two dietary groups. Players followed an individualised diet plan beginning 36-h before kick-off, with habitual diet ingested before the intervention. One group comprising of a relatively high CHO intake (~6 g kg day−1 CHO, ~1.8 g kg day−1 protein and 0.7 g kg day−1 fat) and the other comprising of a non-isocaloric relatively low CHO intake (~3 g kg day−1 CHO, ~1.8 g kg day−1 protein and 0.7 g kg day−1 fat).

Although the results of this study found that a competitive RL match can result in ~40% muscle glycogen depletion, there were no significant differences in match-day performance variables between the 6 g kg−1 or 3 g kg−1 CHO conditions. However, Bradley et al. (2016) continue to suggest that the higher CHO intake results in a more homogenous pre-match glycogen concentration and that, despite no differences in movement characteristics between the low and the high CHO groups, an absolute amount of ~600 g CHO 36-h pre-match is recommended for rugby league players. It would appear that carbohydrate consumption in the week leading into a rugby match is the major contributor to pre-match muscle glycogen concentration, rather than the carbohydrate content of the diet in the preceding 36 h and therefore this should be monitored by coaches and players. Additionally, Tooley et al. (2015) found that a mean daily energy deficit of 947 ± 214 kcal existed when energy intake was compared to estimated energy expenditure in ten professional RL players competing in the ESL. Tooley et al. (2015) continue to suggest that if these findings caloric deficit persist for a prolonged period, then a mean weekly weight loss of 0.12 ± 0.03 kg per player would occur. Although under reporting is an issue which may compromise the integrity of dietary analysis studies, Tooley et al. (2015) explains that the under reporting is unlikely to affect their findings due to the significant differences in energy intake and expenditure. However, under reporting may make it difficult to determine exact energy deficit.

Although the nutritional requirements of a RL match have previously been described Bradley et al. (2016), there is little research on the nutritional requirements for optimal recovery. Despite major differences in the match-day demands between soccer and rugby, similar changes in pre- to post-match muscle glycogen concentrations have been reported, Bradley et al. (2016) and Krustrup et al (2006)

with many players finishing a match with less than 200 mmol kg ‐ 1 dry weight (d.w.) of muscle glycogen in both rugby (Bradley et al 2016) and soccer (Krustrup et al 2006). Bradley et al. (2017) found that substantial muscle glycogen re-synthesis was possible in the immediate dietary re-feed group despite evidence of muscle damage via increase blood proteins suggesting that with appropriate feeding strategies it is possible to replenish a damaged muscle.

Given the requirement for a high lean muscle mass in rugby players (Morehen et al., 2015) and the fact that players report immediate and prolonged sensations of under-recovery across a playing season (Fletcher et al., 2016), dietary interventions are a common strategy. The use of protein and carbohydrate rich diets have been shown to optimise muscle mass and enhance recovery.

2.2 Supplement use

Supplements are an addition to the regular diet intended to offer further nutritional value, or enhance wellbeing and performance. Supplements might be characterised into categories according to their purpose of use. Such categories might include medication, health-related products and ergogenic aids. Supplements, which fall under the category of medication, could include prescription or non-prescription over-the-counter products, which are intended to alleviate symptoms of illness. Health related supplements often consist of, but are not limited to, vitamins and minerals which may treat a deficiency caused by a poor diet or as a consequence of the extra demands imposed by the participation in sport. Ergogenic aids are

supplements designed with the intention of enhancing sports performance in both training and competition (Chester, 2014).

Supplements might also include those of plant origin, for example, herbs or botanical substances. Some traditional medicines (i.e. traditional Chinese medicines) are often the product of a combination of such ingredients. The use of herbal extracts or nutritional supplements containing herbal components is becoming more attractive among the Western population (Pokrywka et al., 2014). This is supported by Kennedy (2005) who analysed data from 31,044 adults who participated in the 2002 National Health Interview Survey in the United States, which estimated that approximately 19 percent of adults in the United States had used herbal or dietary supplements. This could be due to the increased use of herbal and botanical ingredients during the production of health based and sports supplements (Baraniak et al., 2016)

Dietary supplements often include micronutrients (vitamins and minerals), herbs or botanicals (originating from plants), amino acids, or any dietary substance taken with the intention of increasing intake outside of the usual diet. Supplements can range from ‘off the shelf’ multi-vitamin products intended for the general population, to a product specifically designed for the athlete market, intended to aid performance and recovery. The specific demands of the sport are central in the design and manufacture of such products. Given the multitude of ways in which supplements can be utilised, and an increasingly ‘health conscious’ society, the nutritional supplement market has thus grown significantly and become recognized – and seemingly validated – amongst professionals working in the sports industry

as an effective method of meeting dietary demands. This is to such an extent that supplements now have a major role in sport at all levels (elite, amateur and recreational) (Maughan et al., 2004).

2.3 Prevalence of supplement use

In an attempt to understand any issues associated with supplement use, it is essential to establish the prevalence of supplement use. Information on the supplement market size and growth demonstrated the prevalence of supplement use for the general population. However, to identify the prevalence of supplement use amongst specific groups, for example elite athletes, surveys and questionnaires have often been utilised.

Evidence of supplement use through market research

Market research from the past few years has continued to show the growth of the supplements market on a global scale. In 2012, the worldwide supplements market was reportedly worth an estimated $US96 billion (Nutrition Business Journal, 2014). Market research from 2010 shows that the US supplements market generated $22.7 billion profit from the sales of dietary supplements, which were specifically targeted for either use in sport or for aiding weight loss (Nutrition Business Journal, 2011). The size of the market was further demonstrated by Denham (2011), who reported that over 150 million U.S. residents use dietary supplements.

Further market research demonstrates a continual growth in the supplements market in the UK. In 2012, the UK supplement market was valued at approximately £260 million (Euromonitor International, 2013 cited by Chester, 2014). However, in 2013, the UK supplement market was estimated to be worth £301 million (Euromonitor International, 2014 cited by Smith et al., 2015). Although this data gives a good indication of the size and growth of the supplements market, it is not indicative of use amongst athletes per se.

Suggested reasons for the continual growth in the supplements market include developments in advertisements and tailored marketing strategies (Van Thuyne et al., 2006). Van Thuyne et al, (2006) also highlighted the increased accessibility to supplements through advancements in technology, mainly the internet. The internet has made supplements available to a global market via online retail outlets. Another factor, which has enabled the supplements market to grow are the changes in the laws and legislation in the United States. As highlighted by Kozirok (2013), the changes in the law have ensured that supplements are accessible to the general public, thus allowing customers free access to purchase supplements and enabling the manufacturers of dietary supplements to openly market products in the United States without prior Food and Drug Administration (FDA) approval for safety and efficacy. However, in Europe, the European Food Safety Authority (2006) implemented a regulation on the use of nutrition and health claims for food supplements based on nutrient profiles. This regulation was intended to ensure that any claim made on a label in Europe was clear and substantiated by scientific evidence. In the UK, supplements are regulated under food law, which sits under the Food Safety Act (1990). The Food Safety Act (1990) intended to increase

consumer protection by improving the levels of regulation applied to the production and retail of food supplements. Nevertheless, these regulations only apply to supplements manufactured in Europe. Supplements manufactured outside of Europe are not subject to European rules and regulations. Given the globalisation of the retail market via the internet legislation around supplement use is difficult to enforce.

Evidence of the prevalence of supplement use in sport

Many studies have tried to identify the prevalence of supplement use in sport (Table 1). Ronsen et al. (1999) used a nutrition questionnaire to interview athletes across multiple sports including alpine skiing, cross-country skiing and power sports (boxing, weightlifting and track and field), focusing on nutritional habits. During the interviews with these athletes, questions were asked in the same order as listed on the questionnaire, but in some cases, a clarification on certain questions was given. Although the sample of athletes in this study was relatively small (n = 100), they found that 84 percent of all athletes used one or more supplements with power athletes often reporting the use of a large variety of supplements, including multi-vitamins; vitamin C; multi-minerals; proteins/amino-acids and creatine. With the use of an athlete survey, Baylis et al. (2001) reported the widespread supplement use (99%) amongst elite Australian Swimmers (n = 77). The sample essentially reflected junior elite swimmers since only three respondents were senior squad members. Schroder et al. (2002) found similar results in their study, which focused on athletes (n = 55) from the top Spanish Basketball League. With the use of a questionnaire, they found that 58 percent (n = 32) of these basketball players recorded the use of

dietary supplements. Ziegler et al. (2003) looked at the prevalence of dietary supplement use among 105, elite male and female figure skaters. Through the use of a survey and 3-day food records, they found that 71 percent of these elite figure skaters reported the use of dietary supplements. In a study, which focused on athletes competing at the World Indoors Masters Athletics Championships, Striegel et al. (2006) distributed questionnaires to athletes to determine supplement use and achieved a response rate of 38 percent (*n* = 598). Over 60 percent of those who completed the questionnaire used nutritional supplements. Aljaloud and Ibrahim (2013) studied patterns of dietary supplements among professional athletes in Saudi Arabia. Through the use of a survey, they reported the use, consumption and beliefs about supplements of 105 athletes. They report that 93 percent of athletes were using at least one supplement throughout the season with performance and health benefits being listed as the main reasons on use.

In addition to the use of questionnaires or surveys, information gathered during anti-doping sample collection has been used to provide some indication of supplement use. Petróczi, et al. (2007) analysed survey data which was collected by the UK Sport for the 2005 Drug Free Sport. Survey data from 847 high-performing athletes in the UK were analysed to find that 59 percent of them reported the use of at least one nutritional supplement. A more recent study by Lazic et al. (2011) analysed data from doping control forms completed during in-competition (international and national) and out-of-competition sample collection performed by the Anti-Doping Agency of Serbia (ADAS) over almost a three-year period (2006–2008). From a relatively large sample of athletes (*n* = 912) from multiple sports, 61 percent declared dietary supplement use.

Despite the majority of the research reporting a high prevalence of supplement use amongst athletes, Omeragić, et al. (2015) reported a low prevalence of supplement use amongst athletes reporting that only 34.5 percent used dietary supplements. However, this study also confirmed that within this low percentage, athletes were using multiple dietary supplements. The number of dietary supplements used amongst athletes was a mean of 2.9 ± 2.8 regardless of age and gender. This lead to the suggestion of the excessive use of dietary supplements amongst athletes.

In addition to research amongst elite athletes, some studies have also examined the prevalence of supplement use amongst younger, aspiring athletes. Burns et al. (2004) distributed a survey amongst university student athletes to determine supplement use and prevalence amongst other things. The results from 236 completed surveys indicated that 88 percent of university student athletes had used one or more nutritional supplements. Hoffman et al. (2008) also looked nutritional supplementation as well anabolic steroid use in adolescent males and females. This study administered a survey to 3248 students representing grades 8-12 and reports the use of at least one supplement by 71.2% of students. Petróczi et al. (2008) studied the nutritional supplement use among young elite UK athletes. 403 athletes, both male and female and between the ages of 12 and 21 completed a questionnaire which was modified version of the original UK Sport "Drug-Free Sport" survey. This study reported that 48 percent of these young athletes used at least one nutritional supplement. Braun et al. (2009), assessed the past and present use of dietary supplements amongst 164 young elite athletes (mean age of 16.6 ± 3.0 years) with the use of a questionnaire. They report that eighty percent of all

athletes reported using at least one supplement, and the prevalence of use was significantly higher in older athletes.

One potential motivator for such widespread supplement use amongst young athletes is the ever-increasing pressure to attain increasingly higher levels of performance in sport. (Calfee and Fadale, 2006). A more recent study by Wiens et al. (2014) also looked at the motivation for consuming supplements amongst young athletes and found that the majority of young athletes reported using dietary supplements with the belief they would improve performance and health. Athletes between the ages of 11 and 17 years focused on vitamin and mineral supplements whereas, athletes between the ages of 18 and 25 focused on purported ergogenic supplements.

Morrison et al. 2004 found that supplements are most frequently used by amateur and elite athletes, but Molinero and Marquez (2009) suggest that due to aggressive marketing, millions of recreational athletes turn to nutrition supplements in hopes of improving performance. Perhaps one of the most influential factors, suggested by Van Thuyne et al. (2006), may be the use of supplements by professional athletes. The continual improving standard of elite sport places a higher physical demand on the athletes involved, many of whom use supplements to improve their performance. The use of supplements by elite athletes only further promotes the supplement market and seemingly endorses their use amongst individuals from all levels of sport. Those at amateur levels particularly, aspire to achieve the standard of professional athletes and thus strive to become better and achieve greater levels

of performance and success through replicating their training regimes, dietary meal plans and, indeed, their supplement regimes.

Table 1: Studies demonstrating the prevalence of supplement use amongst athletes

Authors	method	Participants	Types of supplement	Prevalence
Baylis, et al. (2001)	Survey	(n = 77) Elite Australian Swimmers	Sports drinks; carbohydrate powders; sports bars; liquid metal; sports gels; vitamins and minerals; vitamin C; anti-oxidants; iron; zinc; creatine; ginseng; garlic; inosine; herbal substances; protein and amino acid; di-methyl-glycine; co-enzyme Q10; glycerol; carnitine; shark liver oil, digestive enzymes; bicarbonate	99% (n = 76)
Schroder, et al. (2002)	Questionnaire	(n = 55) First Spanish Basketball League players	Multivitamins and vitamins; sport drinks; miscellaneous supplements (including: carnitine, co-enzyme Q, inosine, choline, lecithin, iron, ginseng and commercial plant extract mixtures); amino acids; proteins; carbohydrates	85% (n = 32)
Ronsen, et al. (1999)	Questionnaire	(n = 100) multiple sports	Iron, Multivitamins, Vitamin C, Minerals, Proteins and Amino Acids Cod-liver Oil, Creatine	84% (n = 84)
Lazic, et al. (2011)	Doping control form analysis	(n = 912) Multiple sports	Vitamines; Minerals; Amino Acids; Herbal; Creatine; Other; Sports drinks; L-Carnitine; Carbohydrates; Fatty Acids; Proteins; Tribulus terrestris	61% (n = 558)
Omeragić, et al. (2015)	Doping control form analysis	(n = 442) Multiple sports	Amino Acids; Other Groups; Vitamine C; Multivitamines; Magnesium; Sports Meal; Calcium; Ferrum ; Multiminerals; Vitamin B; Zinc; Vitamin B12; Vitamin D; Vitamin A; Cuprum; Vitamin E	34.5% (n = 152)
Slater, et al. (2003)	Questionnaire	(n = 160) Multiple sports	Sports drinks; Caffeine; Vitamin C; Multivitamin/mineral; Essence of chicken; Creatine; Ginseng; Sports bar; Protein/weight gain powders.	77% (n = 123)
Lun, et al. (2012)	Survey	(n = 440) Multiple sports	Sport drinks; Multivitamin and mineral; Carbohydrate sport bar; Protein powder; Meal-replacement products; Vitamin C; Ginseng; Protein bar; Sports gel; Iron; Essential fatty acids; Calcium; Echinacea; L-glutamine; Energy drink	87% (n = 383)

Aljaloud and Ibrahim (2013)	Survey	(n = 105) Professional Football players in Saudi Arabia	Sport supplements (Sport drinks, Health bar, Red bull energy drink); Vitamins (Vitamin C, Vitamin D, Vitamin E, Vitamin B); Multivitamin; Minerals (Iron supplement, Calcium); Carbohydrate (Carbohydrate electrolyte beverage, Fructose syrup); Protein (Amino acids, Ephedra, Weight gainers); Fish oils (Omega 3, Omega 6); Herbals (Ginseng, Gingko biloba); Ergogenic aids (Slimming products, Coenzyme, Caffeine, Creatine)	93.3% (n = 98)
Ziegler et al. (2003)	Survey	(n = 105) Elite male and female figure skaters	Multivitamin and mineral; Protein powders; Amino acid powders; Protein bars; Energy drinks of bars; Creatine; Herbal supplements; Common herbal supplements (Ginseng; Echinacea; Gingko biloba; Garlic; Green tea; St. John's Wort; Chamomile; Ephedra; Kava kava)	71.4% (n = 75)
Petróczi, et al. (2008)	Questionnaire	(n = 403) Multiple sports	Multivitamin; Echinacea; Vitamin C; Iron, Ginseng; Whey Protein; Caffeine; Creatine; Energy Drinks	48.1% (n = 193)
Petróczi, et al. (2007)	UK Sport Survey Data Analysis	(n = 847) Multiple sports	Creatine; Caffeine; Iron; Magnesium; Ginseng; Whey Protein; Multivitamin; Echinacea; Vitamin C	58.8% (n = 498)
Burns et al. (2004)	Survey	(n = 236) university student athletes	Vitamins/minerals; Herbal supplementation; Calorie-replacement drinks; Protein supplementation; Creatine; Other ergogenic aids	88% (n 208)
Hoffman et al. (2008)	Survey	(n = 3248) Adolescent (grades 8-12)	The most popular supplements used were multivitamins and high-energy drinks	71.2% (n = 2313)
Braun et al. (2009)	Questionnaire	(n = 164) Elite young athletes	Vitamins; minerals; carbohydrate; protein and fat supplements; sport drinks; and other ergogenic aids	80% (n = 131)

2.4 The reasons for supplement use

Given the scientific understanding of the anatomy, physiology, biochemistry and biomechanics, which underpins an athlete's ability to succeed in their chosen sport, it is widely understood and promoted that nutrition plays an extremely important role in exercise performance and training (Manore and Thompson, 2000; Benardot, 2012). A diet, which does not account for the nutritional demands of various sports, may adversely influence athletic performance as well as result in individuals experiencing health problems. This notion is supported by the fact that research has shown that athletes benefit significantly from a well-designed and well-implemented nutritional plan. Torres-McGehee et al., (2012), Juzwiak and Ancona Lopez (2004) and Burke et al., (2004) have all stressed the importance of nutrition in athletes and report a link between optimal nutrition and peak performance; recovery and body mass control and reduced illness and injury (Ozdogan and Ozcelik 2011).

Numerous studies show the advantages of using supplements to improve different aspects of physical health and performance. Many individuals use dietary supplements to maintain or improve their health status. Dundas and Keller (2003) examined the use of supplements amongst university students. They reported that the main reason for supplement use amongst these students were to prevent colds or flu, to give more energy, and to make up for an inadequate diet. Many athletes are aware that the use of some supplements may not only benefit and improve performance, but that they can potentially preserve good health and prevent and treat illness (Maughan et al., 2007; 2010).

Supplements can offer athletes a convenient way of meeting dietary demands without major changes to their eating habits. This may be especially important when athletes wish to ingest protein either just before or just after training with the aim of promoting the adaptations that take place in response to the training stimulus (Hawley et al. 2006). Protein synthesis is optimal by the intake of a specified amount of protein in the early recovery phase, less than 2 hours after exercise (Beelen et al., 2010; Phillips, 2012).

Studies by Lippi et al. (2008) and O'Dea and Rawstorne (2001) examined the reasons as to why non-elite athletes use supplements. Both studies report increasing strength; improving performance; and enhancing physical appearance as the primary reason of supplement use amongst non-elite athletes. Lippi et al., (2008) continue to explain that the desire to succeed at any level of sport may play a role in the decision to use supplements and that in recreational settings, the use supplements is not governed by WADA. This means that the athlete is free to use whatever legal supplements they want in a quantity decided by themselves, regardless of the impacts on health. On the one hand, one could argue that this is potentially empowering, as athletes and sports-people have increasing levels of control over their own training and performance. However, it could also be perceived as potentially dangerous as these individuals may not be sufficiently trained in the fields of nutrition or healthcare to make fully informed and sensible decisions about the substances they ingest in the quest to enhance their competitiveness and performance.

Wiens et al. (2014) identified that the sources of information for many young athletes include family and friends, coaches, and athletic trainers. However, this study also reports that less than half of these young athletes had met with a dietitian. This links to a study by Perko et al. (2000) who also identified coaches and parents, as well as physicians as having an influence on the decision-making process regarding supplements among adolescent athletes from multiple sports. However, Perko et al. (2000) continued to suggest that the athletes themselves might have had a lack of credible knowledge concerning supplement safety whilst still reporting supplement use to enhance performance. This relates to Calfee and Fadale (2006) who found that adolescent athletes were using supplements to enhance performance. These issues is also raised in a review paper by McDowall (2007), who acknowledges the need to educate young athletes about supplement use.

Efficacy of supplements used to enhance muscular strength, power, endurance and recovery.

In relation to performance, increases in physical strength and lean mass, a reduction in muscle damage, enhanced recovery and reduced muscle soreness have all been associated with the use of various dietary supplements (Gualano et al., 2012; Cepero et al., 2010; Shimomura et al., 2006; Coburn et al., 2006; Koopman et al., 2005; Burke et al., 2001).

Numerous studies indicate that protein and amino acids are fundamental for the growth and repair of muscle tissue and enhancing muscle mass. The evidence shows that protein and amino acid supplementation stimulates protein synthesis when consumed immediately before, during, or within the first few hours after resistance exercise.

A study by Tipton et al. (2001), in which six subjects participated in two trials involving resistance exercise, found that the consumption of an essential amino acid-carbohydrate supplement before exercise resulted in a greater net muscle protein synthesis than when the supplement was consumed post exercise. This was primarily due to an increase in muscle protein synthesis as a result of increased delivery of amino acids to the working muscle. Another study by Beelen et al. (2008) investigated the effect of protein congestion with carbohydrate on muscle protein synthesis during resistance-type exercise. They found that in ten healthy males who consumed a standardized diet throughout the day, protein congestion stimulates whole body and muscle protein synthesis rates during 2 hours of resistance-type exercise. These studies have examined the effects of supplement ingestion prior to and during exercise, but there is also evidence to support these positive effects when supplements are ingested following exercise. Moore et al. (2008) observed the muscle response in six subjects ingesting varying amounts of protein following intense bout of leg-based resistance exercise. On 5 separate occasions after exercise, participants consumed, in a randomized order, drinks containing 0, 5, 10, 20, or 40 g of protein. They found that the ingestion of 20 g of protein following resistance exercise was sufficient to maximally stimulate the muscle and protein synthesis.The importance of protein is further highlighted in a study by Koopman et al. (2007), the aim of which was to assess the impact of congesting various amounts of carbohydrate combined with an ample amount of protein on post-exercise muscle protein synthesis rates. They found that in ten male subjects who performed sixty minutes of resistance exercise, the amount of carbohydrate ingested during recovery did not further stimulate post-exercise muscle protein synthesis when ample protein was ingested.

Although there are some contradiction amongst these studies regarding the optimal ingestion time, they all identify the important role that protein and amino acids play in the growth and repair of muscle tissue. However, all of these studies are focused on individual exercise bouts. A study by Coburn et al. (2006) aimed to determine the effects of resistance training in combination with a leucine and whey protein supplement or a carbohydrate placebo on strength. This study saw Thirty-three men split into one of three groups, a supplementation group, a placebo group, and a control group. Following eight weeks of resistance training, the study found a significant increases in strength for participants consuming the leucine and whey protein supplement. Another study by Colker et al. (2000) assessed the effects of supplemental whey protein with or without added l-glutamine and branched-chain amino acids on body mass, body composition, and exercise performance over a 10-week period in sixteen male participants. They found that after 10 weeks of hypertrophy resistance exercise training following a diet that restricted food protein, the combination of whey protein plus L-glutamine and BCAAs was more effective than whey protein alone at increasing lean body mass. They also found that both lower body and upper body exercise performance was also significantly increased. A study by Cribb et at. (2006) examined the effects of supplementation with two proteins, hydrolyzed whey isolate and casein, on strength, body composition, and plasma glutamine levels of thirteen male recreational bodybuilders during a 10 week, supervised resistance training program. Although plasma glutamine levels did not change in either supplement group following the intervention, significant improvements in lean mass, fat mass and strength were seen in the subjects who supplemented their normal diet with hydrolyzed whey isolate. In a similar, more

recent study by Cribb et al. (2007), focused on the effects that whey protein and creatine monohydrate had on body composition, muscle strength, fiber-specific hypertrophy and contractile protein accrual during resistance exercise training. Thirty-three recreational male bodybuilders were split into one of four groups based on strength. The groups determined what supplementation they would receive throughout an 11 week, supervised resistance training program. The four supplement groups consisted of: creatine and carbohydrate, creatine and whey protein, whey protein only and carbohydrate only. The results of this study support the previous research by reporting significant increases in strength and muscle hypertrophy in the groups ingesting whey protein. However it would seem that the addition of creatine monohydrate aids these performance improvements. Koopman et al. (2005) also found that the combined ingestion of protein (with additional leucine) and carbohydrate improves whole body protein balance during recovery from resistance exercise as it augmented post-exercise muscle protein synthesis. Shimomura et al. (2006) further examined how recovery might be affected by BCAA supplementation. They found that muscle soreness and fatigue was decreased following supplementation prior to strength training. These findings suggest that the consumption of BCAA supplements may be useful for muscle recovery following exercise.

Whilst the majority of these studies have focused of protein and amino acid supplementation and how they can aid the recovery and development of lean mass, the results from Cribb et al. (2007) has considered and included the use creatine supplementation.

Creatine is has been shown to improve performance in strength, power, lean body mass and in sports that are intermittent in nature (i.e. team sports involving repeated sprint activity) through improving the anaerobic work capacity. A study by Volek et al. (1999) examined the effect of creatine supplementation on nineteen male participants. The subjects were split into two groups, one group supplementing their normal diet with creatine and the other with a placebo, before taking part in a 12 week periodised resistance training programme. Following the 12 weeks of creatine supplementation, they reported that participant's significant increases in lean body mass and increased in both lower and upper body strength by 32 percent and 24 percent respectively. The study also reported significantly greater increases in Type I, IIA, and IIAB muscle fiber cross-sectional areas in those participants using creatine supplementation. This study was followed by research from Rossouw et al. (2000) who looked at how much creatine could improve performance in well-trained individuals, by looking at the effect of creatine monohydrate loading on maximal intermittent isokinetic exercise and sport-specific strength in 13 well-trained power-lifters. Once again, the participants were split into one of two groups, one group supplementing their normal diet with creatine and the other with a placebo. The results from this study relate to Volek et al. (1999) in that significant improvements in performance were reported for participants using the creatine supplementation. Peak torque, average power, total work and work output all increased significantly following creatine supplementation as well as significant increases in deadlift lifting volume after only six days of creatine supplementation. A similar study by Burke et al. (2000a) looked to examine the effects that 21 days of low dose creatine supplementation would have on performance parameters following resistance training. Using forty-one male participants split into two groups, one group

supplementing their normal diet with creatine and the other with a placebo, Burke et al. (2000a) found that the participants using creatine experienced significantly greater improvements in peak force and peak power whilst also performing more total work until fatigue. These results indicate that creatine supplementation over a longer period than previous studies can also significantly improve factors associated with short-duration, high-intensity activity. Another study by Burke et al. (2001), assessed muscular adaptations of 36 male participants during six weeks of resistance training whilst using a protein supplement or a protein and creatine supplement. Similarly to previous studies, the greatest improvements in lean tissue mass and strength were reported in the group supplementing with both protein and creatine. A review by Rawson and Volek (2003) also report that the combination of creatine and resistance training also increased maximal strength and number of repetitions (at a given percentage of maximal strength) more than resistance training alone (8 and 14%, respectively). These results are also in line with a study by Law et al. (2009), in which seventeen trained men were randomly assigned to a creatine or a placebo group. They found that a 5-day creatine loading regime coupled with resistance training resulted in significant improvements in both average anaerobic power and back squat strength compared with just training alone.

However, the main focus of these studies have been the improvements to strength and lean mass associated with creatine supplementation, but there is also evidence to support the benefits of creatine supplementation on anaerobic performance which is often associated with team sports. Aaserud et al. (1998) investigated the effect of creatine supplementation on performance of repeated sprint runs in well-

trained young male handball players and found that, following a creatine loading period of 5-days repeated sprint ability of athletes was improved. Aaserud et al. (1998) reported that the improvements were due to the delaying the onset of fatigue as creatine supplementation had no effect on the run time on the first sprint, but subsequently reduced the time increases of the repeated sprint times. Similar results were found in a study by Izquierdo et al. (2002), who again looked at the performance of handball layers. Following a 5-day creatine loading regime, they reported improvements in lower-body strength, upper- and lower-body power, muscular endurance, and enhanced repeated sprint performance. A more recent study by Eckerson et al. (2005) also found that following 6 days of creatine supplement loading, the anaerobic working capacity was increased by 13 to 15 percent in both males and females.

Although these studies have mainly focused on the benefits, certain supplements have on strength and power there is also evidence to show that supplements and aid muscular endurance. Numerous studies have shown that ingesting carbohydrate in supplement form can improve exercise performance by maintaining blood glucose levels and sparing endogenous glycogen stores.

During exercise, an athletes carbohydrate availability to the muscle and central nervous system can be compromised due to the potentially high energy expenditure during training or competition exceeding endogenous carbohydrate stores. The provision of additional carbohydrate is important because carbohydrate availability limits the performance of prolonged (>90 min) sub-maximal or intermittent high-intensity exercise and plays a permissive role in the performance of brief or

sustained high-intensity work (Hargreaves, 1999). The ingestion of carbohydrate shortly before and during exercise offers athletes an effective strategy to provide an exogenous fuel source to the muscle and central nervous system. Jeukendrup et al. (1997) investigated the effects of carbohydrate ingestion during the equivalent of a 40-km time trial in well-trained cyclists and found that performance was improved by 2.3%. A similar study by el-Sayed et al. (1997) also found similar results in which, following pre-exercise carbohydrate ingestion, the endurance performance in trained cyclists during a 1 hour simulated time trial was significantly increased. Carter et al. (2003) aimed to identify the effects of carbohydrate supplementation on moderate and high-intensity endurance exercise in the heat. This study recruited eight endurance-trained men who cycled to exhaustion twice at 60% VO(2max) and twice at 73% VO(2max) at an ambient temperature of 35 degrees C. This study found that supplementation with carbohydrates improves exercise performance in the heat as time to fatigue was significantly greater when the participants consumed carbohydrate supplements in both the 60% and 73% VO(2max) trials (14.5% and 13.5% improvement, respectively). A more recent study by Cambell et al. (2008) examined the effectiveness of carbohydrate supplements in improving endurance. The participants in this study were required to cycle at 75% VO(2peak) for 80 minutes followed by a 10-km time trial whilst consuming a form of carbohydrate supplement or water. They found that all carbohydrate-supplement types were equally effective in maintaining blood glucose levels during exercise and improving exercise performance compared with water only.

However, these studies have only focused on the effects that carbohydrate supplements have on endurance exercise. There is also evidence to show that carbohydrate supplements can improve high intermittent exercise.

Nicholas et al. (1995) examined the effects of ingesting a carbohydrate-electrolyte solution on endurance capacity during a prolonged intermittent, high-intensity exercise. A group of recreational football players completed two exercise trials, 7 days apart in which they began sprinting and jogging back and forth over the 20m course to the point of fatigue. The subjects were randomly allocated either a carbohydrate-electrolyte solution or a non-carbohydrate placebo immediately prior to exercise and every 15 min thereafter. They found that the distance covered was 33 percent greater when participants drank a carbohydrate-electrolyte solution (6.5 percent) than when they drank a flavoured placebo solution. Davis et al. (1999) studied the effects of ingesting carbohydrate beverages with and without BCAA's before and during intermittent high-intensity running to fatigue. Eight subjects performed three exercise trials consisting of intermittent shuttle running (walking, sprinting, and running) to fatigue. During each of the three trials, participants consumed either a carbohydrate supplement, a carbohydrate and BCAA supplement or a flavoured water placebo. This study found that the performance of the participants was increased following the ingestion of the carbohydrate supplement and carbohydrate and BCAA supplement as compared to placebo, with no differences between carbohydrate and carbohydrate combined with BCAA. These findings confirm a beneficial effect of carbohydrate feedings on fatigue during intermittent high-intensity exercise. Welsh et al. (2002) also examine the effects of carbohydrate-electrolyte ingestion on physical performance and mental function

associated with the performance of intermittent high-intensity exercise. Ten participants completed two trials including a intermittent high intensity shuttle running protocol designed to closely stimulate the demands of an actual competitive sporting event such as football. Participants consumed either a carbohydrate-electrolyte supplement or a placebo drink prior to and during each trial. The results found that following the ingestion of the carbohydrate supplement, participants improved by 37 percent and that self-reported perceptions of fatigue was also improved compared to participants consuming the placebo drink. Alghannam (2011) examined the influence that carbohydrate and protein ingestion had on running capacity towards the end of a simulated football match. Six male amateur football players participated in a laboratory-based, football-specific protocol in which intermittent exercise was allocated for 75 min interspersed with a 15-min recovery, immediately followed by run time to fatigue at 80 percent peak oxygen consumption. This study reported that the following the consumption of a supplement containing both carbohydrates and protein, subsequent running capacity following limited recovery from intermittent exercise was enhanced.

Carbohydrate supplements have also been shown to aid recovery. A study by Ivy et al. (2002) looked at how supplements combining carbohydrates and supplements might further enhance recovery following exercise. Following glycogen depletion, seven participants consumed one of three supplements, carbohydrates, carbohydrates and protein or caloric equivalency. Following 240 minutes of recovery, muscle glycogen was significantly greater for the participants who consumed the carbohydrate and protein supplement following exercise(88.8 ± 4.4 mmol/l) when compared with the carbohydrates (70.0 ± 4.0 mmol/l; P = 0.004) and

caloric equivalency (75.5 ± 2.8 mmol/l;P = 0.013) supplements.This study suggests that a supplement made up of a combination of carbohydrates and protein is more effective for the rapid replenishment of muscle glycogen after exercise than a carbohydrate supplement alone. A more recent study by Cepero et al. (2010) examined how post-exercise recovery in cyclists, was altered when consuming beverages containing different mixtures of carbohydrates and proteins. This study included fifteen male cyclists who performed three trials. In each trial one participants, consumed one litre of a supplement containing carbohydrates, a mixture of carbohydrates and casein protein or a mixture of carbohydrates and whey protein. These supplements were consumed in fasting conditions after one hour ride at 75% VO (2peak). After a two hours recovery period the cyclists rode 20 km at the rider's maximum speed for this distance. Surprisingly, the study reports no significant differences in the 20-km ride between the different supplements consumed. However, there were some different physiological effects as muscle glycogen re-synthesis was enhanced when protein was added to a carbohydrate recovery formula suggesting that a combination of protein and carbohydrates could improve recuperation from intensive exercise and attenuate muscle damage.

Given the evidence base supporting the use of nutritional supplements in sport, a high prevalence of dietary supplement utilization amongst professional and elite athletes (Outram and Stewart, 2015; Baylis, et al. 2001; Schroder et al., 2002; Striegel et al., 2006; Ronsen et al., 1999; Lazic et al., 2011; Omeragić, et al., 2015; Slater et al., 2003; Lun et al., 2012; Aljaloud and Ibrahim, 2013; Ziegler et al., 2003; Petróczi, et al., 2008; Petróczi, et al., 2007; Burns et al., 2004; Hoffman et al.,2008; Braun et al., 2009) is unsurprising. These athletes utilize supplements with the

aspiration to maximize their sporting ability through enhancing body composition (Kiertscher and Di Marco, 2013), recovery (Cepero et al., 2010; Shimomura et al., 2006) and muscular strength and power (Coburn et al., 2006; Eckerson et al.,2005; Izquierdo et al., 2002; Colker et al., 2000;) whilst to attempting to achieve nutritional goals that cannot be met through consumption of a regular balanced diet (Maughan et al., 2007).

The benefit of supplementation in sports, however, is still debated; many argue that a diet which is specifically designed to ensure an adequate intake of calories, macronutrients and micronutrients, negates the need for dietary supplements. In addition, another concern is that use of supplements might have the potential to cause significant side effects, interactions, and distortion of the health status of athletes (Maughan, et al., 2004). Ironically, it would appear that the very substances designed to augment and enhance performance in sport may actually have negative implications on the performance and health status of the athletes consuming them, and thus may prove to be detrimental as opposed to advantageous.

2.5 Risks associated with supplement use

There is an ever-increasingly body of evidence to support the benefits of dietary supplements from a health and performance enhancement perspective. However, it is important to consider the negative consequences attributed to utilising such products. Potential drawbacks of partaking in dietary supplement use include impaired health or performance and the potential for a positive an ADRV (Maughan et al., 2007). Should a player be found to have contravened an anti-doping rule, they

may be subject to sanctions including a ban from participating in organised training and competitions and possible financial penalties.

2.5.1 Health risks

The global trend of increasing dietary supplement use, as aforementioned, does not appear to be linked with improved public health (Radimer et al., 2004). A growing body of evidence within the published literature appears to report adverse health events that have occurred as a direct result of supplement use and, indeed, misuse. Timbo et al. (2006) suggest that dietary supplements are often used for recreational purposes by those who might be misinformed and lacking medical guidance. Uneducated supplement users (which can include athletes) tend to assume that supplements are natural and therefore safe (Gryzlak, et al., 2007).

The incorrect use of supplements can be harmful, and many athletes are susceptible to supplement overuse, as they believe that by taking increased dosages or consume different supplement combinations at the same time will increase their effectiveness leading to enhanced performance (Petróczi et al., 2007; Van Thuyne et al., 2006). This is supported by Kozirok et al. (2013) who found that many athletes use supplements at their own discretion based on prior experience with the role of a doctor or a dietician being overlooked. Such behaviour can lead to one of the most common - and potentially dangerous - problems associated with supplement use, which is hepatotoxicity (Krishnan et al., 2009; Stickel et al., 2009; Timcheh-Hariri et al., 2012). Unfortunately, hepatotoxicity has been seen to affect many recreational and amateur athletes.

Research by O'Connor (2013) found that dietary supplements were accountable for nearly 20 percent of drug-related liver injuries presenting to hospitals compared with 7 percent a decade earlier and, in 2013, there were a number of cases linking liver failure to a herbal dietary supplement marketed for weight reduction and "fat-burning" (Centers for Disease Control and Prevention (CDC). 2013). Similarly, and somewhat ironically, evidence has also been published suggesting that the use of supplements can indeed –promote an individual to adopt an unhealthy lifestyle, through reduced amounts of exercise (secondary to the perceived increased benefit obtain through using the supplements) and developing a preference for unhealthy snacks (Chiou et al., 2011).

There is also evidence that suggest that some dietary supplements can have fatal consequences if misused. A report by Eliason et al. (2012) documents the deaths of two active duty soldiers following the ingestion of dietary supplements containing 1,3-Dimethylamylamine (DMAA). This relates to an article by White (2013), who reports on the death of a healthy, fit, prepared runner during the London Marathon following the consumption of DMAA. Fatalities associated with supplement use are not just limited to those containing DMAA. Mrvos et al. (1998) explained how a 22-year-old female died after consuming diet pills containing caffeine. In 2004, caffeine was removed from the list of substances whose use was restricted in sport and although caffeine can be found in food, beverages, analgesics, and over-the-counter weight loss products, excessive consumption can lead to adverse effects.

2.5.2 Doping risks

Although supplements present a number of health risks, there is also the doping risk for professional athletes to consider. Doping is defined by the United Nations Educational, Scientific and Cultural Organisation as ‘an athlete's use of prohibited drugs or methods to improve training and sporting results.’ (UNESCO, 2017). Within competitive sport, athletes have to abide by the rules and regulations set by the World Anti-Doping Code (WADC). Each year, WADA produces a list of the prohibited substances that all athletes must avoid. Whilst it could be easily assumed that athletes are aware that they should not consume banned substances, inadvertent doping through inappropriate usage of supplement can, and has, occurred (Somerville and Lewis, 2005). Lack of knowledge regarding anti-doping procedures and supplement use, on both the athlete’s part and that of the multidisciplinary team working with them, could potentially lead to a positive doping result as a direct consequence of consuming a contaminated supplement. The World Anti-Doping Programme is based upon the principle of ‘strict liability’. It therefore follows that the contamination or adulteration of a supplement is not an acceptable excuse for an ADRV as it is almost impossible to prove whether doping is intentional or inadvertent after an athlete provides a positive result (Burke, 2000b; Yonamine et al., 2004). Thus, it is imperative that prior to suggesting or ingesting such products, staff working in professional sport should endeavour to find out what exactly the substance contains.

2.5.3 Inadvertent doping

Inadvertent doping occurs when an athlete unintentionally ingests a prohibited substance and leads to an anti-doping rule violation. Possible examples of inadvertent doping include contamination; adulteration; the use of herbal products; sabotage; and irresponsible behaviour.

Contamination

Contamination of a supplement is often a consequence of poor manufacturing and quality control procedures (Maughan, 2005). Contamination may occur through the contamination of the raw materials used in the manufacturing process of supplements. Unlike the pharmaceutical industry, the use and manufacture of supplements is not closely regulated. Under the Dietary Supplement Health and Education Act of 1994 (Dietary Supplement Health and Education Act of 1994), rigorous pre-market testing for safety and efficacy is not required and products introduced after 1994 are only required to submit a relatively low level of evidence suggesting that ingredients are safe (Wallace et al., 2008).

Whilst dietary supplements and over the counter medication can contain ‘legal’ but ‘prohibited’ substances (which are clearly stated on the label), some studies have identified that some products contained compounds that were either not listed on the label or compounds in significantly greater or lower amounts than what was claimed on the label (Ayotte et al., 2001; Geyer et al., 2004; Green et al., 2001; Kamber et al., 2001). De Cock et al. (2001) explains how this opens up the

possibility for athletes to unwillingly take prohibited substances through the use of supplements.

A number studies have reported the inclusion of prohibited substances in dietary supplements through contamination. Geyer et al. (2000), analysed a number of legitimate dietary supplements, none of which declared on the label that they contained steroids, and therefore gave no warning to athletes that problems might result from their use. However, they found the presence of nandrolone, testosterone and other steroids within these products. Furthermore, when the supplements were fed to healthy volunteers in the recommended doses, they gave positive nandrolone urine tests, with urinary concentrations of up to 623 ng/ml. Delbeke et al. (2002) found similar results showing that the ingestion of contaminated supplements in amounts substantially less than the recommended dose could result in urinary concentrations above the doping threshold for up to 120 hours. Suspected supplement contamination is reported once again by Parr et al. (2003). From the analysis of 110 different supplements, Parr et al. (2003) reported the presence of caffeine or ephedrine in 16 products despite these ingredients not being declared on any product labels. At the time of this study, both substances were listed as prohibited by WADA and could have led to a positive ADRV from an athlete using these products.

A study by Geyer et al. (2004) reported how an investigation by the International Olympic Committee (IOC) found that 15 percent of 634 supplement products tested found to contain anabolic steroids. Furthermore these anabolic steroids which were not declared on the label. A more recent study by a UK-based drug surveillance

laboratory found similar results. They investigated 114 supplements (including energy drinks, protein shakes, tablets and gels) from the top 24 brands across Europe, and found that ~10 percent contained a banned substance. Once again, these banned substances were not declared on the label (Russell, et al., 2013).

These studies indicate that not only has there been an issue with supplement contamination for a number of years, but that the same issues are still prevalent in sports supplements. De Cock et al. (2001), conclude their study by advising athletes to consider that nutritional supplements do not pass appropriate quality tests as and that there is no guarantee that these supplements contain no prohibited substances. This is reinforced by Geyer et al. (2011) who states that there is a real risk that athletes who use dietary supplements may unknowingly ingest a banned substance that will cause them to record a positive doping outcome.

Adulteration

Although there is plenty of evidence in support of supplement contamination, there needs to be a consideration of a more ominous reason behind the presence of a prohibited substance within a supplement. Adulteration of supplements in the manufacturing process may enhance or speed up the positive effects of a supplement through adding a prohibited substance. From a seller's perspective, these benefits can increase profits. For example, consumers using weight-loss dietary supplements, tend to stop using those products if they do not see any initial effects, but if the supplement offers the desired results quickly, sales of that supplement are likely to increase. Adulteration can be done by either the addition of an illegal substances; the intentional swap of substances or misidentification of

substance on the label. Van Thuyne et al. (2006) have also highlighted misidentification of substances on the label by finding that products may contain substances, which are not stated on the label, and that substances which are stated may contain different quantities than that declared.

A study by Lisi et al. (2011) explains how many supplements, advertised as fat burners or pre-workout boosters can contain stimulants (for example methylhexaneamine), which are banned in sport. Methylhexanamine was originally developed as a pharmaceutical to aid nasal congestion. However, it has since been added as an ingredient in supplements to aid sports performance. Lisi et al. (2011) identified that the inclusion of methylhexaneamine in a product is often accompanied by one of many pseudonyms including geranamine or geranium oil/extract, on the list of ingredients. Research by Zhang et al. (2012) has identified that geranium oil/extract does not contain the active ingredient methylhexanamine. This would suggest that methylhexanamine was added as an adulterant not only to increase the efficacy of a supplement but also enable unscrupulous manufactures to market their product as a dietary supplement rather than a pharmaceutical. Because of this, many athletes using these supplements risk an ADRV.

Methylhexanamine is of particular importance due to the fact that since its inclusion on the WADA list in 2010, it has been linked to many inadvertent doping cases through accidental ingestion. Cases of inadvertent doping may occur not only as a consequence of supplement adulteration but also due to the use of numerous chemical names such as 1,3-Dimethylamylamine, 1,3-dimethylpentylamine, 2-amino-4-methylhexane. Methylhexanamine is of particular concern; not only is it

prohibited by the World Anti-Doping Agency (WADA), but Methylhexanamine (Derave and Tipton, 2014) has been attributed to several adverse events including fatalities in response to physical activity (White, 2013; Eliasin et al., 2012; Chester 2014). Lisi et al. (2011) also identifies other stimulants such as caffeine, phenpromethamine, synefrine, and phenethylamines, which have been found in supplements.

Herbal products and ingredients

Herbal Products are classed as food supplements and not as pharmaceuticals, which means that they are subject to less rigorous quality control procedures prior to their sale. The risks relating to herbal products relate to the lack of information concerning their active ingredients, the purity of the ingredients and the possibility of contamination due to the relaxed quality control procedures. Many herbs or botanical ingredients have not been fully characterized and therefore the identity and quantification of specific active ingredients is unknown. Given that it is difficult to determine their active ingredients, the outcome of an ADRV as a result of using herbal products is a real possibility (Chester, 2014).

Whilst many pharmaceutical agents originate from plant sources, modern manufacturing processes have enabled large-scale synthetic production of therapeutic agents. Nevertheless, traditional Chinese medicine continues to be popular, as does the use of herbal products for health-related reasons. Many individuals believe that herbal supplements offer a natural and safe alternative to more conventional therapy (Firenzuoli and Gori, 2007)

Herbal supplements that have infiltrated the sporting arena include, those aimed at weight loss, muscle hypertrophy and increased alertness. Plant species Ephedra sinica, Ephedra equisetina, and Ephedra intermedia are collectively known as ‘ma huang’ in Chinese medicine (White et al. 1997). They are a natural source of the stimulants ephedrine, pseudoephedrine, norephedrine and norpseudoephedrine (Chester, 2014). As stimulants, they may be found in pre-workout formulas. Given the thermogenic and anorectic properties of ephedrine, ma huang ingredients are often used in weight loss products. Some weight loss products often contain citrus aurantium (Seville orange or bitter orange extract) as a substitute for ephedra due to ephedrine being a prohibited substance (Chester, 2014). The peel of bitter orange is used as a traditional Chinese medicine to treat digestive problems. However, due to its principal active ingredient, synephrine (Haller et al. 2005), it is also a mild stimulant which may contribute to appetite suppression and increased metabolic rate and lipolysis. Although citrus aurantium is often used as a substitute for ephedra one of the active ingredients, (albeit in small amounts) is octopamine, which is also a prohibited substance (WADA, 2016).

Sabotage

Sabotage of a supplement refers to the deliberate addition of a prohibited substance. The intention of sabotage is for an athlete to consume a prohibited substance unknowingly and thus risk committing an ADRV. Perhaps the only way for athletes to prevent sabotage is to ensure that supplements are stored securely and prepared by themselves or by trusted support staff. Athletes are often recommended to keep their feeding bottles in view at all times (Chester, 2014). Evidence of sabotage occurring is however, difficult to ascertain due to the covert nature of this practice.

Irresponsible behaviour

Recreational drug use has become an increasingly common aspect of social behaviour in many countries and it is reasonable to assume that some athletes use drugs recreationally. Uvacsek et al (2011) examined the relationships between projected use, self-reported behaviour and attitudes to performance-enhancing and recreational drugs amongst 82 competitive Hungarian athletes. They found that over 30 percent of the athletes in the study reported using recreational drugs. The more frequently used recreational drugs, which are included in the WADA Prohibited List and may therefore result in inadvertent doping, are amphetamines, narcotics, cocaine and cannabinoids. These classes of drugs may have the potential to enhance sport performance and therefore may be used deliberately as doping agents. However, many of these drugs may be considered ergogenic and their presence on the WADA Prohibited List is based on the notion that their use is against the 'spirit of sport'.

2.5.4 Gateway hypothesis

The use of legal and illegal performance-enhancing substances permeates sports at all levels and includes athletes of all ages (Pereti-Watel et al., 2004, Lippi et al., 2008). Doping is presumed to be a deliberate action that is planned and requires considerable commitment from the offending party (Petroczi and Aidman, 2009) and Strelan and Boeckmann, (2006) suggests that although athletes know that they may face consequences if they are caught doping, some feel that it is worth the risk if the benefits outweigh the costs. As Backhouse et al., (2007) explains, the risk factors for doping behaviour are sometimes undetermined, which hinders

prevention efforts. However, one theory that is strongly linked to supplement use is the gateway theory (Kandel, 2002) whereby supplement use serves as a “gateway” to use of prohibited substances and doping. There are multiple studies that suggest that there is a positive relationship between the use of supplements and doping behaviour (Dodge & Jaccard, 2006; Backhouse et al., 2011; Molinero and Márquez, 2009; Yussman et al., 2006; Goldberg et al., 2000) with one study by Papadopoulos et al. (2006) stating that athletes were four times more likely to dope if they used legal supplements, compared to individuals who didn’t use supplements. These findings are supported by a more recent study by Backhouse et al., (2013) which found that doping use was three-and-a-half times more prevalent in supplement users compared with nonusers in a sample of competitive athletes.

Some studies have proposed certain mechanisms that could contribute to the transition from legal to illegal substances. Doping users, it has been found, tend to hold more positive outcome expectancies and attitudes toward doping use as compared with non-user athletes (Backhouse et al., 2011; Hildebrandt et al., 2012) and therefore this could explain the motivation underpinning their actions. As of yet, however, there is still no definitive answer as to how the presumed gateway mechanism develops from the transition to supplement use into doping.

2.5.5 Anti-doping rule violations as a consequence of supplement use

The UK Anti-Doping (UKAD) programme produces quarterly reports that identify anti-doping violations. UKAD figures from 2012 indicate that approximately 44 percent of positive tests in the UK during that year were linked to inadvertent doping

(UKAD, 2015) through the presence of prohibited substances in supplements. There is plenty of research that highlights the anti-doping risks posed to athletes in relation to supplements (Delbeke et al., 2002; Van Poucke et al.,2007; De Cock et al., 2001; Geyer et al.,2011). However the contamination or adulteration of a supplement is not an acceptable excuse for an anti-doping violation as it is almost impossible to prove whether doping is intentional or inadvertent (Burke, 2000b; Yonamine et al., 2004). The UKAD figures from 2012 could suggest that there may have been a lack of awareness amongst professional athletes concerning anti-doping risks.

One sport in particular has been highlighted due to the high number of ant-doping violations. From the reports produced by UKAD, rugby (RL and Rugby Union) appears to have one of the highest rates of ADRV's in the UK. Across both codes of rugby, between 2012 to 2016, there were a total of 47 anti-doping violations. 32 of these occurred in Rugby Union with a further 15 anti-doping violations in RL. At the end of 2016, there were still 37 players across both codes serving ADRV sanctions (16 in RL and 21 in Rugby Union). This highlights the potential issues relating to professional player education with regards to anti-doping. This issue is not just limited to UK findings, as similar findings have been reported by the Australian Sports Anti-Doping Authority (ASADA). Between 2012 and 2013, the ASADA reported 12 ADRVs in RL (ASADA, 2013) of which 50 percent of cases could potentially be linked to supplement use.

2.6 Risk minimisation

Given the risks that athletes face concerning supplement use, it is important to identify the risk minimisation strategies in place to help athletes reduce the risk of inadvertent doping. Supplement testing schemes aim to provide athletes with clean supplements which have been tested for prohibited substances. Educational support also aims to give athletes the knowledge they need to consume supplements safely.

Supplement Testing

In an attempt to safeguard athletes against inadvertent doping, a number of supplement testing schemes have been developed. The aim of such schemes is to certify an internationally recognised standard, which detect contaminants in accordance with the WADA. Many of these schemes also aim to educate athletes in an attempt to raise awareness of inadvertent doping, and how it may occur.

In the UK, there is a risk minimisation scheme called ‘Informed-Sport’, which is a supplement manufacturer testing and certification programme. Informed-Sport aim to provide objective evidence that the product has been independently tested for prohibited substances in accordance with the WADA Prohibited List (Close et al., 2016). By working with supplement manufacturers and suppliers, Informed-Sport reviews the quality assurance in place during the manufacturing process. Through reviewing the quality assurance systems, raw materials and supply chain, Informed-Sport ensures a minimum risk of contamination in the finished product. Pre-certification product testing, which includes testing of five samples from different

production runs, is also required prior to acceptance onto the Informed-Sport programme. By providing high quality analytical testing for products and ingredients to minimize the incidence of banned contaminants, every batch of a supplement product and/or raw material that bears the Informed-Sport logo has been tested for banned substances. The programme also aim to provide athletes with an effective risk management service so that they can choose products that have undergone additional quality control testing as required in elite sport.

At present, such programmes offer the best “risk minimisation” for athletes who wish to use supplements and therefore it is important that athletes, and professionals working alongside them, are aware of the resource and utilise it where appropriate. Having said that, it must be stressed that even when using these tested supplements, it is not possible to provide a complete guarantee that any supplement is totally free of contamination and caution must be suitably exercised.

Athlete Support

With the evolution of sports science and sports nutrition, the growth of the use of supplements is understandable in team sports and now reaches athletes at all levels. This development has also seen qualified nutrition professionals become part of many sports science teams involved in sports at all levels (Wolinsky, 1998). Qualified nutrition personnel not only have the responsibility of providing nutritional support to athletes, but they also have to educate athletes around the risks relating to anti-doping. This is supported by SENr (Sport and Exercise Nutrition register) which is a voluntary register designed to accredit individuals who have the competency to work autonomously with athletes, from the elite to the exercising

public. In an attempt to support and protect athletes and athlete support staff, all SENr registered nutritionists are expected to undertake the UKAD Accredited Advisor course, as well as abide by UKAD's anti-doping policies and procedures.

However, many teams do not have access to sports scientists or sports nutritionists and consequently a coach – who is a central team member with regular contact with athletes – takes responsibility for advising on nutrition practices (Juzwiak and Ancona-Lopez, 2004). This involves prescribing meals, diet regimes and, indeed, supplements for the athletes they train (Wolinsky, 1998).

2.7 Sports nutrition and anti-doping knowledge

Supplements now play a role in sport at all levels. In conjunction with this, the advancements in marketing and technology have made supplements accessible to everybody, with ecommerce enabling people of all ages to purchase whatever supplements they so desire. Understandably, athletes continue to use supplements under the guidance of athlete support staff, to satisfy their belief in their performance and health enhancing effects. However, limited sports nutrition and anti-doping knowledge (in both athletes and athlete support staff) may result in some of the dangers associated with supplement misuse.

2.7.1 Knowledge in athletes

There are a number of studies, which report that supplements are often used without full understanding or evaluation of the potential benefits and risks

associated with their use and without consultation with a qualified practitioner (Maughan, 2005; Maughan et al., 2007; Waddington et al., 2005). Furthermore, there is also evidence to suggest that athletes use supplements without having a clear rationale behind their choices. A study by Petróczi et al. (2007), which analysed at data from the 'UK Sport 2005 Drug Free Survey', found a high level of incongruence as athletes appeared to take supplements with a poor understanding of why they are taking them. Although the survey used for this study had a low response rate of 29 percent, this was still a large sample size including 874 participants from over 30 sports, sixty percent (*n* = 528) of whom reported taking nutritional supplements. A similar study by Petróczi et al. (2008), focused on elite young UK athletes between the ages of 12 and 21 years old. This study found that for young athletes, the most notable congruence was performance-related. This study also suggested that young athletes appeared to be less 'health conscious' and more 'performance focused' than their adult counterparts. Although the survey used for this study only had a low response rate of 24 percent, this still resulted in a large sample size of 403 participants, 28 percent of which were rugby union players. A study by Giraldia et al. (2015) focused on team sport and sought to investigate the knowledge, attitudes and behaviours of young amateur football players about doping and the use of nutritional supplements with the use of a questionnaire. With a high response rate of over 76 percent (*n* = 423), they found that there was a potential lack of knowledge about supplements and substances concerning the possible side effects. In another study focusing on football, Waddington et al. (2005) used a postal questionnaire, which was designed to examine issues related to drug use in English professional football. With a response

rate of only 25 percent (*n* = 706) they found that 32 percent were not aware of UK sport guidelines on banned drug use.

These studies suggest a lack of knowledge amongst athletes who use supplements. Indeed, Dascombe et al. (2010) suggested that among athletes who used supplements, many did not know the active ingredients, any potential side effects or even the reported mechanisms of action of the supplement. This study continued to demonstrate a lack of knowledge in relation to supplements by finding that elite athletes (from a variety of sports) decided to use supplements (due to the perceived performance-enhancing effect) despite believing that supplements are not needed with a balanced diet. This is a cause for concern, as O'Dea (2003) found that the knowledge of the negative side effects of supplement use is generally poor. Whilst examining supplement use amongst adolescents, O'Dea (2003) reported that none of the participants in the study could name any potential risks or negative side effects of the supplements and nutritional products that they were consuming which suggests little intellectual engagement with the process of taking supplements. This is interesting to note, as it is in seeming contradiction with Morente-Sanchez and Zabala (2013). Their review of elite athletes' attitudes, beliefs and knowledge reported that the current generation of athletes are more familiar with anti-doping rules than earlier generations.

2.7.2 Knowledge in coaches

Many studies have identified that sports science and sports nutrition are now a given in professional sports and that qualified nutrition professionals have become part of

many sports science teams (Wolinsky, 1998). It has also been reported that in the absence of a sports scientists or sports nutritionists, a coach – who is not necessarily qualified in nutrition specifically, but who is a central team member with regular contact with athletes – takes responsibility for advising on nutrition practices (Juzwiak and Ancona-Lopez, 2004). This notion is supported by recent research from Torres-McGehee et al. (2012) who found that athletes often turn to athletic trainers and strength and conditioning specialists rather than registered dietitians for advice on nutrition. A further study by Cockburn et al. (2014) found coaches proved the predominant source of advice for athletes. Despite coaches and athlete support staff having been identified as the individuals who athletes turn to for advice, there is limited research that actually investigates coaches' nutritional knowledge, and thus this is an important area for development.

Previous studies from North and South America (Torres-McGehee et al., 2012; Juzwiak and Ancona-Lopez, 2004; Smith-Rockwell et al., 2001) looked at the nutritional knowledge of various athlete support personnel and found the majority of coaches have inadequate levels of knowledge pertaining to nutrition. This notion is further supported by a study investigating rugby coaches in New Zealand, in which Zinn et al. (2006) used a two-part questionnaire to evaluate the nutritional knowledge of New Zealand Premier Club Rugby Coaches. With a response rate of 46 percent (n = 168), this study concluded that the majority of coaches were not adequately prepared to provide good quality sports nutrition information to athletes. This study also highlighted that over 60 percent of participants had not undertaken any nutrition training and that to practice as a coach in New Zealand, the only compulsory nutrition training was a brief document addressing principles of nutrition

and hydration as they apply to rugby, which is included as part of an injury prevention course. Despite many coaches recognizing this lack of education, the reported use of dietitians as a source of nutrition information was low.

All of these studies suggest that coaches are not suitably informed to give nutritional recommendations and strategies to athletes. Similar results have been observed domestically. A study by Cockburn et al. (2014) used an online survey to assess the nutritional knowledge of UK coaching certificate level 2 and 3, hockey and netball qualified coaches. With a sample size of 163 coaches, this study concluded that UK coaches did not possess adequate nutritional knowledge to impart the correct advice to their athletes. This study continued to identify that coaches who had undertaken formal nutrition training still had inadequate knowledge (although these coaches achieved significantly higher scores than their less-trained counterparts). Many studies have questioned the level of knowledge amongst coaches in relation to nutritional practices. Torres-McGehee et al. (2012) found that the majority of athletes and coaches demonstrated poor understanding of nutritional knowledge but this same study reported that athletic trainers and strength and conditioning specialists did have sufficient nutrition knowledge to disseminate appropriate information to athletes. Eskici et al. (2016), on the other hand, found that the nutritional knowledge of most coaches was adequate to provide their athletes with specific nutrition advice regarding a balanced diet, ergogenic supplements and nutrition during exercise/competition periods. Interestingly, this study also concluded that the nutritional habits of most coaches were insufficient which is in seeming contradiction with the previous findings. In conclusion, these studies seem to suggest there has been some positive improvement in recent years in the level

of knowledge amongst some athlete support staff, although there is still scope for further improvements to be made with respect to coach and staff education.

This perceived lack of knowledge on the part of coaches regarding optimal nutritional management extends further; research suggests coaches know very little about their responsibilities under the 2015 World Anti-Doping Code (WADC). This places both themselves, and their athletes, in a position whereby they may be vulnerable to sanctions. Mazanov et al. (2014) found that athlete support personnel had very poor knowledge of anti-doping rules.

2.8 Summary of literature

In summary of the literature, the continual development of the supplement market has made supplements available to recreational, amateur and elite athletes all over the world. Having identified the potential benefits associated with supplement use, it is easy to understand why athletes may utilize supplements. Many studies have shown the high prevalence of supplement use amongst athletes of all levels. However, there is little research examining supplement use amongst elite RL players. Given the nutritional and physiological demands of the sport and the reported sensations of under-recovery across a playing season, the use of supplements amongst this group of athletes would be expected.

Elite athletes have to abide by the rules and regulations set by the WADC which includes a list of the prohibited substances that all athletes must avoid. However, current research suggests that, amongst elite athletes, there may be a lack of

education and awareness concerning the safe use of supplements from an anti-doping perspective. Further research suggests that a potential reason for this may relate to the education players receive, which in the absence of a qualified individual, seems to come from athlete support staff. Current research highlights that these individuals may not possess the adequate nutrition and anti-doping knowledge needed to inform and advise elite athletes, thus, increasing the possibility of an ADRV.

CHAPTER THREE

DIETARY SUPPLEMENT USE WITHIN PROFESSIONAL RUGBY LEAGUE: DO PLAYERS KNOW AND UNDERSTAND THE RISKS?

3. Dietary supplement use within professional Rugby League: prevalence, knowledge and opinions of players

3.1 Introduction

Given the requirement for a high lean mass in rugby players (Morehen et al., 2015) and the fact that players report immediate and prolonged sensations of under-recovery across the playing season (Fletcher et al., 2016) use of dietary supplements amongst this group of athletes might be considered beneficial in meeting dietary requirements and optimising sports performance. Whilst supplement use is considered widespread amongst both athletes and non-athletes (Molinero and Marquez, 2009). To our knowledge, the prevalence of supplement use amongst elite RL players is unknown as is their knowledge, attitudes and beliefs concerning supplement use.

It is important to recognise that use of dietary supplements may have negative consequences, such as adverse health effects, decrements in performance and Anti-Doping Rule Violations (ADRV; Maughan et al., 2007). Evidence over recent years has shown that a significant proportion of supplements on the market contain prohibited substances that are not present on the label (Geyer et al., 2004;2008; Russell et al., 2013) as a consequence of contamination or adulteration during the manufacturing process (Maughan, 2005). It is therefore essential that athletes check the supplements they use to ensure their efficacy, safety and whether they contain prohibited substances.

The risk of inadvertent doping associated with supplement use has led to the implementation of a number of 'risk minimisation' strategies. Independently testing batches of supplements for the presence of prohibited substances is one strategy. Whilst Morente-Sanchez and Zabala (2013) identified that the current generation of athletes were more familiar with anti-doping rules than earlier generations, there is still a lack of knowledge regarding the safe use of supplements.

The UK Anti-Doping (UKAD) programme identifies rugby as having one of the highest rates of ADRVs in the UK with 47 ADRVs across both codes (Rugby League and Rugby Union) between 2012 and 2016. However, figures from 2012 indicate that approximately 44 percent of positive tests in the UK during that year were linked to inadvertent doping (UKAD, 2015) through the presence of prohibited substances in supplements. Therefore, it is essential to assess the knowledge of elite rugby players with regards to sports supplements and the risks associated with doping.

3.2 Methodology

3.2.1 *Questionnaire design*

A questionnaire was developed (see appendix one) to assess the prevalence and knowledge of supplement use amongst elite RL players. The issues of safety and doping associated with supplement use were also addressed. Both open and closed questions were used as appropriate with Likert-style questions assessing attitudes towards supplement use. The questions included in the survey were

developed following a thorough search of the literature associated with supplement use amongst athletes (Baylis, et al., 2001, Schroder, et al., 2002, Striegel, et al., 2006, Lun, et al., 2012). Consultation with the research group which comprised of experts in the fields of sports nutrition, supplementation and anti-doping enabled the development of a survey for piloting. The survey was piloted using academy athletes resulting in only minor changes to the layout of the survey. The study was granted full ethical approval by Liverpool John Moores University Research Ethics Committee.

The first phase of the questionnaire focused on some basic respondent information. Demographic details such as age and country of origin were collected to characterise the respondents and assess their influence upon the responses to questions concerning supplement use. Phase 2 questioned respondents of their supplements use. Information relating to the types of supplements used, the reasons for use and who was involved in the decision making proses regarding supplement practice was collected to assess the supplement practices that respondents are involved in. Phase 3 aimed to identify the education and knowledge levels of participants in relation to supplements. Details relating to what education/information participants had received and where they got that education/information from, were gathers to evaluate their effectiveness. Phase 4 featured questions, which aimed to identify the participants' attitudes towards supplements and how those attitudes could influence other responses relating to supplement use and knowledge. Finally, phase 5 focused on the anti-doping knowledge of the participants. Information relating to the awareness of prohibited substances and anti-doping education and advice was collected to try and identify

some possible reasons for the number of potentially accidental ADRV's associated with rugby.

3.2.2 *Questionnaire distribution*

The Super League, being the highest level of RL club competition in Europe comprised of 12 teams during the 2014-15 season with only one club residing outside of the UK. All 11 UK-based RL clubs from the Super League (Season 2014-15) were approached to take part in the study. Initial communication with English super league clubs requesting access to their players for the purpose of the study was made and subsequent data collection occurred between august 2015 and February 2016. Following gatekeeper consent, eight clubs were recruited and the questionnaire was distributed to first team squad members. Each club received 30 questionnaires hand delivered by the researcher. This number was based on the estimated number of squad members across the league. Squad members completed the questionnaire anonymously, usually following training, and they were immediately returned to the researcher in a sealed envelope.

3.2.3 *Respondent information*

From the eight Super League clubs, 166 professional male RL players completed the questionnaire. This represents an estimated response rate of 68 percent based on the squad numbers of each club. All respondents were part of the first team squad and aged 18 years and above. A summary of the respondents' characteristics is provided in Table 2.

Table 2: Characteristics of respondents

Respondent characteristic		No. of respondents
Age of Players	Young Players (18 to 21 years old)	37 (23%)
	Senior Players (22 years old and above)	124 (77%)
Origin of Players	Domestic Players	125 (79%)
	Overseas Players	34 (21%)

3.2.4 *Data analysis*

Completed questionnaires were coded and entered into a data file for analysis using the Statistical Package for the Social Sciences (SPSS®), version 23 (Chicago, Illinois, USA). Frequency analysis and comparison between frequency counts was performed using cross tabulation matrices and Chi^2 analysis. Statistical significance was accepted at $P < 0.05$.

3.3 Results

3.3.1 Supplement use

Of all respondents 95 percent (*n* = 157) reported using supplements. The proportion of supplement users was not significantly different according to respondents' age or country of origin (Table 3). There were only five percent of respondents (*n* = 9) that reported no supplement use and of those that provided a reason (*n* = 6) a mistrust in the efficacy of supplements was most commonly quoted (*n* =3).

Table 3: Use of Supplements amongst Rugby League Players (n = 166)

		Do you take supplements? Response	
		Yes	No
All respondents		95% (157)	5% (9)
Age	≥18 ≤ 21 years	97% (36)	3% (1)
	≥22 years	94% (116)	7% (8)
Origin	Domestic	95% (119)	5% (6)
	Overseas	91% (31)	9% (3)

Of those respondents that reported supplement use, the main reasons for their use were identified for the purposes of recovery (90%) and building muscle (86%) with proportionately less respondents identifying energy provision (40%), meeting

dietary requirements (18%) and fat loss (16%) as the reasons for their use. Whilst these reasons were identified across both young and senior players and domestic and overseas players there were some notable differences in responses to the questionnaire (Table 4). A higher proportion of younger players reported muscle building (Age $\chi_1^2 = 4.448$, P= 0.025), fat loss and meeting dietary requirements as a reason for their supplement use. Similarly, a higher proportion of overseas players reported energy provision and fat loss as a reason for their supplement use whilst less overseas players identified their supplement use associated with meeting dietary requirements.

Table 4: The reasons for taking supplements as stated by elite Rugby League players and how this differs according to age and whether they are domestic or overseas players.

Reason	Percentage (n)	Age		Origin	
		Young ≥18 ≤21 y	Senior ≥22 y	Domestic	Overseas
Recovery	90% (141)	89% (32)	91% (106)	91% (108)	90% (28)
Build muscle	86% (136)	97% (35)	84% (97)	88% (105)	81% (25)
Energy	40% (63)	42% (15)	40% (46)	37% (44)	52% (16)
Meet Dietary Requirements	18% (28)	28% (10)	16% (18)	21% (25)	10% (3)
Fat Loss	16% (25)	22% (8)	14% (16)	14% (17)	23% (7)
Meal Replacement	10% (15)	11% (4)	9% (10)	8% (9)	16% (5)
Instructed to	6% (9)	6% (2)	6% (7)	5% (6)	10% (3)

3.3.2 Ingredients

The following ingredients contained in the supplements consumed were identified as the most common by respondents: protein (100%); creatine (64%); vitamins and minerals (60%); carbohydrate (56%) and caffeine (36%; Figure 1). Branch chain amino acids (47%) were also highly cited as common ingredients contained in the supplements that respondents consumed.

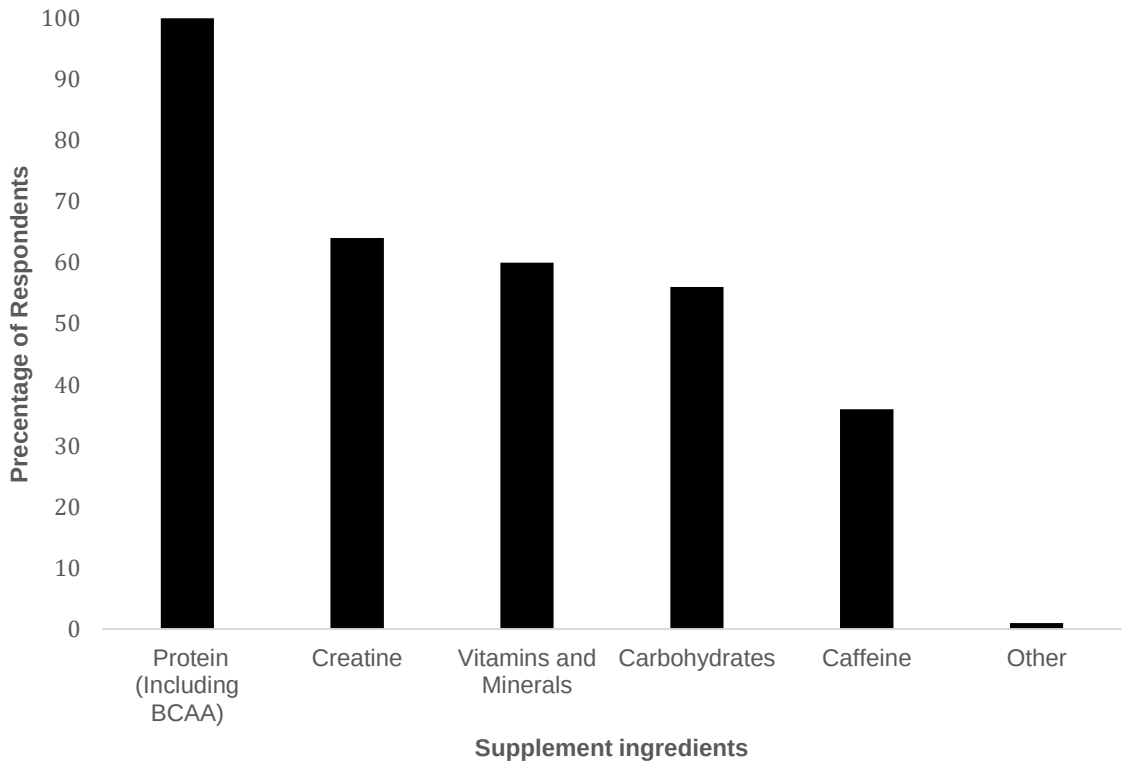


Figure 1: The ingredients of the supplements that are used by elite Rugby League players

The consumption of herbal ingredients or supplements was reported by very few RL players (*n* =9; 6%) although 13 percent of respondents (*n* = 21) were unsure as to whether the supplements they consumed contained herbal ingredients. Of those

that identified herbal supplements as part of their supplement regime green tea was most commonly cited (*n* = 3; 33%).

The number of supplements that RL players consumed varied between one and ten, however the most common number of supplements consumed 'in-season' was three (*n* = 48). Players were asked whether their supplement regime altered according to the time of year (i.e. in-season and off-season; Figure 2). Over half of respondents stated that their supplement regime did alter (*n* = 92; 59%) with more supplements used during in-season compared with off-season

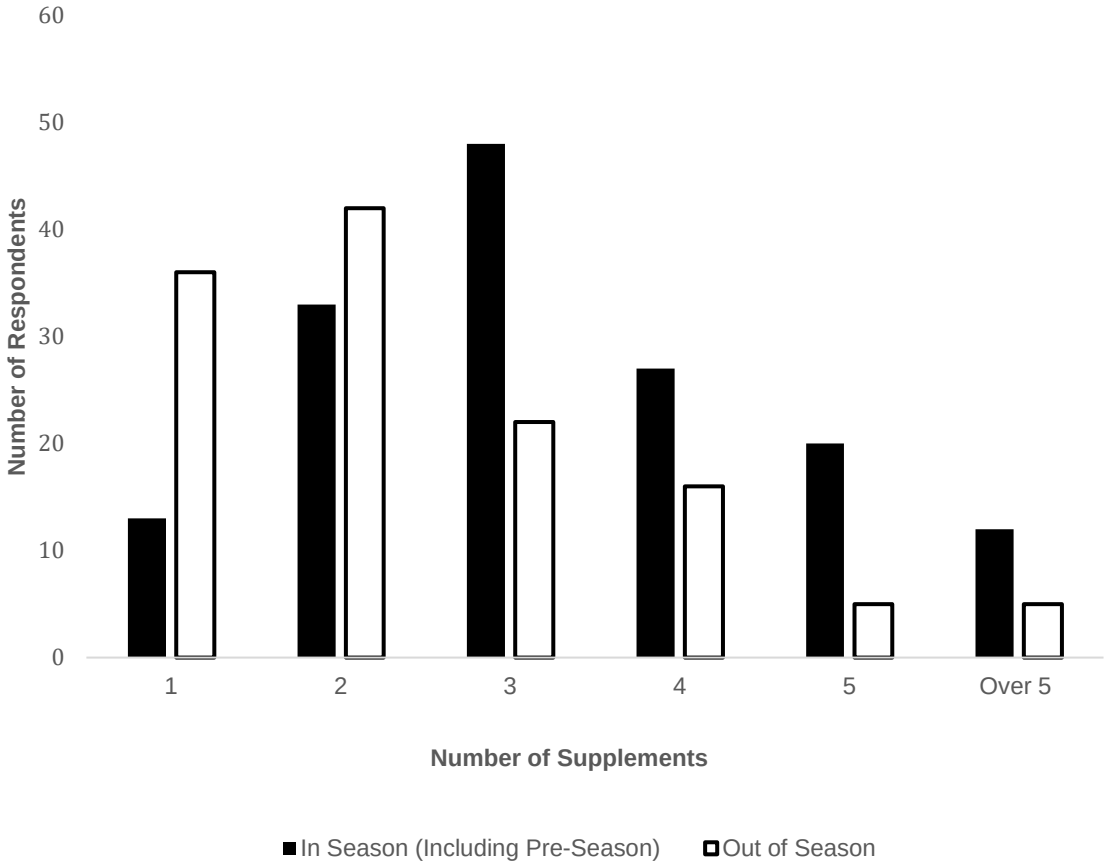


Figure 2: The number of supplements used by elite Rugby League players and the difference between in season and out of season

3.3.3 Thoughts towards supplement use

Players were asked whether they believed that they needed all the supplements they were taking and whether they believed that, they helped to maximise their sports performance. Of those that responded (*n* = 156), 24 percent (*n* = 34) believed they did not require all of the supplements they were consuming and eight percent (*n* = 12) believed that the supplements they were consuming did not help to maximise their performance. Conversely, of all respondents (*n* = 159) 72 percent agreed or strongly agreed that supplements play an important part in the development and success of a RL player. Of those that take supplements 98 percent (*n* = 153) believed that they were aware of the intended purpose of the supplements that they consumed.

3.3.4 Decision making process

Apart from themselves (64%; *n* = 101), strength and conditioning coaches (85%; *n* = 134) and dieticians or nutritionists (29%; *n* = 45) were identified as the most common individuals that decide what supplements they take (Figure 3). Twenty-five percent of respondents stated that they had no input into the supplements they consumed. Of those players that decide the supplement regimes they follow (*n* = 101) 20 percent (*n* = 20) stated that they were not aware of the health risks associated with their use and 41 percent (*n* = 41) had not seen the Informed-Sport logo.

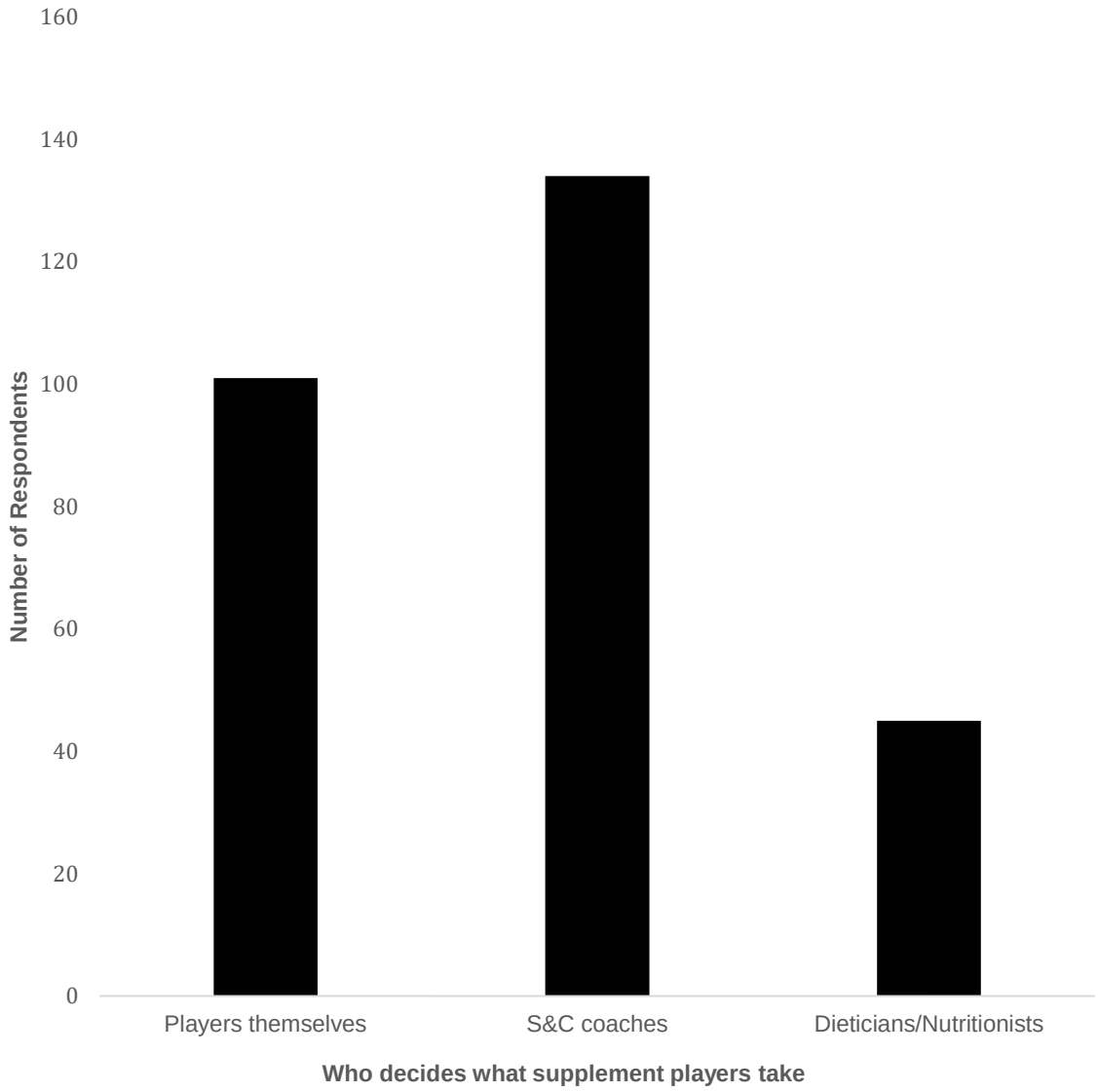


Figure 3: Individuals involved in selecting what supplements players use as identified by elite rugby players

3.3.5 Supplement provision

As regards supplement provision, many respondents identified the club (74%; *n* = 116) and club sponsor (41%; *n* = 64) as the main provider. However, a significant proportion of respondents taking supplements reported self-purchase as the source of supply for the supplements they consume (25%; *n* = 40; Figure 4).

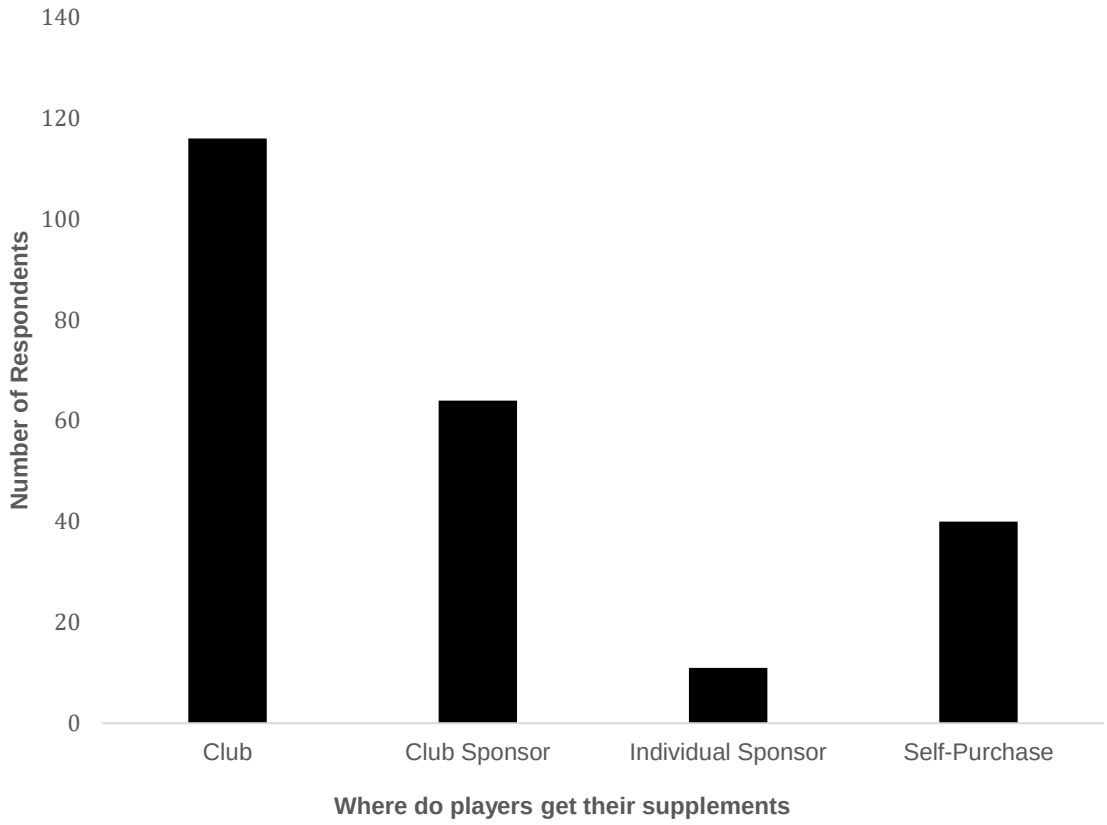


Figure 4: Sources of supplements identified by elite rugby players

Those players that self-purchase their supplements identified the following as the main outlets for their supply are: Internet (50%; *n* = 20); Shop (48%; *n* = 19); and club sponsor (43%; *n* = 17). Those that stated that they purchased supplements from a shop subsequently identified the following as the main outlets for their supply: independent health food/sports supplements store (42%; *n* = 8); and sports shop (37%; *n* = 7).

Of those respondents that self-purchase (*n* = 40) 35 percent (*n* = 14) had not seen the Informed-Sport logo and of those that had (*n* =26) 31 percent (*n* = 8) did not know what it represented. Only ninety percent (*n* = 36) were aware that the supplements they were using had been tested for contaminants.

3.3.6 Supplement education

RL players were asked questions relating to their education and knowledge in relation to the issues around supplements. Three percent (*n* = 5) of respondents stated that they had not received any advice relating to supplement use, all of which were categorised as senior players (≥22 years). Of those that had received advice (*n* = 160) the strength and conditioning coach (87%; *n* =139), dietician or nutritionist (73%; *n* = 116) and sport scientist (39%; *n* = 62) were identified as the main sources for such guidance (as seen in Figure 5).

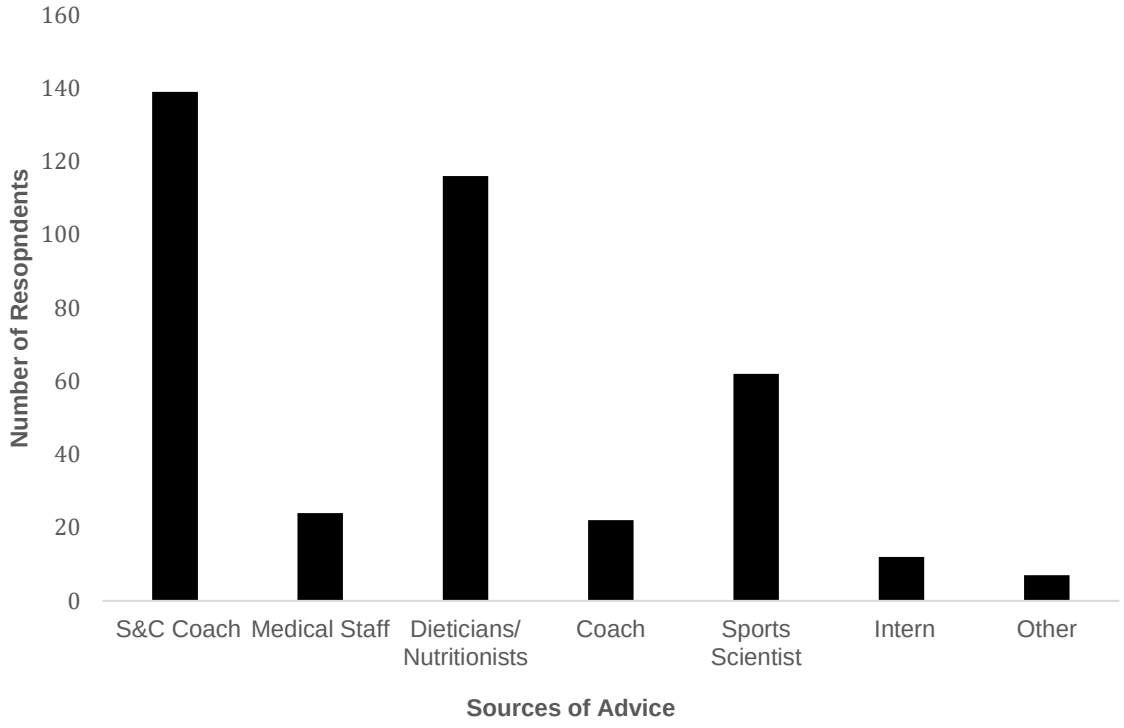


Figure 5: The sources of advice relating to supplements as identified by elite rugby players

Unfortunately three percent of RL players acknowledged that they did not fully understand this advice. Whilst most respondents had received advice, fewer respondents had looked for or asked for advice regarding supplement use (77%; *n* = 126). Whilst 85 percent (*n* = 104) of domestic players had looked for advice only

50 percent (*n* = 17) of players of overseas origin had looked for advice ($\chi_1^2 = 17.995$, P < 0.001). A greater proportion of senior players (*n* = 33; 27%) had not looked for advice compared with younger players (*n* = 4; 11%) ($\chi_1^2 = 3.853$, P= 0.05 or 0.036). [Of those that have,] the following were acknowledged as the main sources of information/advice: strength and conditioning coach (88%; *n* = 111); dietician or nutritionist (61%; *n* = 77); Internet (30%; *n* = 38); and sport scientist (25%; *n* = 32).

3.3.7 Supplement risks

Whilst 92 percent (*n* = 151) of respondents acknowledged an awareness of potential risks associated with supplements from a doping perspective only 75 percent (*n* = 124) of respondents acknowledged an awareness of potential health risks associated with supplement use. Most respondents stated that they were aware of the risks associated with supplement contamination (93%; *n* =153), however only 56 percent (*n* = 92) of respondents had seen the Informed-Sport logo (Figure 6).

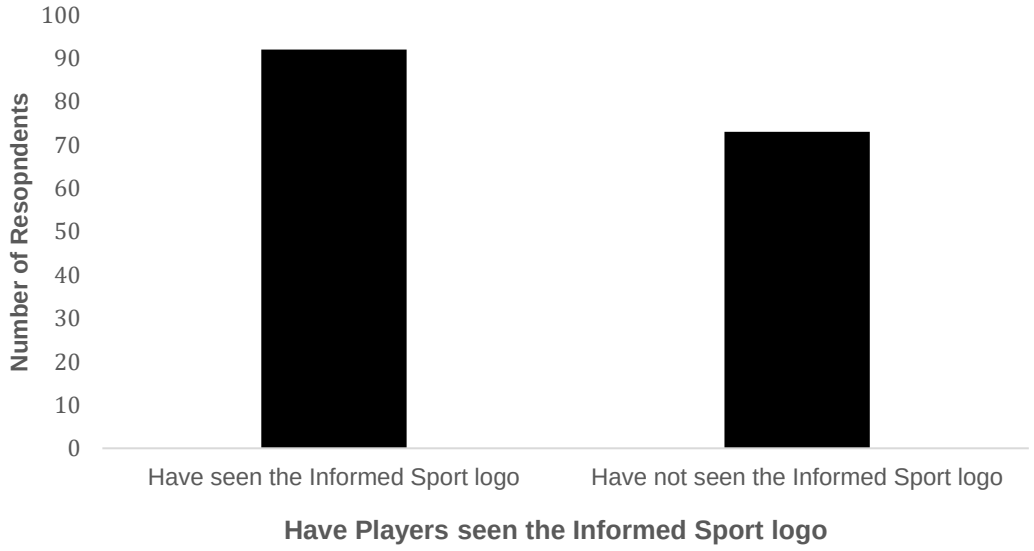


Figure 6: Recognition of the Informed Sport logo amongst elite rugby players

Worringly, of the 92 respondents who had seen the Informed-Sport logo, 29 percent (*n* =27) did not know what the logo represented. As seen in Figure 7 eighty-two percent (*n* = 134) were aware that the supplements they were taking were tested for contamination which is a key component of the risk management strategy associated with responsible supplement use. However, 16 percent (*n* =27) stated that they did not know whether the supplements they were taking had been tested and two percent (*n* = 3) revealed that the supplements they were taking had not been tested. Respondents who were either unsure or indeed aware that the supplements they were consuming had not been tested were most likely to have reported that they have no input into the use of the supplements they consume ($\chi_1^2 = 12.198$, P = 0.001). Those who were aware that the supplements they were taking had not been tested were all senior athletes, who had been given advice relating to supplement use and agreed with the statement: 'I believe I have sufficient knowledge to consume supplements in a safe manner'.

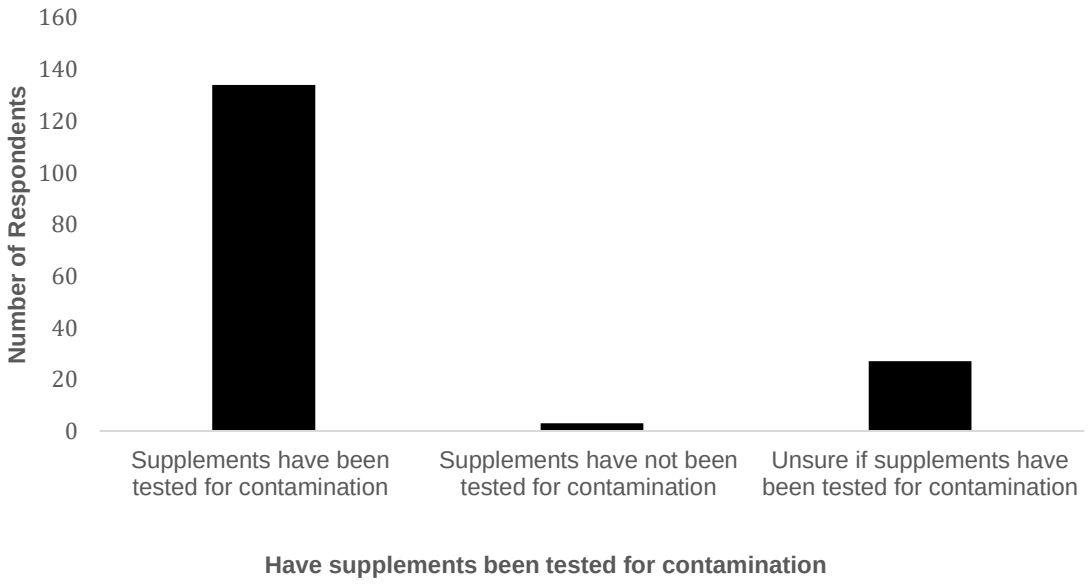


Figure 7: Elite rugby players knowledge of product testing in reference to the supplements they consume

From a list of substances/potential ingredients contained in supplements, RL players were asked to determine whether they were prohibited or not according to the current WADA Prohibited List. Overall, players demonstrated limited knowledge, with a high proportion of respondents unsure as to the status of potential ingredients in reference to the WADA Prohibited List. A substance identified in many cases of inadvertent doping is Methylhexaneamine (Geyer et al. 2011) and a significant proportion of respondents were either 'unsure' of its status, (51%; *n* = 81) or identified it as 'not prohibited' (9%; *n* = 14). Those who incorrectly identified methylhexaneamine as 'not prohibited' were all senior RL players ($\chi_1^2 = 6.440$, P = 0.040) who reported that they had been given advice relating to supplement use and 79 percent of which were in agreement with the statement: 'I believe I have sufficient knowledge to consume supplements in a safe manner'.

A significant proportion of respondents agreed or strongly agreed with the statement 'I believe I have sufficient knowledge to consume supplements in a safe manner' (83%; *n* = 134) however, 21 percent (*n* = 28) of these respondents reported that they were unaware of any potential health risks associated with supplement use, that they had not seen the Informed-Sport logo (46%; *n* = 62) and that they were either unaware that the supplements they were consuming had been tested for contaminants or aware that they had not been tested (19%; *n* = 25). However, whilst a significant proportion of respondents disagreed or strongly disagreed with the statement that all supplements were safe to consume if purchased from a well-known brand (60%; *n* =96) those that agreed and strongly agreed with this statement (26%; *n* = 41) were most likely to report that they had not seen the

Informed-Sport logo (61%; *n* = 25; ($\chi_2^2 = 7.018$, P = 0.030). A high proportion of respondents also acknowledged that they would benefit from learning more about the safe use of supplements (67%; *n* =106); and that more help and advice was required regarding the safe use of supplements within their sport (62%; *n* =100).

3.4 Discussion

The primary aim of the present study was to assess supplement use in elite professional RL players and to identify the reasons that players choose to use them. The secondary aim of this study was to assess the supplement knowledge of elite RL players, including their knowledge of WADA, Informed-Sport and their understanding of inadvertent anti-doping violations. A total of 166 professional RL players from a first team squad of one of eight ESL clubs completed the questionnaire providing a true representation of elite super league players.

3.4.1 Prevalence

For the first time in RL, we report the prevalence of supplement use by players at the highest level of the sport with findings to suggest a lack of knowledge as well as the attitudes and beliefs surrounding supplements.

Many previous studies have shown a high prevalence of dietary supplement intake (ranging from 35%-99%) amongst professional/elite athletes from both individual sports (Baylis et al., 2001; Ronsen, et al., 1999; Lazic, et al., 2011; Omeragić, et al., 2015; Slater, et al., 2003; Lun, et al. 2012) and team sports (Schroder et al.,2002;

Aljaloud and Ibrahim, 2013). However, the prevalence of supplement use in elite RL players was previously unknown. To our knowledge this is the highest report of supplement usage in professional team sport with ninety-five percent of elite RL player have reported using supplements.

3.4.2 Ingredients

Protein was seen to be the most commonly used ingredient, followed by creatine. This is perhaps understandable given that both protein (Burke et al., 2001; Cepero et al., 2010; Coyle et al., 2012) and creatine (Burke et al., 2000a; Buford et al., 2007; Garazhian and Azimkhani, 2014) supplementation have been shown to promote lean mass which will help players to achieve and maintain the physiques required to play competitive rugby (Morehen et al., 2015). Vitamins and minerals and carbohydrates are also popular answers. There is existing research to demonstrate the prevalence of vitamins and minerals being taken in supplement form by athletes (Wiens et al., 2014; Diehl et al. 2012). Many athletes have reported the use of vitamins and minerals for reasons relating to health and sports performance. Elite rugby players are likely to consume carbohydrate supplements in relation to performance enhancements. Previous literature has shown that consuming carbohydrate supplements (both alone and with protein supplementation) will promote improvements in performance, recovery and reduce fatigue, whilst reducing markers of muscular damage when ingested before (Kerksick et al. 2008; De Sousa et al. 2012), during (De Sousa et al. 2012), and after exercise (Cockburn et al. 2008; Costa et al. 2011).

It was noted that the use of caffeine as a supplement was reported by 36 percent of players. The use of supplements in this context was deemed to be for performance-related purposes. Indeed, there is a wealth of evidence to support the use of caffeine as a performance enhancing aid in team-based sports of an intermittent nature (Foskett et al., 2009; Stuart et al., 2005; Schneiker et al., 2006). The consumption of caffeine as a performance aid in the form of supplements rather than through tea or coffee highlights a particular issue concerning its current position as a 'non-prohibited' substance. However, these ingredients have been identified by players themselves without the access to the labels of the product whilst filling out the questionnaire. There is no sure way of knowing if these answers are correct as it is only what the players perceive themselves to be taking.

3.4.3 Reasons for supplement use

Lippi et al. (2008) has previously identified that the desire to succeed might play a role in the decision to use supplements. Athletes use dietary supplements with the expectation that they will help to improve their performance and enhance their development. We report that two of the most common reasons for elite RL players to use supplements were specifically for "recovery" and to "build muscle" rather than the generic answer of 'improved performance'. Previous literature has reported that throughout the course of a Super League season, players are in a constant state of pain (Fletcher et al. 2016) and therefore supplements to enhance recovery are especially relevant to this sport. Moreover, given the physical demands of the game and the need for players to maximise their lean muscle mass (Baker, 2001; Austin

& Kelly, 2013; Twist et al., 2014) supplements that claim to enhance muscle mass will be attractive to the rugby player.

Kiertscher and Di Marco (2013) reported that another common reason for the use of supplements among athletes is to reduce body fat in an attempt to enhance performance. We report that 16 percent of players used supplements with the intention of reducing body fat. Whilst this was not the most popular reason reported for supplement use it warrants particular consideration since there are no known supplements that are not prohibited proven to reduce body fat *per se*. It would therefore appear that elite players may be guided by marketing claims rather than strong scientific evidence. The risk to athletes are stressed by Smith et al. (2015), who suggests that along with herbal products, fat loss supplements pose the biggest risk for an anti-doping offence. This highlighting the importance to improve athletes' education relating to fat loss supplements.

These findings highlight the need for specific education of players to means by which they can safely enhance recovery and increase muscle mass to minimise the reliance of supplements to achieve these two objectives.

The use of supplements for the provision of energy was also cited as a reason by 40 percent of players. Carbohydrates are considered the primary fuel during team-based sports such as rugby (Williams and Rollo, 2015; Jeukendrup, 2014; Phillips et al. 2011) and 67 percent of players of those identifying energy as a reason for their supplement use consumed carbohydrate supplements. However, there appeared to be some confusion when linking particular supplements and the

purpose for their use. Indeed 19 percent of respondents who stated that they used supplements for energy indicated that they did not supplement with carbohydrate but used caffeine. Whilst caffeine is often cited as a supplement used for energy provision it does not provide energy per se and there is conjecture around the proposed mechanism relating to enhanced fat mobilisation. Nevertheless, the effects of caffeine on the central nervous system provide individuals with the perception of increased energy.

The suggestion of confusion when linking supplements and the purpose for their use again highlights, that these reasons have been identified by players themselves without the guidance of support staff. These answers are only the players' perceived reasons for taking supplements and there is no way of knowing how informed these perceptions are.

Given that sport nutrition advice tends to be focussed more at the senior players than the academy players, we also sought to identify if age played a role in the supplement usage of the players. It could be argued that it is in fact the younger players who have a greater need to build muscle mass to achieve the physiques required to play competitive rugby (Morehen et al. 2015). We report that significantly more "younger players" use supplements with the aim of building muscle mass. A similar trend (although not significant) can also be seen with "fat loss" which as discussed previously is of particular concern.

The pressure to attain increasingly higher levels of performance in sport may be a factor in pushing these young athletes towards supplements (Calfee and Fadale,

2006). Previous studies have shown that young athletes reported using supplements for the purposes of building muscle, recovery, increasing energy levels and enhancing performance (Perko et al., 2000; McDowall, 2007; Wiens et al., 2014; Sobal & Marquart, 1994). Taken together, these observations support the hypotheses that young players are striving particularly hard to achieve the physique required for rugby and therefore nutritional education must be targeted at this particularly vulnerable group of players. However, these reasons for supplement use for increasing performance can be seen in athletes of all ages (Heikkinen et al. 2011; Aljaloud & Ibrahim 2013; Sousa et al. 2013; De Silva et al. 2010).

The use of herbal supplements is recognised as a significant risk to the athlete from a doping perspective. Herbal ingredients are of particular concern given that it is difficult to determine the active ingredients of a herbal supplement is often difficult and therefore an ADRV is a real possibility (Chester, 2014). Players were asked if any of the supplements they used contained herbal ingredients. The majority of respondents answered “no” indicating that, to their knowledge, none of the supplements they were taking contained herbal ingredients or substances. However, a small percentage of respondents revealed that they did take a supplement that consisted of or included herbal ingredients. Worryingly, some players were unsure as to whether their supplements contained herbal ingredients or not suggesting that they were unsure as to the active ingredients in the supplements they were consuming. These findings suggest that players still need to be made aware of the risks of herbal supplementation to minimise the chances of anti-doping violations.

3.4.4 Decision making process

Most players have identified their strength and conditioning coach (85%; *n* = 134) as the individual who makes the decision on what supplement regime they follow. Only 29 percent of elite RL players identified nutritionists or dieticians as those with the role of setting their supplement regime (whilst the question posed did not enable answers to be mutually exclusive it does illustrate the high proportion of clubs where strength and conditioning coaches have responsibility outside of their expertise). This is noteworthy since nutritionists and dieticians are considered the most qualified individuals to make this decision. However, S&C coaches interact with players on a daily basis and are most likely to work with club officials to negotiate deals with sports supplement companies. They have long been considered to have a dual role despite not being a qualified or registered nutritionists. Torres- McGehee et al. (2012) have highlighted that the majority of athletes and coaches demonstrated poor understanding of nutritional concerns for athletes. This is supported by Mazanov et al. (2014) found that athlete support personnel had very poor knowledge of anti-doping rules. Given all players should abide to the UKAD 100% me policy, it is of particular concern that 1 in 4 players have no input in the supplements they are being administered and 22 percent (n=8) of these in fact do not believe that they need all the supplements that they are being asked to take. This clearly must be addressed with immediate effect.

3.4.5 Knowledge of supplement risks

If athletes are going to take supplements it is essential that they are taken in a safe and responsible manner which should involve the products being independently batch tested contaminants and/or prohibited ingredients (SENr position stand 2016). Whilst the independent batch testing of supplements does not guarantee a product is safe to take, it is at present the best way to minimise the risk of supplement contamination. Informed-Sport independently batch tests supplement for contaminants and produces a supplement register to provide evidence that the supplement has been independently tested for prohibited substances. Each supplement range they test will carry the Informed-Sport logo to ensure the user that that supplement has been batch tested and though their quality assurance programme. Although the majority of elite rugby players have selected that they are aware of the potential risks associated with taking supplements from an anti-doping perspective, their awareness may not necessarily mean that they fully understand the risk. For example, over 90 percent of elite RL players stated that they are aware of the risks associated with supplement contamination. However, nearly half of respondents had not seen the Informed-Sport logo. Out of those players who have seen the Informed-Sport logo, nearly one third did not know what it meant.

Worryingly, out of those who had not seen the Informed-Sport logo, 89 percent (n=62) said they had sufficient knowledge to consume supplements in a safe manner. This clearly shows that although supplement education is being provided, the effectiveness of this education might be questioned. We would suggest that

future education strategies must assess learning to ensure these key messages are being received and understood by elite rugby players.

Nearly 20 percent of these elite rugby players were either unsure or indeed aware that the supplements they were consuming had not been tested. This clear lack of knowledge in relation to anti-doping procedures could potentially lead to a positive doping result as a direct consequence of consuming a contaminated supplement. It is important to stress that contamination of a supplement is not an acceptable excuse for an anti-doping violation. Previous research has identified contaminants that include a variety of anabolic androgenic steroids as well as stimulants such as ephedrine (Maughan, 2005) and most recently methylhexanamine, which may be a particular concern since not only is it prohibited by WADA, but methylhexanamine (Derave and Tipton, 2014) has been attributed to several adverse events including fatalities in response to physical activity (White, 2013; Eliasin et al., 2012; Chester 2014). Over half of the elite rugby players who completed the questionnaire have stated that they are either unsure of the status of methylhexanamine, or that methylhexanamine is not prohibited. Worryingly, many of these respondents also believe that they have sufficient knowledge to consume supplements in a safe manner.

In light of the issues surrounding inadvertent doping WADA and many NADOs support a zero tolerance attitude towards supplement use. It is understandable why such organisations might not advocate supplement use in light of the lack of governance around their manufacture and supply which culminate in the issues around supplement contamination. However, there are numerous reasons why a

risk minimisation programme might benefit the athlete and therefore it is essential that we look at mechanisms that can support this and limit the risks. In elite sport, supplement use is commonplace and this study as well as others support this notion. Where supplement use approaches 100 percent in our sample, a zero tolerance approach to their use is unhelpful. Issues may however revolve around the numbers of supplements used, the type of supplements and the quality of those consumed. It is essential that a supplement programme is implemented that is informed by the needs of the individual and the risks associated with their use. Athlete support personnel need to be versant with the issues around safe supplement use from a health and anti-doping perspective in order to manage the needs of athletes appropriately.

3.5 Conclusions

The aim of this study was to assess supplement use and Knowledge in elite professional RL players and to identify the reasons that players choose to use them.

This study reports the highest prevalence of supplement use in professional RL and in elite sport. With regards to the reasons for supplement use, players reported recovery and building muscle as the main reasons of use with protein; creatine; vitamins and minerals; and carbohydrates being reported as main ingredients. Although the majority of players did have some input into what supplements they used, strength and conditioning coaches were identified as the most influential individuals when deciding supplements practices. The majority of players did

acknowledged an awareness of potential risks associated with supplements but only 56 percent of players were aware of the risk minimisation scheme in the UK.

CHAPTER FOUR

DIETARY SUPPLEMENT USE WITHIN PROFESSIONAL RUGBY LEAGUE: KNOWLEDGE, OPINIONS AND BELIEFS OF PLAYER SUPPORT STAFF

4. Dietary supplement use within professional Rugby League: knowledge, opinions and beliefs of player support staff

4.1 Introduction

It has been reported that sports science and sports nutrition now play an important part in professional sports (Wolinsky, 1998). However, many athletes may not have access to qualified personnel and in the absence of a sports scientists or sports nutritionists, coaches (Juzwiak and Ancona-Lopez, 2004; Cockburn et al., 2014), athletic trainers and strength and conditioning specialists (Torres-McGehee et al., 2012) often takes responsibility for advising on nutrition practices.

Despite being identified as the individuals who often advise athletes on nutrition, there is limited research examining the nutritional knowledge of coaches and athlete support staff. From the limited research that has examining the nutritional knowledge of coaches and athlete support staff (Torres-McGehee et al., 2012; Juzwiak and Ancona-Lopez, 2004; Smith-Rockwell et al., 2001; Zinn et al., 2006) it would seem that the level of knowledge relating to nutrition is inadequate and that these individuals may not be adequately prepared to provide good quality sports nutrition information to athletes.

To our knowledge, there is no research investigating the nutrition and supplement knowledge of support staff in elite RL. Furthermore, previous literature examining the level of nutrition and supplement knowledge amongst support staff across multiple other sports suggests that there is a potential lack of education. Given the

high rate of ADRVs in the UK between 2012 and 2016, it was essential to assess the nutrition and supplement knowledge of these athlete support staff who have a significant input on supplement regimes.

4.2 Methodology

4.2.1 Interview design

For the purpose of this study a semi-structured one-to-one interview was developed (see appendix two) to assess the knowledge of and attitudes towards supplements amongst player support staff from clubs currently competing at an elite level (European Super League, ESL). The interview was deductively developed (Biddle et al., 2001) and structured in order to obtain information relating to the reasons influencing current practice.

The interview was split into four phases in order to obtain a wide range of information. Phase 1 attempted to examine the participants' history and current position and featured questions relating to the participants role at the club and any previous experience. Phase 2 of the interview was developed to assess the knowledge and understanding of the participants in relation to supplements. This phase included questions that would allow the participants to express their thoughts and beliefs on the role supplements play in sport. Phase 3 was developed to identify how the participants put their knowledge into practice by asking the player support staff how they implement supplementation within their club. Finally phase 4, enabled

respondents to disclose their opinions around player and staff education and the resources that were available.

As identified by Gall et al. (2003), an ‘open-ended’ format was used to present the questions within each phase of the interview. All participants were asked identical open-ended questions in each phase to allow them to fully express their thoughts and opinions about the use of supplements in sport and express their own experiences. To follow up these open-ended questions, subsequent ‘probing’ occurred (Gratton and Jones 2004) through the use of follow-up questions. These follow-up questions had not previously been set but were prompted by the responses given to the open-ended questions, thus facilitating further in depth responses (Turner 2010). All questions were delivered in a conversational and informal manner to make the participant feel comfortable and to develop rapport in order to maximise the detail and authenticity of the data (Lincoln and Guba 1985).

The study was granted full ethical approval by Liverpool John Moores University Research Ethics Committee.

4.2.2 Participants

The Super League, being the highest level of RL club competition in Europe comprised of 12 teams during the 2014-15 season with only one club residing outside of the UK. All 11 UK-based RL clubs from the Super League (Season 2014-15) were approached to take part in the study. Initial communication with English super league clubs requesting access to their support staff for the purpose of the

study was made and subsequent data collection occurred between august 2015 and February 2016.Following gatekeeper consent eight clubs were recruited and allowed access to one member of support staff. These support staff interviewed, who were selected for interview due to their role and influence on sports nutrition practice within the first team squad, included club nutritionists, heads of strength and conditioning and assistant strength and conditioning staff.

The first phase of the interview relating to the background of the participant, was used to identify any past experiences, whether they be academic or sporting, and to try any understand how they have progressed into their current position and involvement within elite RL.

Of the eight interviews conducted with individuals who had a significant influence on the delivery and use of supplements at a professional super league club, only two participants identified themselves as nutritionists. The two nutritionists were also post-graduate research students working on sports science related programmes and working in elite rugby through their respective universities. The remaining six participants identified themselves as strength and conditioning coaches; four of whom were head strength and conditioning coaches and two were assistant strength and conditioning coaches.

All of the participants identified that they had been to university and had gained a bachelor's degree in a sport related subject. However, those who had identified themselves as club nutritionists and assistant strength and conditioning coaches, had gained masters degrees.

Five of the participants identified an internship or voluntary role as their gateway into professional sport. These participants mentioned that they took these roles towards the end of their time at university or shortly after finishing university. Although some participants revealed that these roles many not have been with their current club, they had played an important part in personal and professional progression to their current role. Some of the participants also revealed a sporting background, which had contributed towards their current role. Two participants played rugby union at an amateur level and three participants had a background in playing RL, one of which played at a professional level.

4.2.3 Interview procedure

Following fully informed gatekeeper and participant consent, each interview was arranged at a convenient time and place for the participant. This was usually at the participant's place of work and following a training session. Each interview typically lasted approximately 30 minutes and followed a set structure which allowed both individuals to elaborate on areas of particular importance or interest. The interview was recorded with the permission of the participant so that the interview could be transcribed at a later date. However, Biddle et al. (2001) identified the issue of trustworthiness with respect to interviews. Whilst it is difficult to establish, multiple criteria have been highlighted to maximise trustworthiness. Some of these criteria may be associated with elements of the interview process. Bloom *et al*. (1998) identified the need for a knowledgeable researcher to conduct interviews to ensure credibility and integrity of the data collection. In the current study, the researcher

was trained in interview techniques and delivery and engaged in multiple mock interviews prior to data collection. Hayashi (1996) explained that trustworthiness was maximised through having a common background with the participants. This common background allowed the researcher to establish a rapport with the participants leading to acceptance. This relationship between the researcher and participants can only aid the trustworthiness of the data collected from interviews. The interviewer in the present study was familiar with RL culture having worked in RL in a player support role. Being recognised as an 'insider' could potentially encourage answers that are more truthful and reduce the 'interaction' effects of a researcher perceived as and outsider (Burawoy 1998). Alternatively, there is a potential for participants to be guarded with the information they might provide as the independence of the interviewer might be questioned.

4.2.4 Data analysis

Each interview was transcribed and uploaded to the software package NVivo10 (QSR International Ltd, 2012) to facilitate the analysis of the interviews and allow content analysis. A systematic, line-by-line process of initial coding took place on each transcript to identify any relevant content. This coding was used to identify different themes and common trends when comparing the different data sets (Clarke and Braun, 2008; Biddle et al., 2001). Once the coding was complete, the themes were reviewed allowing identifiable general dimensions to be developed, resulting in the transfer of some codes to other themes and the removal of some codes.

Triangulation, involving multiple analyst, was used to review the findings. This was done, not only to provide a check on the selective perception and illuminate any blind spots or misinterpretations during the initial analysis but to also reveal and examine multiple ways of seeing the data (Denzin, 1978; Patton, 1999).

4.3 Results and discussion

This section is an integrated results and discussion, which presents the general dimensions that are identified in the content analysis of raw interview data. The general dimensions encompasses a group of higher order themes which are supported by verbatim vignettes (i.e., participant quotes) that serve to illuminate the unique social context associated with the responses. The raw data from the interviews is presented in in appendix three, which includes three separate content analysis tables.

Content analysis table 1 presents the raw data and content analysis for phase 2 of the interview which aimed to investigate the knowledge and understanding of the participants in relation to supplements in sport. The general dimensions to emerge from this phase of the interview were; the role supplements play in sport; major influences on supplement beliefs; and risks relating to supplement use. Content analysis table 2 presents the raw data and content analysis for phase 3 of the interview, which aimed to identify the current supplement practices in use at the subjects' clubs. The general dimensions to emerge from this phase of the interview were; supplement brand influences; decision making process regarding supplement practice; supplement delivery; and supplement risk management strategies.

Content analysis table 3 presents the raw data and content analysis for phase 4 of the interview, which focused on the player and staff education. The general dimensions to emerge from this phase of the interview were; player education; and the perceived level of Knowledge amongst staff and potential reasons for this.

4.3.1 *Knowledge and understanding of supplement practice*

Three general dimensions emerged in relation to the participants' knowledge and understanding of supplements. These dimensions (presented in content analysis table 1) are (1)the role supplements play in sport, (2) major influences on supplement beliefs and (3) the risks relating to supplement use.

General dimension one gives insight into the beliefs of the participants with regards to the role that supplements play in sport. The second general dimension highlights the potential reasons for these beliefs and the third general dimension reveals the participants thoughts relating to the potential risks relating to supplement use.

4.3.1.1 *The role supplements play in sport*

The initial general dimension demonstrates the varying views towards supplements and the role they play in sport. As participants shared their thoughts and beliefs with regard to supplements in sport, a number of themes began to emerge. The first theme to emerge related to the positive role that supplements play in aiding the development of athletes through helping them to meet dietary demands. The second theme, which developed from the first theme, related to where supplements fit into the diet as participants gave their views on a food first approach to meeting

dietary demands and how supplements can influence that. After initially identifying the positives associated with supplement, the third theme focused on the negative views associated with supplement use. The fourth theme in this general dimension developed as participants shared their thoughts on how some athletes may be dependent on supplements.

The positive role of supplements in sport

There was an overall belief amongst participants that supplements could play a positive role in sport through aiding the development of an athlete. Each had their own thoughts and opinions as to the role supplements played in athlete development, whether it be for convenience, helping players meet dietary requirements or aiding recovery. These beliefs were in line with Braun et al. (2009), who identified that a well-chosen nutrition plan should provide what an athlete needs, but there are times when athletes choose to use supplements to increase performance, increase energy, aid recovery, support the immune system, improve nutrient intake and alter body composition. These reasons for supplement use all relate to improving performance. It is therefore reasonable that the participants in the current study would advocate the use of supplements given their role in maximising performance.

The majority of participants identified convenience as one of the major benefits of using supplements. As one participant identifies, the use of supplements as opposed to whole food was a lot easier from a time perspective in terms of consumption, digestion and absorption:

“I think it's a lot easier to take a shake after training than eat because it's a convenience thing and obviously the research says that it get broken down quicker in your system and you start recovering quicker” P8

This was also reported in previous research by Josse et al. (2010), which suggests that gains in muscle mass and strength are greatest with immediate post-workout supply of protein. Protein synthesis is optimal by the intake of a specified amount of high biological value protein in the early recovery phase, less than 2 hours after exercise (Beelen et al., 2010; Phillips, 2012). Clearly recovery is a key reason for supplement use and the convenience of using supplements to promote optimal recovery was identified by all participants and is illustrated in the following quotes:

“they have certainly got a key role in recovery, yeah definitely have a key role to play in sport, any sport” P3

This positive support of supplements and the role they play in the development of athletes continues as participants reveal that supplements were used to obtain things that are difficult to get from diet. An example of this can be found as one participant who explains how they avoided potential vitamin D deficiencies during winter months:

“Vitamin D plays a fundamental importance in not only immune function and bone health but also force generation. So if our players are deficient in the winter months which in England you would bet most athletes are then yeah, a

supplementation of vitamin d3, which you can't get from your diet, I thought was important" P4

This approach towards supplements, which was taken by some participants, gave the impression that they would only use supplements when food alone might not be deemed sufficient. This relates to a study by Braun et al., (2009) who suggested that supplements should always augment a balanced nutrition plan. This is reiterated by a more recent study by Thomas et al., (2016) which identified effective eating plans, which are associated with the right supplements, can contribute to and positively affect sports performance.

Where supplements fit into a diet

Although many participants highlighted the importance of supplements, it became apparent that the majority of participants believed that supplements were used as an adjunct to a good diet, not a replacement for it. It could be suggested, that in some cases, responses were motivated by the social desirability bias, whereby some participants recognized that a food first approach to meeting dietary requirements was a more desirable strategy. The validity of some responses might be argued although this would be difficult to confirm. The importance of using whole food to meet the primary dietary requirements of athletes was an underlying philosophy. This notion was pervasive amongst interviewees as highlighted by the following quotations:

“I think that supplements are exactly that, they supplement what you are currently doing, they are by no means a replacement for what you should be having, first and foremost, my views always have been and always will be whole food first.” P2

“the word supplement to me means missing from your diet, so it’s something that you have to take additionally” P3

“I think that supplements are just that, I think that they should supplement a good diet” P7

“it has to start with the diet first, and once you've got that right and once that has been assessed and if that's adequate for your needs, then if your still struggling to improve, then a supplement protocol might come into position” P8

However, some participants also offered their thoughts as to why a whole food first approach to meeting dietary demands was not always successful. One participant highlighted the lack of dietary education in some players as a potential barrier to simply promoting a food first approach:

“when you sit down with players and we do the one-to-ones and talk about food, its blatantly obvious that there’s bigger problems to tackle that just turning straight to supplements” P5

It was clear that some participants believed that athletes lacked the fundamental knowledge relating to healthy dietary habits and that supplements were used as an

intervention to help meet dietary demands. There were however, differences in terms of whether supplements were prioritised over whole food or not**.** Each participant had their own views on where supplements fit in terms of maximising athlete performance.

Negative views regarding supplements

Although many participants initially identified the positives associated with supplement use, some negative observations were identified. Originally, convenience was identified by many participants as a positive use for supplements. However, there were some concerns when participant were asked about the potential reasons for supplement use by athletes. A common perception amongst some of the participants was that athletes used supplements as a shortcut to ensuring their dietary demands were met. One participant states that players are *"masking a bad diet with supplements" (P5).* Whereas another participant suggested that athletes might turn to supplements before even trying to sort their diet out:

"on the whole, athletes take supplements when they probably shouldn't be worrying about supplements" P4

The positive idea of supplements being used for convenience seems to be closely linked with the negative idea of laziness. Identifying laziness as a motivation to use supplements links with previous literature by Chiou et al. (2011) who examined the ironic effects of taking supplements in non-athletes. This study suggested that health promotion involving dietary supplement use alone, in the absence of exercise

and healthy whole foods might lead to self-indulgence with respect to health-related behaviours. This idea is often referred to as the 'magic pill' whereby supplement use alone improves health and performance. This was explicitly expressed in the current study by one participant who stated:

"It's that sort of, I can't really be bothered cooking a meal so I'll just have a protein shake or protein bar" P2

Dependency on supplements

These negative attitudes which were associated with convenience lead some participants to believe that some athlete have become dependent on supplements to help meet the dietary demands required for their sport. As one participant states:

"I think they are depending on it [supplements]" P6

The interviews seem to suggest that supplement use has become part of the sporting culture irrespective of whether their use is advised under the supervision of an appropriately trained professional (i.e. a nutritionist). There was also a suggestion of superstition could be a potential reason for supplement use and that athletes were using supplements for a psychological boost. As one participant states, a certain supplement might have been a part of a daily/competition routine which was associated with a good performance:

"what I would say is that, people can become set in their ways a little bit. If a player takes a certain supplement, and then goes out and performs well. They will

make that link between the supplement and the good performance, even if the supplement didn't really contribute to the performance, they will make that association. So the next time they play they'll want it again and it becomes a routine. If they keep the same pre-game routine and they keep playing well then why change it?" P7

A change in this routine could potentially result in a bad performance and could be, in some part due to the psychological effects resulting from a different routine. This relates to previous literature by Burke and Read (1993) who suggested that supplements could help athletes fulfil the physiological requirements arising from an acute bout of exercise that accompany an intense training programme.

The scale of variation as to how important the role of supplements actually were was demonstrate by one participant who suggested that it would be difficult to compete at the top level without the use of supplements:

"I think that you can do it without them, I think it would be easier to be successful with them if I'm being honest" P8

Whereas another participant believed that, there might not be much need for supplements if the athletes were educated, dedicated and willing to maintain a good diet, which was specifically tailored to helping them meet the demands of the sport:

“If people are prepared, and put in the hard work with their nutrition then no I don’t think there is a need for them, but I know that every athlete isn't perfect and they are used for convenience” P9

However, athletes’ supplementation should be guided by sport science professionals and dietitians, and not by family, friends or coaches (Braun et al., 2009). The variation between the participant’s views on supplements were strongly related to their previous experiences. These experiences include different education, qualifications and training concerning sports nutrition. This suggests that nutritional knowledge of athlete support staff can directly influence the supplement practices that professional athletes use to maximise performance.

4.3.1.2 Major influences on supplement beliefs

The second general dimension reflects on the factors and influences that shaped supplement beliefs. Three higher order themes materialised as participants explained how their beliefs had been influenced in the past. The first theme to emerge related to the academic and educational background of participants. Although these experiences vary between participants, a number of participants did revealed that education did influenced their beliefs on supplements to some extent. The second theme emerged as participants explained how negative sporting events, in which athletes had tested positive for a banned substance, made them question supplement safety. The third theme developed as multiple participants expressed their uncertainty towards supplements, which appeared to have

originated from the unrealistic marketing campaigns employed by supplement companies.

Academic and educational background

The majority of participants revealed that some form of education had shaped their supplement beliefs in some way. However, given the varying backgrounds of the participants, there were a number of educational recourse that were identified by participants. Some participants identified that attending university was the educational influence on their supplement beliefs:

"doing a sports science degree was an eye opener as to what supplement s where and how they could be used" P2

"education through the John Moores under my two supervisors, who are both very well respected within their arena so yeah, definitely from an education standpoint" P4

Whilst some participant identified that, they themselves had attended educational workshops or courses focusing on supplement use:

"I did a nutrition course that was a diploma in advanced nutritional weight management" P6

"I did the 100% me course about 3 or 4 years ago now" P7

Fortunately, it appeared that for some participants, some form of education had positively influenced their beliefs on supplements and their role in sport. However, the majority of participants revealed other influences that did not seem to have the same positive effect.

Sporting influences

Although multiple participants identified that some sort of education regarding supplements had influenced their beliefs on supplements, many participants also highlighted events or experiences in sport that had shaped their beliefs. The second theme began with some participant explaining how they researched how other, more successful clubs implement supplement practice:

"coaches, players and conditioners over here felt that if they are taking those supplements in the NRL, that these must be the best thing to take, these are the way forward, if we do this we are going to be something like them" P3

However, although some participants focused on the positive sporting influences of supplements and how they could potentially help athletes, multiple participants revealed that their beliefs had been negatively influenced by recent doping scandals. Although doping may not be a direct result of using supplements, the misuse of substances had clearly affected the beliefs of some participants:

"Some of the athletes from years ago, and they are redoing the tests and things, and it saying that a lot of them were taking something they shouldn't" P6

"recently around the athletics scene and previously the cycling scene, that shows that there is always sort of a cloud of doubt around supplements and the legitimacy of, first of all what they are and then whether they are safe to take from a sports persons view point" P7

Although the incidents that the participants referred to may not have a direct result of the use of supplements, they have clearly had a negative influence on the thoughts and beliefs surrounding supplements and supplement use. Over recent years, doping scandals would have appeared to cast a cloud of uncertainty towards supplements due to the apparent lack of legitimacy of the substances used in supplements. This was highlighted further by one participant who expressed his concern about the risks of being misinformed:

"being involved in rugby league, you see certain people that get the bans and everything else and you know, a lot of it does come from the people themselves that have been misinformed, or there has been a genuine mistake that's happened" P7

Uncertainty towards supplements through marketing

This uncertainty surrounding the use and prescription of supplements developed into the third theme as another reason for this observed lack of trust was identified. Multiple participants revealed that the marketing campaigns employed by supplement companies, only fuelled their mistrust and uncertainty towards supplements:

“you can easily be fooled by the adverts and the things that you see on TV that make you believe that this is going to give you all of the mass, all the power and all of the brutality that other athletes have got, but obviously, there is a lot more to it than that” P3

The observed mistrust of supplement companies by the interviewees seems to emanate from the marketing strategies adopted to promote the products. Advertisement campaigns aimed at the masses, promise unrealistic results from product usage and one participant explained that athletes are susceptible to being drawn in by these advertisements in the misguided belief that the product will significantly enhance their performance and make them into a better athlete:

“I don't like how they are advertised, I think it creates an illusion, that if you take x supplement or if you take x drink, it will make you into an x athlete” P8

All the participants appeared to be fully aware of the potential dangers to athletes, who might be drawn in by these promises made by supplement companies. Athletes may have intended to use these supplements for the right reasons after seeing the advertised results, but in reality, without the correct guidance and trustworthy information, they have opened themselves up to a number of risks relating to supplement misuse from both a health and an anti-doping perspective. These issues have arisen because supplements are negatively associated with doping due to numerous reports and evidence associated with contamination and adulteration of products. These advertisements highlights the unscrupulous nature of the

supplement industry which is contrary to the code of practice/professionalism employed by ‘many’ athlete support staff.

This has understandably lead to a lack of trust towards the marketing campaigns employed by many supplement companies, which has been identified by numerous studies. Fernández-Celemín and Jung (2006) found that consumers were often presented with conflicting information, which made it difficult to distinguish between reliable and false or inaccurate content. Another study, which looked at the information on supplements in such advertisements, found that ingredients were typically unusual or unidentifiable, and 22 percent of the time, no ingredients were listed at all (Philen et al., 1992). Further studies suggest that images depicting muscle-bound men can drive men to desire muscularity as an ideal body image (Ricciardelli, et al., 2010; Pope et al., 2000). A study by Hatoum and Belle (2004) also found that those who read magazines depicting and promoting such images, report increased dietary supplement use. This could be due to the majority of supplement advertisements including at least one health claim, which relates to the body’s structure and/or function. These claims are used to enhance product appeal by promoting unrealistic fitness goals of consumers who perceive these claims to be accurate (Ethan, et al., 2016). Although the majority of the literature refers to magazine advertisements aimed at the public the message can be easily transferred to athletes. Having already identified a lack of education amongst athletes (Petróczi et al.,2007; Petróczi et al., 2008; Giraldia et al., 2015; Dascombe et al., 2010; O’Dea, 2003), it is safe to assume that athletes can easily be drawn in by supplement advertisements without knowing much information about the supplements.

4.3.1.3 *Risks relating to supplement use*

The third general dimension relates to the risks relating to supplement use in sport. Participants gave their thoughts as to why the use of supplements is such a risk to athletes. Two higher order themes were expressed in this general dimension. The first theme focuses on the lack of supplement knowledge amongst athletes. The majority of participants agreed that the education levels of athletes was not sufficient. The second theme, which is almost a continuation of the first theme, was the risk to younger athletes who might not have the same support and guidance as senior athletes.

The lack of supplement knowledge amongst athletes

Whilst all participants agreed that supplements played a role in professional sport they were mindful of the potential danger for athletes – both young and old – to be drawn in by persuasive, and potentially misleading, advertisement campaigns. One theme to emerge from this approach to supplements by athletes, was the concerns over the level of education athletes had:

"I genuinely don't think that there is enough education that goes through the game" P8

"they've all got different little pieces of knowledge, and that's not always the best knowledge either, you know, its not always come from the best sources" P5

These concerns are not surprising given that there is previous literature, which highlights a lack of education amongst athletes representing varying sports. Many athletes that use supplements are often unaware of the active ingredients, any potential side effects or the reported mechanisms of action of the supplements they take (Dascombe et al., 2010). However, some participants have linked lack of education to the attitude of some players towards the safety of supplements from an anti-doping perspective.

Regardless of the reasons, numerous participants were in agreement with regard to the education of athletes and the suggestion that it might not have been as good as it could be. Petróczi et al., (2007) suggested that athletes often use supplements without knowing why and the potential risk posed to athletes is highlighted by one participant who stated *"you can buy these things without knowing what it is really" (P7).* Many participants were also aware of the potential consequences athletes could face because of poor knowledge and attitude:

"for the uneducated athlete they get drawn in very quickly and unfortunately this is where you see athletes becoming banned, because they are not aware of substances that might be in the product" P4

Worryingly, there was a suggestion that knowledge on the safe use of supplements may not be a concern for some players *"I don't think it's something that the players even think about until the day that the testers come in" (P7).* There seems to be varying thoughts as to the reason for this. One participant stated that it is not the athlete's job to know about supplements given the support that is provided *"in*

reality, it [knowledge] shouldn't necessarily be down to the athlete" (P2). However, in contrast to this, another participant explained that this attitude from players, might have originated from the belief that athletes did not have to think for themselves as everything is done for them:

"I think there is a general consensus that an athlete is given supplements and not really told why they are given it or what exactly it is or how it can benefit them or you know the risks of taking something" P6

The risk to younger athletes

These issues are not just limited to senior athletes, a second theme related to the risks of supplement use emerged regarding younger athletes, as many participants were aware the increasing pressure to succeed and progress in professional sport had resulted in younger athletes looking towards supplements in order to succeed. This has also been reported by Calfee and Fadale (2006), who found that young athletes were being pushed towards supplements due to the pressure to attain increasingly higher levels of performance in sport. Some participants suggested that younger athletes might have perceived supplements use as a route way to success, rather than focusing on a good diet. However, these participants also identified younger athletes as a group with a particular interest in supplement use:

"in a younger athlete, certainly, their mind set and view is that they need to be on absolutely everything to be able to catch senior players and to be as big as them" P3

"I have worked with the academy, so that's lads around 16 to 19 years old, and one of the first questions they ask you is "what supplements should I be taking?" P5

"the young lads within sport will be doing everything they can to increase their chances of becoming successful and make it at the top level, and if being bigger and stronger helps to increase those chances then you can see why they look to supplements when these adverts promise the results they need" P7

Young athletes may be at particular risk of falling for biased advertisement campaigns and false information regarding the benefits of supplement use. Whilst the support networks are relatively established at a senior level in elite sport, this support might be less than optimal within younger age groups.

A particular issue in relation to supplement use associated with the aspiring athlete is the 'gateway hypothesis' (Kandel, 2002). This hypothesis considers the possibility that supplements can serve as a gateway to doping since there is a body of evidence, which suggests a positive relationship between the use of supplements and subsequent doping behaviour (Dodge & Jaccard, 2006; Backhouse et al., 2011; Molinero and Márquez, 2009; Yussman et al., 2006; Goldberg et al., 2000). Whether intentional doping ensues or not, if a more relaxed attitude towards supplement use has developed this might lead to an increased risk of negative health effects and inadvertent doping.

4.3.2 Identify current supplement practices in use at the subjects' club

Four general dimensions emerged when examining the supplement practices employed by the participants. These dimensions (presented in content analysis table 2) are (1) supplement brand influences, (2) decision making process regarding supplement practice, (3) supplement delivery and (4) supplement risk management strategies. General dimension one examines the factors that influence the decision on what supplement brand the participants' club used. The second general dimension explores who is involved in the decision making process with regards to supplement and what factors influence these decisions. The third general dimension reveals how supplements are delivered to players and the fourth general dimension relates to the risk management strategies that the participants employ.

4.3.2.1 Supplement brand influences

The first general dimension to emerge in relation to current supplement practices in use by elite rugby league clubs developed as participants were questioned about what supplement brand their club uses and what influenced that decision. As participants revealed the influences which have a direct impact on supplement brand choice, a number of themes developed. The first theme to develop was the financial benefits associated with sponsorship and how many decisions were influenced by the most financially profitable deal. However, not all participants were in full support of selecting a supplement brand solely on the financial gain. The

second theme, related to the long standing and successful working relationships between the clubs and supplement companies**.**

Financial benefits associated with sponsorship

When examining the choice of supplements utilised by the participants and their respective clubs, sponsorship proved to be the main influencing factor - every club represented in the study was in receipt of sponsorship from a supplements company for the use of their product line. Direct quotes in support of this include:

"we have never paid for supplements since I've been at the club" P5

"we are with [A supplement company], and the main reasons for that are financial, they're one of our biggest sponsors" P7

Many of the participants continued to explain that these sponsorship deals were influenced directly by the financial gain to the rugby club. However, not all of the participants believed that deciding which supplements company to use should be based solely on the best financial deal available. Some participants even explicitly objected to the choice of supplement company:

"comes down to sponsorship and at the moment there are no other suppliers that will give us that amount of sponsorship, and believe me, I have tried to get that changed" P9

"In my opinion, we made a mistake coming out of [a previous supplements deal with another company] but at the time, the club wanted the money to spend elsewhere" P5

Although the majority of participants have identified the financial benefits of sponsorship deals as a leading factor in supplement brand choice, multiple participants expressed their disapproval of choosing a supplement brand solely on the financial benefits available. This raised the question of whether the choice of supplement brand should be swayed by the financial benefits over the quality of service and the integrity of the company. However, given the financial limitations that some clubs face, it is understandable that clubs are drawn to the best financial deal.

Long standing and successful working relationship

In addition to the tangible financial benefits from sponsorship, a good working relationship, additional support, reliability and reputation were considered additional factors influencing their choice in terms of the brand of supplement used. This was highlighted in the following quotations:

"[A supplement company] are really good with us as a sponsor so they will look at all of the body compositions we do as well and they will give their verdict on who takes certain supplements" P6

"Everybody has been tested whilst using that companies supplement and they haven't failed, then you start to feel quite confident in what products that company gives you" P3

"We get a really good deal with them and we have got a really good working relationship" P7

4.3.2.2 Decision making process regarding supplement practice

The second general dimension developed as participants were questioned about the decision making process regarding supplement practice. The first theme was established as participants revealed who was directly involved in the decision making process regarding supplement practice and who made the final decision. The second theme arose as participants discussed the different factors that influence their decisions when planning and implementing supplement practice.

Personnel involved in the decision making process

All of the participants identified that in the absence of a club sports nutritionist, the strength and conditioning coaches assumed the role of deciding what supplements were to be used with the head strength and conditioning coach having the final say on supplement practice:

"myself, the assistant strength and conditioner, and even with the 19's conditioner as well, we will all chip in" P3

“just down to me and the head of conditioning” P5

This cultural approach is not just limited to RL as Juzwiak and Ancona-Lopez (2004) found that in the absence of a sports scientist or sports nutritionist, the responsibility often falls on a coach. Interestingly, even when clubs did have access to a sports nutritionist, the head of strength and conditioning still made the final decision as this quote suggests:

“my line manager at the club is the head of strength and conditioning so a lot of the stuff that I do I will present to him first to make sure he is happy before we then roll it out” P4

This might suggest that from a cultural perspective the ultimate responsibility of supplement use falls to the lead strength and conditioning coach. This is supported more recently by Cockburn et al. (2014) who identified coaches to be the predominant source of advice for athletes and Wolinsky (1998), who identified that this responsibility often included advising athletes on nutritional practices by prescribing meals, diet regimes and supplements for their athletes. However, the qualitative data from the interviews suggests that some participants may feel that this practice is not one to be encouraged. Multiple participants who identified as strength and conditioning coaches and have undertaken the role of deciding what supplements their players used expressed their negative feelings toward the added responsibility, as outlined by these comments from strength and conditioning coaches:

"I will never say to a player "you must take this", you know, that's not my job, my job it to advise them and to try and help them as best I can. But not to say "you have to have this at this time, 5 times a day" or whatever, I don't think that's the right thing to do ethically" P5

"to be the person in charge of the distribution of supplements at the club, there is a bit of a weight, a bit of a burden that comes with that" P7

Factors that influence supplement practice

Other than the few who generalised supplement practice across the squad, the majority of participants identified they utilise a system which categorizes players based on what supplements they need in order to optimize their body composition, whether that be to lose fat, gain muscle or maintain what body composition they already have:

"we will tend to categorise them into players who we think need to lose a bit of weight, player who we are happy with so they need to maintain and also players who may need to gain some weight" P2

"what we do is we split the groups into three main areas, so we have a gainer, a maintainer and a loser" P6

"increase lean mass or increase bodyweight, decrease your fat mass or maintain what you've already got, so depending on where you sit on that will decide what you get from us supplements wise" P8

When asked further about the factors that influence what supplements players are on, body composition obtained through skinfolds or DEXA analysis, the individual needs of the player based on the position they play and verbal feedback from meetings or talks with players seemed to be recurring themes across many of the clubs (as highlighted by the following):

"we do have a look at body composition, we do skinfolds quiet frequently" P5

"I will sit down with each player and have a one to one meeting to discuss what supplements they will be on and why they are on those specific supplements "P7

"its all down to their individual needs and what we are looking to achieve with them physically" P8

Two participants explained how they received additional support from external nutrition staff who worked on a consultancy basis. However, only three participants (two of which were Nutritionists) revealed that they used current research in helping them to decide what supplements certain players used as this quote demonstrates:

"it's not solely based on body composition in terms of individual body composition, it's also based on the research out there" P4

4.3.2.3 Supplement delivery

The third general dimension covers the day-to-day strategies used by the participants for the preparation and delivery of supplement. As participants explained exactly how players received supplements, numerous themes arose. The first theme materialised as participants explained how the supplements were prepared each day. Most participants stated that the players themselves were not involved in the preparation of supplements and only received the supplements once they had been made up. A second theme emerged as participants continued to describe the methods in which they delivered these supplement to players.

Preparation of supplements

The majority of participants explained that supplements were prepared for players on a daily basis, whether this be by the participants themselves, other staff at the club or by the younger player who were breaking into the first team squad:

"we [strength and conditioning staff] make them up fresh every morning" P2

"we print that list off and it is then down to the younger players who are just breaking into the first team squad to deliver the supplements" P7

"an intern does all of that for us, so he will make up and put out all of the supplements for all of the players in the morning" P9

In these instances it appeared that the players themselves, were not involved in the purchase or preparation of the supplements they consumed. A postulated rationale for this from participants was that it was the only way to ensure players abided by their supplement regime:

"At least in the daytime we can kind of control and regulate and see that they are done but you're not with the players 24 hours a day" P3

"it sound awful, but you can't trust them, you can't trust them to do it themselves" P8

Although some participants revealed that they took the decision to prepare supplements for players, it was evident that players placed a lot of trust in staff to provide and prepare safe supplements on a daily basis as one participant divulged:

"I think the players, like we've said, just go on what you give them, I believe or, it's a trust thing" P6

Delivery procedure

Variation existed between clubs regarding when and how supplements were delivered to the players - some participants stipulated supplements were taken at certain times, while others provided loose guidance, leaving it up to the player themselves to take them when convenient:

"Whether it's before training, after training or after a gym session, their supplements will be there ready and waiting" P7

"*The first team has their supplements put out for them" P9*

"we told them that we are not going to make it up for them this year, because when we did make it up for them in previous years, you know, there was a lot of wastage" P5

4.3.2.4 Supplement risk management strategies

The fourth general dimension relates to the risk management strategies employed by the participants to limit the risk associated with supplement use. A number of themes emerged as participants explained what supplement risk management strategies they used. The first theme relates to the guidance given to players in relation to the self-purchase of supplements. Although the responses varied between participants, most took certain steps to guide and sometimes restrict the self-purchase of supplements. The second theme developed as participant explained the steps that they took to ensure the safety of the supplements that the club provides to players.

Self-purchase guidance/advice

Many participants took steps to safeguard players against the risks that they face outside of the club, by giving them advice on buying their own supplements. Some

participants delivered educational workshops and made sure players knew how and where to check the legitimacy of supplements. Some participants even advised players against buying their own supplements and to look for alternatives through the club. These Quotes show the wide range of responses by participants with regard to their policies on players buying their own supplement:

"unless we give it to you there is nothing else you need to be taking" P2

"if a player orders something that isn't from the [A supplement company] range, I make sure that they can go on websites like Global DRO, and the [Informed-Sport] website where they can actually check the batch numbers" P4

"if a player came to me and said look, I'm thinking of buying something, we would straight away go no, and we would then look to give them an alternative which we know is tested and that we know is safe" P6

"they know that it has to be Informed-Sports tested, and if they do get anything that is out of our, kind of, jurisdiction, and out of [A supplement company], then they have to run it by us first" P8

"it is recommended that they buy through the club but if they don't then they check it with us first" P9

One point of particular interest, which further highlighted the risks of purchasing supplements, was that batch tested products for a particular supplements range were only available through the club:

"isn't actually a batch tested product for the public, it gets tested for the club, it's great that ours gets batch tested" P9

This is an important concept as buying their own supplements in a shop or online could assume that products that were given to them by the members of staff at the club were safe (and legal?) to consume regardless of when or where it is purchased, when this may not, in fact, be the case. This risk can also relate back to younger athletes, who as previously identified, often turn to supplements to increase their chances of success.

According to the responses given by the participants, it would appear that clubs are aware of the risks relating to supplement use and inadvertent doping. This seems to have led to clubs employing clear strategies to help players identify and use supplements in a safe manner. It is essential that the same strategies are employed at an academy level and communication is extended across all levels of the sport. These populations often look at nutrition/supplement strategies employed by professional athletes and try to replicate them, often without the professional support or advice from informed individuals.

Batch Testing

Despite some participants expressing reservations around how a supplement company was selected (due to financial benefits) all participants confirmed that the products that they were providing to players were subject to a risk minimisation programme:

"(company name) is now registered on the informed sports programme so that every single raw ingredient that they have, sell and produce is now tested" P4

"we make sure its all batch tested" P5

"We can only buy stuff from them which has been batch tested" P6

Many studies have highlighted the risks relating to sports supplements having found that they many contain prohibited substances (Delbeke et al., 2002; De Cock et al., 2001; Geyer et al., 2011; Van der Merwe and Grobbelaar, 2005). This is often a consequence of contamination or adulteration during the manufacturing process (Maughan, 2005) because, unlike the pharmaceutical industry, the use and manufacture of supplements is not closely regulated (Wallace et al., 2008). As it is extremely difficult to determine whether doping is intentional or accidental, the principle of strict liability is enforced to ensure that athletes must prove their innocence beyond reasonable doubt meaning that inadvertent doping is not an acceptable excuse for an anti-doping violation (Burke, 2000b; Yonamine et al., 2004).

Some strategies are in place to help reduce the risk of inadvertent doping. Supplement testing schemes (such as Informed-Sport) offer the best risk minimisation approach for athletes who wish to use supplements. These schemes provide assurance that independent testing for prohibited substances has taken place for a particular product. Although a full guarantee that a product does not contain prohibited substances is not possible the use of such products (over and above products that have not undergone a recognised testing programme) offers the best assurances of safety and demonstrates due diligence.

4.3.3 Player and staff education

Two general dimensions emerged in the final phase of the interview relation to the current levels of education provided to players and staff within elite RL. These dimensions (presented in content analysis table 3) are (1) player education and (2) the perceived level of Knowledge amongst staff and potential reasons for this.

Having previously identified a potential lack of knowledge amongst athletes and elite RL players, general dimension one gives insight into the education that elite RL players receive. Participants have also identified that the responsibility of deciding supplement practice often falls on unqualified members of staff. The second general dimension highlights the potential reasons for this and also looks at the educational recourse available to the staff at elite RL clubs.

4.3.3.1 *Player education*

The first general dimension covers the education that players receive about the safe use of supplements. In attempting to identify the thoughts of the participants in relation to current levels of supplement knowledge amongst players, participants were questioned on their thoughts on player education and the recourses that were available. A number of themes developed as the participants revealed what education was provided to player. The first theme to emerge suggested that most participants took steps to educate players themselves through in-house education. As the interviews proceeded, a second theme developed regarding potential problems with the external educational resource players received. Throughout this part of the interview, a final theme arose as many participants revealed their thoughts towards the attitude of players towards the education.

In-house supplement education

The majority of responses suggest that the bulk of the education players received came from an internal source, in that staff at the club developed and delivered it. For multiple participants, this included personally designing and delivering educational material to players as and when it was required. Furthermore, many of the participants highlighted that most of the education/information that was delivered to players, related specifically to the supplements that were provided to them at the club, as these quotes show:

"within the club we will sit down with the players and discuss their diet and then go through what supplements they might use and the reasons for that" P7

“we try and give them as much information as we possibly can about their products” P3

“they know 100 percent what they are taking” P2

“this [supplements at the club] was all educated to the players about the supplement products and what each product does, so the players know that” P4

“every player knows why they take supplements and every player will know what each supplement is and why we want them to take it for their specific needs” P8

One participant revealed that they received educational support though their supplements company sponsor who provided the services of a qualified nutritionist who would educate players through presentations and consult of supplement practice via email:

“they [supplements company] come down and do presentations” P6

“[supplements company] are really good with us as a sponsor so they will look at all of the body compositions we do as well and they will give their verdict on who takes certain supplements” P6

Although many of the participants have explained that they have taken steps to educate players on supplements, it would seem that this in-house education was

often specific to the supplements that were being used at the club. Conversely, some participants suggested that players might have lacked knowledge about the supplements they were taking:

"No, I don't think they do [know enough about what they are taking]; if I asked a player what was in their little supplement tub… I bet more than half of them wouldn't know what it was" P9

Only two clubs have access to the services of a sports nutritionist, it would appear that in the absence of such an individual, this responsibility falls on the strength and conditioning staff. Even with access to nutritionists Torres-McGehee et al. (2012) found that from a random sample of athletes from multiple sports felt most comfortable seeking nutrition advice from athletic trainers and strength and conditioning specialists rather than registered dietitians. Similar results can be found in a study by Burns et al. (2004), who found that from a sample of athletes from multiple sports, athletic trainers and strength and conditioning coaches were selected ahead of registered dieticians as an athletes primary source of nutritional information. A study by Hornstrom et al. (2011) also found relatable results in individual sport. Whilst focusing on Mid-American softball players they reported that physicians and athletic trainers were the preferred source of nutritional information ahead of a dietitian. This may be cause for concern as previous studies have identified inadequate levels of nutritional knowledge amongst some coaches (Cockburn et al., 2014; Zinn et al., 2006; Smith-Rockwell et al., 2001).

Fortunately, one common factor to emerge when examining the in-house education was the safe use of supplements from an anti-doping perspective. The majority of participants highlighted that they made players aware of the potential risks relating to supplements:

"when we did the presentation with [a supplements company] together, we chatted about it, and we covered the fact that a supplement on the street can be made in a factory with various other supplement or with other ingredients and are at risk from cross contamination" P6

"we do make them aware of the risk [supplement contamination]" P2

The risk to athletes is highlighted by a number of studies, which examined the quality of supplements in terms of the absence of contamination with prohibited substances (Ayotte et al., 2001; Geyer et al., 2004; Green et al., 2001; Kamber et al., 2001). It is therefore essential that athletes are fully aware of risk minimisation strategies including how to ensure the safety of the supplements they consume. These quotes shows how some participants informed players about some of the current risk minimization strategies available to them:

"they know that it has to be Informed-Sports tested, and if they do get anything that is out of our, kind of, jurisdiction, and out of [a supplements company], then they have to run it by us first" P8

"there was a big chat that we did do and it was about the fact that everything we give them has been batch tested" P6

"I've done workshops with all of the players around checking their supplements and obviously I see it through the diet diaries so if they are taking anything then it gets flagged up then, but it is recommended that they buy through the club but if they don't then they check it with us first" P9

"in terms of the players knowledge, yeah I'd say we try and give them as much information as we possibly can about their products but again we would always tell them and suggest to them to go on GlobalDRO, go on these sites and try and look for the ingredients yourself, anything you're not sure of, bring it back in, let the physio have a look, let myself have a look, let the doctor have a look, and between the three of us at some point we will be able to have some sort of ideas as to whether it was a safe product or not" P3

"I make sure that they can go on websites like GlobolDRO, and the LGC website where they can actually check the batch numbers" P4

There appears to be confusion amongst some participants around supplements and medication and the risk minimization strategies available. As well as supplements, some over-the-counter and prescription only medicines could pose a possible threat to professional athletes from an anti-doping perspective. Chester et al. (2003) reported that athletes participating at a high-level tend to avoid over-the-counter medicines since they may contain prohibited substances. Nevertheless, in 2003,

UK Sport reported that out of the 100 adverse analytical findings that required further investigation, 49 were for stimulants, almost half of which were due to those typically contained in OTC preparations, such as ephedrine, pseudoephedrine and phenylephrine (Mottram et al., 2008). It is therefore essential that athletes are not only aware of the risks but follow a risk minimization strategy that might include: consultation with medical staff and the use of a specifically designed on-line tool to determine the prohibited nature of medicines (i.e. Global Drug Reference On-line). A participants also mentioned that education around the safe use of drugs and medication was also delivered to players:

"one of the things we do as a club, is that the club doctor delivers a workshop on prescription drugs and we tie that in with a little bit of the anti-doping stuff just to make the lads aware" P7

External educational support

Since it was established that the majority of education is designed and delivered 'in-house' and that the effectiveness of that information might be questioned, participants were asked about education delivered external to those in the club. Many of the participants revealed that players received educational support from the national governing body and when questioned about the content and delivery, the response was consistent throughout the majority of participants:

"As for the education programme that is rolled out by the RFL is ok but, it's just a one off and it seems to be a bit of a box ticking exercise" P7

"the minimal 20 minutes to half an hour a year that they get on the education from another voice other than ourselves at the club is probably not adequate in my opinion" P7

"We sometimes get past players who have had some involvement or potentially been banned or we just get a kind of, RFL employee who starts off with "look, I know nothing about supplements" and that loses the boys straight away" P8

"well we only had it [RFL workshop] once this year, and I just think that its not enough" P6

These responses indicate that the main source of education provided externally to the club by the national governing body came in the form of a short talk/presentation, which focused on prohibited substances. The majority of participants share similar thoughts on this education and agree that, the content and deliver may not be adequate. The world governing body, which oversees the RFL is the Rugby League International Federation (RLIF) and as signatories of the World Anti-Doping Code, they have the responsibility to ensure the provision of anti-doping education to players and athlete support personnel.

Perceived player attitude towards education

The majority of participants reported that although players were given information on the safe use of supplements and told how and where to check the safety of supplements, many do not engage with the process. This lead to some participants interpreting this as a lack of interest amongst players:

“players have all had these chats throughout every club and I think that sometimes they just switch off to it and the importance” P6

“at the moment, I just don’t think there’s enough interest” P8

The perceived lack of interest in the safe use of supplements was further interpreted by some participants as a poor attitude of some players towards the education of supplements. One participant stated that the only time that players really thought about the potential dangers of supplements was when testers turned up at the club:

“I don't think it's something that the players even think about until the day that the testers come in” P7

This could relate to the notion that within an elite sport setting, athletes are often supported in many different aspects of their professional life, one of which is nutrition and supplementation. From a club perspective, this ensures that all players receive the adequate support they require. From a supplements perspective, the club is able to control, as far as possible, the safety and welfare of its players. However, this unfortunately leads to clubs often fostering an environment of dependency, which is not conducive to promoting autonomy.

Petróczi et al. (2007; 2008) found that athletes from multiple sports often use supplements without having a clear rationale behind their choices and without knowing the active ingredients or potential side effects (Dascombe et al., 2010).

This suggests that athletes are simply following instruction from athlete support staff. This issue is further highlighted in the current study by one participant who states:

"even though that [tested products] list is available online a lot of players and a lot of people in general need spoon feeding" P2

Furthermore, this culture where professional athletes are 'spoon fed' information and supplements are purchased and prepared for them, is highlighted by one participant who explains how players are continually surprised at what they could and could not take:

"you will still have players saying "I thought you could take that" and "I didn't know you could take that" every single year"" P3

Whilst a number of participants raised their concern about player attitude towards the potential dangers of supplements there were some comments, which praised the attitudes of some players and indicated that there was a willingness to learn more about the safe use of supplements. One participant stated, *"the group we have are pretty inquisitive" (P2)*. This is similar to another comment from another participant who also revealed that players would sometimes take a proactive approach:

"some players that will come to you and ask for certain information and do take the steps to learn more" P7

One participants even revealed that some players were turning to social media to gain more knowledge about nutrition *"a lot of the boys now follow some of the nutritional experts on twitter and things like" (P8).* The ease of access to social media and the internet makes it an attractive source of information. However, it may be difficult to gauge the authenticity of the information accessed. It would therefore seem important that clubs ensure there is access to credible personnel to safeguard against false information.

4.3.3.2 *Perceived level of Knowledge amongst staff and potential reasons for this*

The second general dimension identifies the perceived level of knowledge amongst support staff and continues to explore the potential explanations for such knowledge. After identifying the participants' thoughts of player knowledge and education towards supplements, similar questions were asked with the aim of identifying their thoughts in relation to current levels of supplement knowledge and education amongst support staff. The first theme to develop was the perceived low levels of knowledge amongst support staff in elite rugby league. The second theme, which arose from the first, highlighted the potential reason for this level of knowledge as a lack of educational support. However, the third theme also took into consideration the attitudes of some support staff and questioned whether staff were willing to take on the extra responsibility.

Perceived levels of knowledge amongst support staff

When asked about staff knowledge in relation to supplements, a number of participants gave a similar response to earlier questions regarding players in that, like players, staff need more education about the correct and safe use of supplements:

"If I spoke to my interns, because they're not always directly involved in it, I think they wouldn't know half of this stuff [education on the safe use of supplements]" P5

"I just think that there needs to be a little bit more, education and willing that we have to be at the forefront of things" P8

"I certainly think that the staff structure needs education" P9

"I think everyone would benefit from it [education] and it would be worth educating the whole coaching staff" P4

The majority of participants are in agreement that support staff, who are in some circumstances in charge of supplement practice, need more education in relation to supplements. Previous studies have shown that in the absence of a nutritionist, athletes often turn to other athlete support staff (such as strength and conditioning staff) for advice and guidance on nutrition, which includes supplementation (Juzwiak & Ancona-Lopez, 2004; Torres-McGehee et al., 2012; Cockburn et al., 2014). However, previous research has also indicated that the nutritional knowledge of

various athlete support personnel from various sports may be inadequate (Torres-McGehee et al., 2012; Juzwiak & Ancona-Lopez, 2004; Smith-Rockwell et al., 2001; Zinn et al. 2006; Cockburn et al. 2014). These findings are congruent with the findings in the current study. The dangers of inadequate supplement knowledge not only affect players, but the staff themselves. This is of particular concern since the World Anti-Doping Code emphasises the importance of athlete support personnel in terms of their influence on doping practices amongst athletes. That is, coaches, sports scientists and physiotherapists are now considered an important part in an athlete's decision making process and may be liable if they are deemed to be complicit with a breech in the anti-doping rules. The anti-doping rules state that if support personnel who are found to be involved in, or covering up any ADRVs, can be sanctioned in the same way as the person who has committed the rule violation. The rule violations also state that athletes associating with support staff who have been found guilty of an ADRV offence can be sanctioned. Indeed, the risks to support staff are represented in the current study since one participant revealed that they had previously been involved in an inadvertent doping case resulting in a ban from the sport:

"Well I have been banned, I have been banned from the sport for 2 years for one of my players testing positive, so don't ever want anything like that to ever happen to me again" P8

This case illustrates that the ban happened due to a potential lack of knowledge in relation to supplement use:

"I'll be honest, I was a bit blasé to it all before that [] happened, in the fact that, I'm certainly not a drugs cheat and I certainly don't condone it, but before that [] I was probably a little bit 'laxed' to what the players were taking, I probably didn't know everything that they were taking away from the club, and I certainly wasn't as strict on the testing myself as what I needed to be" P8

The same participant highlights the importance of staff education as, in their opinion, there may be a lack of awareness amongst staff with regards to anti-doping rules:

"definitely the staff as well, because I bet if you asked any kind of staff member, I bet they wouldn't realise that they are subject to the same guidelines as their players, so they can get done for drug use" P8

However, this issue is not limited to RL. A review conducted by Backhouse and McKenna (2012) suggested that some coaches knew very little about their responsibilities under the World Anti-Doping Code (WADC) (World Anti-Doping Agency (WADA), 2009). Similarly, Mazanov et al. (2014) found that athlete support personnel had very poor knowledge of anti-doping rules.

Staff education

After identifying what the participants thoughts were on the current levels of knowledge amongst staff, questions were asked to try and identify the possible reasons for this level of knowledge. It appeared that the education on offer to staff was limited. The majority of participants explain that there were limited resources available through the governing body. One participant reveals that the staff attend

the same workshops that are designed for and delivered to players and that there was nothing designed specifically for staff:

"Not specifically, not that I'm aware of, the staff just attend the player workshops" P9

Worryingly, another participant reveals that they have never received any education in the form of workshops or educational talks, and that their knowledge on the area has been self-taught:

"I don't think I've ever been to anything that's been put on that's told me, no one has ever said to me, this is how you look for supplements for players at the top level" P5

"I've just picked it up myself really" P5

Staff attitudes towards supplement education

Although all of the participants who were interviewed revealed that they had taken steps to educate themselves on the safe use of supplements in relation to anti-doping, some suggested that other coaches and support staff may not consider this to be their responsibility:

"It's [supplement knowledge] just in the back of their mind and I don't think it sort of plays any prevalence in any thought process in what they do and what they need to do as part of their daily role as part of the coaching staff" P7

"I do think that there is a bit of a blaze' about it [supplement use] in the game" P8

As participants highlighted this attitude toward supplements, it could be suggested that some staff were happy to pass the responsibility to others. Although these members of staff might be aware that there are risks associated with supplement use, they appear to prefer to devolve responsibility to other staff members and therefore essential 'pass the buck' as one participant explains:

"They won't put themselves in that position where they've had to give their advice or they have advised someone on something like that because they know that it's not their area of expertise" P2

This seemingly lack of education and unwillingness to understand supplements from some support staff appeared to have led to a hesitant approach towards supplement from some support staff. Although it was positive to see that coaches were aware of the risks relating to supplements and that they realised that they themselves might not have been in a position to give advice, it does suggest that some coaches were happy to pass that responsibility on to another member of staff (more often the S&C coach). This further highlights the negative perception that supplements seem to have amongst sports practitioners, as people are almost wary of their use. One participant in the current study identifies this negative perception of supplements as he explains:

"the whole supplements thing is almost like a little bit of a dirty topic" P3

Another participant not only supports the notion that supplement use is a negative topic but also emphasises a perception that managing a supplement programme within a club is an onerous task.

"to be the person in charge of the distribution of supplements at the club, there is a bit of a weight, a bit of a burden that comes with that" P7

When participants were questioned as to why there were these thoughts towards supplement use, the answers relayed back to education and the potential lack of support available from the governing body. One participant reveals that there might have been issues with the support which was provided by the governing body, for both players and staff:

"I just don't think that the recourse out there are highlighted enough. I mean they might be there but players might not really know how to find them, and it's the same for the staff really" P7

"But having said that I don't think it's very effective in getting the message across and as soon as its over it in the back of everyone's mind again" P7

Other participants had similar thoughts towards the education provided by the governing body, which seemed to be delivered in the form of a short presentation taking place once a year. The general opinion amongst participants was that this

presentation was not an effective method of educating players or staff and that more needed to be done.

4.4 Conclusion

The aim of this study was to assess the knowledge of and attitudes towards supplements amongst player support staff from clubs currently competing at an elite level of RL (ESL).

Out of the eight teams who took part, only two have a nutritionist as part of their support staff. The research also found that in the absence of a nutritionist, the related responsibilities often fall to members of the strength and conditioning team. There was also a belief that nutritional and anti-doping knowledge which included the safe use of supplements was limited in some staff. Some participants suggested that a perceived lack of interest amongst players and coaching staff may have been a barrier towards adequate anti-doping knowledge and responsible supplement use. Furthermore, it would appear that there might have been an issue regards the external educational recourse available to support staff and players. Many participants revealed that there was a lack of education directed at and relevant to support staff concerning the safe use of supplement use and anti-doping issues.

CHAPTER FIVE

SYNTHESIS OF FINDINGS

5. Synthesis of findings

5.1 Realisation of aim and objectives

The overall aim of the research was to gain a better understanding of sports supplement use in elite RL and this was achieved through several key objectives.

Prevalence of supplement use

The first objective focused on the prevalence of supplement use within elite RL. For the first time, we have reported the prevalence of supplement use at the highest level of English RL. Supplement use was reported by 95 percent of all respondents. Our research supports the majority of previous literature by demonstrating the high prevelance of supplement use amongst athletes (Outram and Stewart, 2015; Baylis, et al. 2001; Schroder et al., 2002; Striegel et al., 2006; Ronsen et al., 1999; Lazic et al., 2011; Omeragić, et al., 2015; Slater et al., 2003; Lun et al., 2012; Aljaloud and Ibrahim, 2013; Ziegler et al., 2003; Petróczi, et al., 2008; Petróczi, et al., 2007; Burns et al., 2004; Hoffman et al.,2008; Braun et al., 2009).

Knowledge, belief and attitudes of athletes

The second objective addressed the knowledge, beliefs and attitudes towards supplements amongst elite RL players. The reasons for supplement use, the decision making process involved and the knowledge of anti-doping regulations regarding supplement use were identified. The main reasons for supplement use were reported to be for the optimisation of recovery and muscle building. Participants also revealed that athlete support staff (more specifically, strength and

conditioning coaches) have a significant role in the decision-making process relating to their supplement choice. This is in line with previous literature as many studies have identified athlete support staff as the main source of nutritional and supplement information for athletes (Juzwiak and Ancona-Lopez, 2004; Torres-McGehee et al., 2012; Cockburn et al., 2014). A potential lack of education regarding anti-doping procedures and strategies associated with minimising the risk of inadvertent doping attributed to supplement use, was also identified since many participants expressed a lack of awareness concerning these issues.

Knowledge, belief and attitudes of athlete support staff

The third objective focused on support staff who have a direct influence on the sports nutrition practices within elite RL clubs and their knowledge, beliefs and attitudes towards supplement use. There was a belief that knowledge concerning the safe use of supplements for players and staff was limited. A lack of interest amongst other support staff and many players was considered to be barrier towards adequate anti-doping knowledge and responsible supplement use. Furthermore, the educational resources regarding anti-doping delivered to players and support staff within elite RL in England was considered inadequate.

The findings are supported by previous literature highlighting the lack of supplement and nutrition knowledge of athlete support staff in various sports (Torres-McGehee et al., 2012; Juzwiak & Ancona-Lopez, 2004; Smith-Rockwell et al., 2001; Zinn et al., 2006; Cockburn et al.,2014). The role of sports nutrition has grown to the extent that it is now considered a vital part in the development and success of an athlete. However, not all sports/clubs/athletes have access to suitably qualified individuals

able to provide appropriate nutritional advice coupled with relevant anti-doping education. This highlights the importance of the assessment of current levels of knowledge amongst coaches and support staff, since these are the individuals who interact with athletes on a daily basis and influence dietary choices made by athletes (Juzwiak and Ancona-Lopez, 2004; Torres-McGehee et al., 2012; Cockburn et al., 2014).

5.2 General discussion

To the author's knowledge, this is the first body of research to investigate the opinions and practices of elite rugby players and support staff concerning supplement practice and education. By including both players and support staff, the culture of supplement use within elite RL was fully explored.

Many support staff revealed that players received in-house education relating to the safe use of supplements from a health and anti-doping perspective. The majority of support staff also informed players of support and strategies to help minimize these risks. The responses from players support this through an acknowledgement that supplement use carries potential risk from a doping perspective. However, through further analysis of player education it would seem that the education provided by support staff may not be effective. Perhaps the clearest finding from this research was the current perceived lack of anti-doping knowledge with respect to nutrition and supplement use amongst players and more specifically, the risk minimisation strategies. Our results indicate that almost half of the players were not aware of specific approaches to risk minimization (i.e. Informed-Sport). Furthermore, out of

those players who were familiar with the ‘Informed-Sport’ logo, many did not know what it represented.

A small number of players revealed that, they were unsure as to whether the supplements they were taking had been tested or not. This highlights the current lack of awareness relating to the importance of risk minimisation strategies and relates to the rationale given by some support staff for taking responsibility over supplement provision. It would seem that staff are aware of the lack of education and therefore do not trust that players are able to safely purchase or consume supplements independently. These beliefs might be somewhat justified as a number of anti-doping rule violations have been attributed to inadvertent doping associated with supplement use. Thus, further emphasises the need for awareness, accountability and vigilance

The findings of the current research suggests that there may be some issues with the content or delivery of the information players receive relating to the safe use of supplements. Multiple support staff have identified that the responsibility of educating players on nutrition and supplements has fallen on strength and conditioning coaches. Despite some participants expressing negative feelings towards the added responsibility, many reveal that they provide in-house education to their players. Whilst this model of practice might be considered appropriate, the pervious literature suggests that members of support staff from varying sports have inadequate levels of knowledge relating to nutrition (Smith-Rockwell et al., 2001; Juzwiak and Ancona-Lopez, 2004; Zinn et al., 2006; Torres-McGehee et al., 2012; Cockburn et al., 2014). Furthermore, this lack of knowledge extends as Mazanov et

al. (2014) found that athlete support staff had very poor knowledge of anti-doping rules. This only highlights the need to ensure both accuracy and consistency of the information provided by support staff. Good support from the governing body and in particular, the national anti-doping organisation is imperative for quality assurance purposes. Nonetheless, many support staff are also critical of the support they and their players receive from external educational sources. Issues with the delivery, content, frequency and accessibility of education from sources outside of the club have been raised by multiple support staff suggesting that the education and support programmes in practice could be improved. Whilst there is no gold standard with regards to anti-doping education, Backhouse et al. (2012) emphasizes the need for further research to enable evidence-based strategies.

The lack of education amongst players could be a result of a much larger issue relating to professional sports culture. Clubs often foster an environment of dependency, which is not conducive to promoting athlete responsibility. The professional sports culture, which fosters a reliance upon support staff has been identified by Moen and Verburg (2012). They state that dependent relationships, as seen between athletes and support staff are characterised by the reliance of athletes on another person. There is an appreciation of the potential importance of a dependent relationship for young athletes when it is necessary to receive help, guidance and instil good practice. However, the dependent relationships can carry negative consequences as athletes may not develop sufficient skills for independent thinking and autonomy. When faced with decisions concerning supplement use they may not be in a position to make the correct choices. It would seem that in the current research, this dependent relationship between the players and support staff

might have resulted in a lack of practical anti-doping knowledge with respect to nutrition and supplement use.

Whilst many players revealed that, they had some input into their own supplement use they were cognizant of the role of strength and conditioning coaches in the decision process. Indeed the support staff interviewed in study two were selected due to their role and influence in sports nutrition practice within elite sport (i.e. first team squad of an ESL club), the majority of which identified themselves as strength and conditioning coaches. The literature supports the notion that coaches (Juzwiak and Ancona-Lopez, 2004; Cockburn et al., 2014), and more specifically athletic trainers and strength and conditioning specialists (Torres-McGehee et al., 2012) as an athletes predominant source of nutritional advice. There were however, some contradictions between the two studies in relation to who decides what supplements are used. Many players identified that they were involved in the decision making process, whereas the majority of support staff identified themselves as the individuals that decided what supplements players administered with no recognition of player input. This might reflect the way in which support staff consult with players regarding supplement choice and use. Support staff may encourage engagement with players to explain the reasons for supplement use without giving them the freedom of choice. Some players may perceive this as having input into supplement practices but in reality, the input from the athlete was negligible.

A significant proportion of players (25%) revealed that they had no input into the supplements they consumed. This dependency on support staff from players extended to the preparation of supplements on a daily basis. The rationale behind

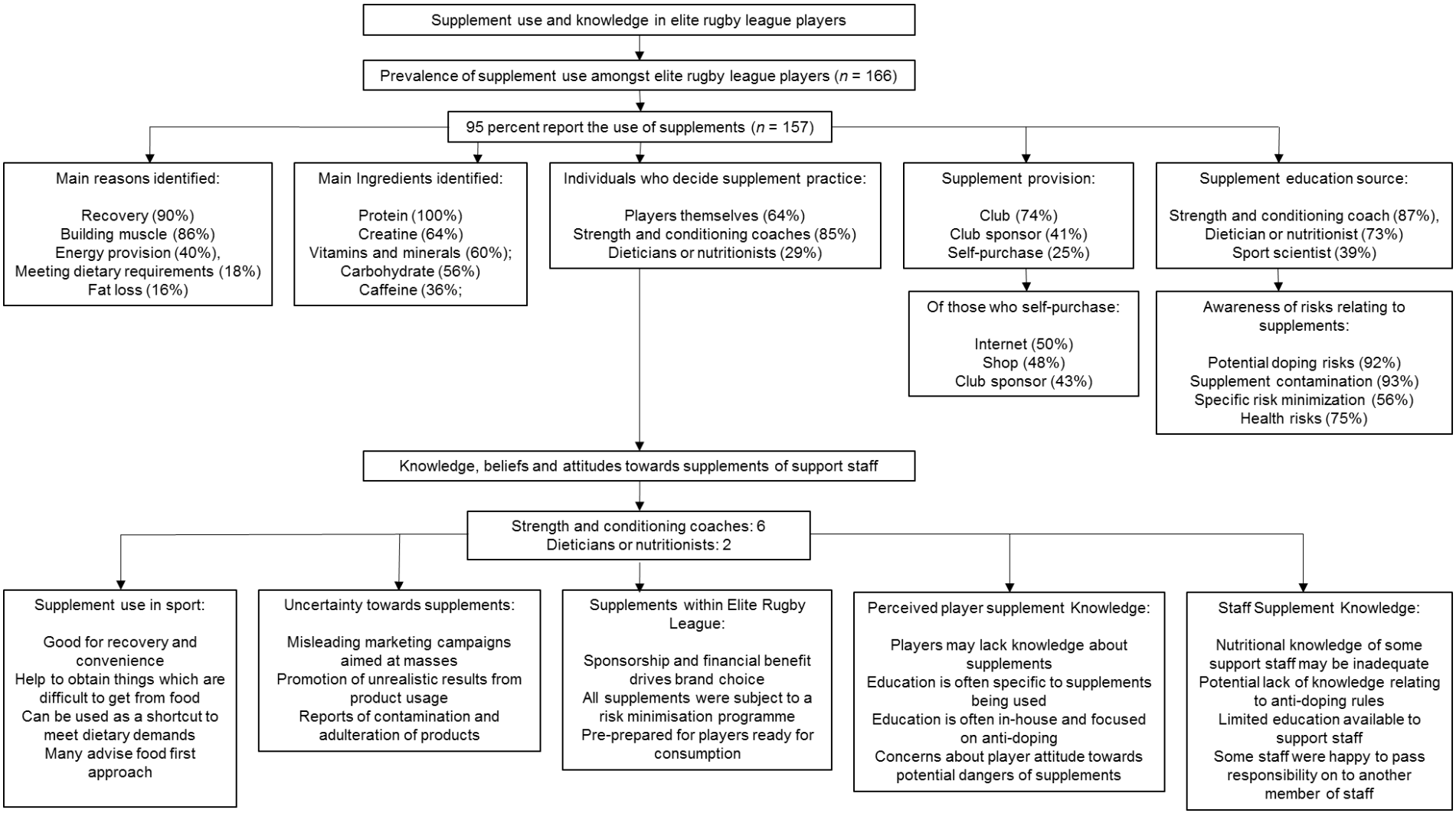
this approach is that, from a club perspective, this not only ensures that all players receive the adequate support they require, but from a supplements perspective, the club is able to control, as far as possible, the safety and welfare of its players by providing supplements that they believe to be safe. However, this risk management strategy employed by numerous clubs means many players have restricted involvement in supplement selection and preparation. Because of this, the first time many players see a supplement is when it is already prepared and ready for consumption. This removal of the thought process behind supplement choice understandably leads to players having limited knowledge around the ingredients contained in a product and reasons for their use. This finding is in line with literature which report that supplements are often used without full understanding or evaluation of the potential benefits and risks associated with their use (Maughan, 2005; Maughan et al., 2007; Waddington et al., 2005; O'Dea 2003; Dascombe et al., 2010), without having a clear rationale behind their choices (Petróczi et al. 2007; 2008).

The culture of dependency in elite sport is contrary to the principal of strict liability set out in the World Anti-Doping Code (WADC; WADA, 2015). Despite the appreciation of the importance of athlete support personnel as key players in anti-doping rule violations as demonstrated in recent revisions to the WADC, the athlete remains responsible for what substances they consume(WADA 2015). Recent changes to WADC have resulted in the sanctioning of athlete support staff and the publication of a prohibited association list highlighting individuals, who are currently suspended from working with athletes (WADA 2017).

It is illustrated that the purchasing of supplements is understandably a role that a professional club typically takes responsibility for. In the current research it was recommended that all supplement use should be reviewed by the relevant support staff. However, the self-purchase of supplements was not universally condemned with some support staff stating that the self-purchase of supplements was acceptable providing that the supplements were reviewed by the appropriate support personnel prior to use. Although a significant number of players reported purchasing their own supplements, given the general lack of knowledge surrounding risk minimisation amongst players there was no way of knowing whether these supplements had been reviewed by the appropriate support personnel prior to use. This raises a particular concern regarding player's nutrition outside of the club environment and highlights the need to provide sufficient skills and knowledge enabling them to make safe choices.

After identifying a perceived lack of nutrition and supplement knowledge within RL, it is believed that a lack of effective education is the leading factor. Many players demonstrated a lack of understanding, but have revealed that they would consult with support staff, mainly strength and conditioning coaches, for nutritional advice and support. However, a potential lack of supplement and nutrition knowledge amongst support staff, who typically have a role in sports supplement provision, albeit not their primary role, was also identified. Both players and support staff expressed a desire to learn more about the safe use of supplements and that current educational resources may not be sufficient.

5.3 Figure 8: Schematic of findings



5.4 Limitations

The recruitment for both study one and two was restricted to English clubs competing in the ESL therefore may not be fully representative of European RL or indeed the sport of RL. Furthermore, only eight English ESL clubs granted access to players for the purpose of the study one and only eight English ESL clubs granted access to one member of staff who was involved with setting supplement practice for the purpose of study two. Given that, there was not a 100 percent response rate from the English clubs competing in the ESL for either study, these findings may not provide a complete picture of elite RL in the UK. However, the sample would be considered to be fully representative of the population in question. Given the nature of elite sport, access to athletes and support staff is particularly difficult.

The data for study one was collected with the use of a questionnaire at a time and place which was deemed convenient by the head coach or head of strength and conditioning (these individuals acted as the gatekeepers for data collection). Although questionnaires were distributed and completed by participants in the presence of the researcher the decision regarding the time and location was decided by the gatekeeper. This was often during a break which was scheduled into a typical training day. Given the busy schedule of professional athletes, it is important to consider the timeframes in which participants were given to complete the questionnaire. A potentially limited timeframe in some cases may raise concerns over the accuracy of responses given and the completeness of data. Unfortunately, access to the participants was at the convenience and goodwill of the gatekeeper who ultimately controlled data collection. Furthermore, there was unfortunately no

way of knowing whether the participants completed the questionnaire truthfully and given the negative perception by many towards supplements, some participants many not have given full and accurate responses, by not reporting/underreporting what may been considered undesirable activities. This is an example of how social desirability bias may have affected the data collection using a questionnaire.

Although a questionnaire was deemed the most appropriate way to collect data from players, there are some limiting factors to take into consideration. A questionnaire does not enable the researcher to follow up questions and facilitate further analysis of responses. Therefore, it might be difficult to assess the opinions and attitudes of players from responses to set questions as the researcher has made assumptions/inferences based on the data available. However, further analysis of responses could only be achieved through the use of interviews where follow up/probing questions could be implemented. Given the participants involved in the current study and the completeness of the sample, interviews would not have been appropriate.

The data for study two was collected through semi-structured interviews with a member of the athlete support staff who were selected for interview due to their central role and influence in sports nutrition within the first team squad. However, these participants were selected by the gatekeepers without consultation with the research team. Therefore, although the members of staff selected for the interview did have a role in sports nutrition within the first team squad, there was varying levels of influence amongst the participants on supplement practices. Some

participants were directly involved in the decision making processes regarding supplement practices whilst others only implemented those decisions.

There may also have been an issue with the number of participants selected from each club. Although the initial aim of the study was to interview one member of staff, the selection of one individual for interview did not allow for the exploration of the complexities within the club structure. Another important consideration was that the members of staff recruited for this study had very different backgrounds and knowledge in sports nutrition, thus, limiting the comparison between them. Further work might consider the way in which decisions are made and the different individuals involved in the process.

Given the negative perception by many towards supplements and the close links made between supplement use and doping there may be an issue with the social desirability bias. Tackling issues around supplement use and inadvertent doping may have created an inextricable connection which would further reinforce the potential for social desirability bias. Given that some topics in the interview and questionnaire may have been of a sensitive nature, some participants many not have given full and accurate responses, though not reporting undesirable activities and over-reporting desirable activities. Tourangeau and Yan (2007), suggest that this is often the case when the characteristic, behaviour, or attitude being measured conflicts with existing social norms and is perceived as being undesirable or even unacceptable by most of society.

5.5 Practical implications and future studies

Based on the unique findings of these studies, further areas of investigation and practical recommendations could be suggested. Firstly, a sports specific education programme could be developed to educate and benefit both players and staff on nutrition. Involved in this could be a focus on the correct and safe use of supplements in professional sports with reference to anti-doping rules and regulations. Through a well-designed education programme which is consistent throughout the teams competing in the ESL, support staff would be better equipped with the necessary education to autonomously influence and deliver safe supplement practice. Future workshops could include more RL specific information, but also be delivered by suitably qualified individuals that might be external to the club structure. Suitably qualified individuals might include those that are registered sports nutritionists with a good understanding of the demands of the sport and the anti-doping rules. From a supplements perspective, this individual must be fully aware of the risks surrounding supplement use with respect to inadvertent doping and must have the knowledge and skills to implement appropriate risk management strategies.

The results from the current research have demonstrated that there is an appreciation of the importance of safe supplement use from both players and support staff. However, the findings also suggest that there is also a possible culture of dependency within rugby league, which appears to be commonplace amongst elite sports and in particular, team sports. Future education programmes should look to discourage this dependency culture by encouraging autonomy and self-

dependency. The principal of strict liability set out in the World Anti-Doping Code (WADC; WADA, 2015) is the cornerstone of doping control and is contrary to this dependency culture. Nevertheless, the code does recognise the importance of other stakeholders, namely, athlete support personnel through the introduction of further anti-doping rules and the prohibited association list (WADA, 2017). Both players and support staff require more education informing them of their responsibilities in professional sport relating to the use of supplements (WADA, 2015).

The current research would suggest that this dependency culture is often employed by professional clubs to protect professional athletes from potential adverse events associated with supplement use. It would appear that by taking away responsibility from athletes and having support staff purchase and prepare supplements, professional clubs hope to eliminate the risk of human error regarding supplement use and doping. However, not only is there insufficient knowledge amongst some of the support staff taking on that responsibility, the athletes they are trying to protect are not always within that club environment. As a result of this dependency culture, these athletes are more at risk since they are not equipped with the necessary skills for safe supplement use outside of the club environment.

Furthermore, elite RL players would also benefit from being included in such education schemes. The current research was limited to elite RL players competing in the ESL. To the authors' knowledge, there is no research looking at the level of knowledge within players or staff from lower levels of RL, whether that be amateur level or youth/academy level. Given that some of these players face the same risk associated with inadvertent doping, it would be useful to establish the prevalence

of use of supplements and their knowledge and opinions around supplements and anti-doping. This would be particularly important since, at lower levels of participation/competition, players may not have access to the same support network. Future research should also look to explore and examine the dependency culture within RL. It is also important to consider the diversity of dependency within the RL culture as each club has its own individual way of implementing supplement practice. The anti-doping movement recognises the central role of athlete support personnel in the doping landscape, it is essential that research examine the knowledge beliefs and attitude of athlete support personnel in relation to nutrition, supplements and anti-doping. Such research would help in the development of anti-doping strategies such as education targeted at athlete support personnel.

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APPENDICIES

APPENDIX ONE

QUESTIONNAIRE ON THE USE OF SUPPLEMENTS WITHIN RUGBY LEAGUE

Code: .....

Questionnaire on the use of supplements within Rugby League

The purpose of this questionnaire is to assess current supplement use amongst rugby league players. The questionnaire will also include additional questions to gather information on players' knowledge and attitudes of supplements and current supplement practices.

Please refer to the Supplement Information Sheet attached to the questionnaire as a reference when identifying supplements that you may use.

Before beginning this questionnaire, please read the participant information sheet and the implied consent statement located directly below:

"I have read the information sheet provided and I am happy to participate. I understand that by completing and returning this questionnaire I am consenting to be part of this research study and for my data to be used as described in the information sheet provided"

If you have read the implied consent statement and are happy to complete the questionnaire, please tick this box:

☐

Definition:

For this study, supplements are defined as products, taken orally that are used to address nutritional and performance needs by supplying one or more nutrients (that are usually present in a normal and balanced diet) in a concentrated form.

Please answer all of the questions as honestly and as accurately as possible. Please write your answers in the space provided or tick the appropriate boxes corresponding to your response.

Section 1 - Respondent Information

1) Age: ……..

2) Nationality: ……..

3) At what level do you **currently** compete?

Professional (European Super League) □ Amateur (All other leagues) □

Non-Super League Professional (Kingston Press Championship/Kingston Press League 1) □

4) Are you currently playing for more than one club under duel registration?

Yes □ No □

If you have selected "yes" for question 4, please continue the questionnaire and answer the questions as a player from the club competing in the highest league

5) What is the highest level you **have** competed at?

Professional (European Super League) □ Amateur (All other leagues) □

Non-Super League Professional (Kingston Press Championship/ Kingston Press League 1) □

Section 2 – Supplements Use

1a) Do you currently take supplements?

Yes □ No □

1b) If you answered "No" to question **1a** and do not currently take any supplements, could you please state the reasons why?

……
……
……
……
……
……

*If you have answered no to question **1a**, please skip the next few questions and continue the questionnaire from question **18** in this section.*

2) Who decides what supplements you take?
(Please tick all that apply)

Myself □ S&C Coach □ Dietician/Nutritionist □ Medical Staff □

Coaching Staff □ Sports Scientist □

Intern/Trainee staff□ Other □ *please specify*: ……

3) Do you have any input on the use of any of the supplements you take?

Yes □ No □

4) Who provides the supplements you take?
(*Please tick all that apply*)

Club □ Club Sponsor □ Individual Sponsor □ Self-Purchase □

Other □ *please specify:* ……

5a) If you purchase your own supplements where do you purchase them from?
(Please tick all that apply)

Shop □ Internet □ Club Sponsor □ Individual sponsor □Team-mates □

Other □ *please specify*: ……

5b) If you selected the "shop" option for question **5a**, could you please specify the type of shop in which you purchase your supplements?
(Please tick all that apply)

Chemist/Pharmacy ☐ Supermarket ☐ Health Food Store ☐ High Street Chain (e.g. Holland & Barrett) ☐ Sports Shop ☐

Independent Health Food/Sports Supplement Store ☐

Other ☐ *Please specify:* ……

6) Do the supplements you take change according to the time of year? (e.g. Pre-season, In-season, Off-season)

Yes □ No □

7) How many different types of supplements do you take in a typical pre-season week? (*Please specify a number*)
……

8) How many different types of supplements do you take in a typical competition week? (*Please specify a number*)
……

9) How many different types of supplements do you take in a typical off-season week? (*Please specify a number*)

……

10) Thinking about each of the supplements you use, why do you use them?
(Please tick all that apply)

Build Muscle ☐ Fat Loss ☐ Recovery ☐ Energy boost ☐Medical purpose ☐

Meal Replacement ☐ Meet dietary requirements ☐ Instructed to by support/medical staff ☐

Other ☐ *please specify*: ……

11) Overall, do you believe that you are aware of the intended purpose of the supplements you take?

Yes ☐ No ☐

12) Overall, do you believe that the supplements you consume help to maximise your sports performance?

Yes ☐ No ☐

13) Overall, do you believe that you need all the supplements that you are taking?

Yes ☐ No ☐

14) If known or the details are available, please list the supplements you take.

*Please include **product name**, product **brand** and **key ingredients**. Please refer to the supplements tip sheet attached to the back of the questionnaire if necessary.*

……
……
……
……
……

15) Please indicate which of the following ingredients are contained in **any** of the supplements you take?
(Please tick all that apply)

Protein □ Creatine □ Carbohydrate □ Vitamins and/or Minerals □ Caffeine □

Zinc □ Chromium □ Branch Chain Amino Acids □ Phosphates □

Other ☐ *Please specify*: ……..

16) For any supplements that require preparation before use (i.e. protein shakes), who does this?
(Please tick all that apply)

Myself □ S&C Coach □ Medical Staff □ Coaching Staff □

Dietician/Nutritionist □ Sports Scientist □ Intern/Trainee staff □

Other □ *please specify*: ……

17a) Do you take any herbal supplements or substances that contain herbal ingredients?

Yes □ No □ Don't Know □

17b) If you answered "yes" to question 17a, thinking about all of the supplements you take that contain herbal ingredients, do you know the name of the herb and what they are used for?
Please state the name and reason for use for each herbal ingredient you consume

Name of the herbal substance/ingredient:……

Please tick box if unsure □

Reason for use: ……

Please tick box if unsure □

Name of the herbal substance/ingredient:……

Please tick box if unsure □

Reason for use: ……

Please tick box if unsure □

Continue in the space provided at the end of the questionnaire if there are other herbs that you use

18) Have you taken any medication in the last 12 months?

Yes □ No □ Don't Know □

19) Thinking of all of the medication you have taken in the last 12 months, who has prescribed it? *(Please tick all that apply)*

Self-Prescribed □ GP □ Club Doctor □ Physiotherapist □ S&C Coach □

Coaching Staff □ Dietician/Nutritionist □

Other □ *Please specify*: ……

20a) Do you take medication on a regular basis (e.g. daily or weekly)?

Yes □ No □

20b) I you have answered yes to question **20a**, what are the reasons for the medication you use? (*Please tick all that apply*)

Long-term Medical Condition □ Short-term Medical Condition □ Short-term Pain Relief □

Section 3 – Education and knowledge in relation to supplements

1a) Have you ever been given any advice relating to supplement use?

Yes □ No □

1b) If you answered "yes" to question **1a**, who gave you the advice? *(Please tick all that apply)*

S&C Coach □ Medical Staff □ Dietician/Nutritionist □

Coaching Staff □ Sports Scientist □ Intern/Trainee staff □

Other □ *Please specify*: ……

1c) If you answered yes to question **1a**, did you fully understand the advice you were given?

Yes □ No □

2a) Have you ever asked or looked for advice on supplement use?

Yes ☐ No ☐

2b) If you answered "yes" to question **2a**, where did you look or ask for advice?
(Please tick all that apply)

S&C Coach ☐ Medical Staff ☐ Dietician/Nutritionist ☐ Coaching Staff ☐

Sports Scientist ☐ Intern/Trainee staff ☐ Friends ☐ Books ☐

Magazines ☐ Internet ☐ Shops ☐

Other ☐ *Please specify*:……

3) Are you aware of any potential health risks associated with supplement use?

Yes ☐ No ☐

4a) Have you ever seen this logo?

Yes ☐ No ☐

4b) If you answered "yes" to question **4a**, do you know what it represents/means?

……
……
……

5) Are you aware of any potential risks associated with supplements from a doping perspective?

Yes ☐ No ☐

6) Are you aware of the risks related to supplement contamination?

Yes ☐ No ☐

7) Have the supplements you are consuming have been tested for contaminants?

Yes ☐ No ☐ Don't Know ☐

Section 4 – Attitudes towards supplements

The following section will feature a set of statements from which we would like to assess your attitude towards supplements. These statements will be followed with options which will indicate how much you agree or otherwise with the statement.

Please tick the appropriate boxes corresponding to your response.

Statement	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
I believe that supplements play an important part in the development and success of a Rugby League player					
I would consider supplements to be a suitable replacement for food at meal times					
I believe supplements can provide the same nutritional benefits as food					
Overall I consider there to be few health risks involved in consuming supplements					
All Supplements are safe to consume from an anti-doping perspective if they are purchased from a well-known brand [i.e. not contain any prohibited substances]					
I believe I have sufficient knowledge to consume supplements in a safe manner					
I know enough about the supplements I take in terms of the reasons for taking them					
I would benefit from learning more about the safe use of supplements in Rugby League					
More help, advice and information should be available with regards to the safe use of supplements in Rugby League					
I am happy with the supplement regime I currently follow					

Section 5 – Anti-Doping Knowledge

1) Are you aware that there is a list of substances prohibited in sport?

Yes □ No □

2) Are you aware of the World Anti-Doping Agency (WADA)?

Yes □ No □

3) What is the status (i.e. prohibited or not prohibited) of the following substances in regard to the 2015 Prohibited List? (*Please tick all that apply*)

	Prohibited	Not prohibited	Unsure
Codeine	☐	☐	☐
Methylhexaneamine	☐	☐	☐
Salbutamol	☐	☐	☐
Citrus Aurantium	☐	☐	☐
Clenbuterol	☐	☐	☐
Leucine	☐	☐	☐
Oxymetholone	☐	☐	☐
Maltodextrin	☐	☐	☐
Phenylephrine	☐	☐	☐
Tribulus Terrestris	☐	☐	☐
Pseudoephedrine	☐	☐	☐
Colostrum	☐	☐	☐

4) What is the likely sanction that would follow a positive drugs test for a first offence involving intentional doping (i.e. use of an Anabolic Steroid)?

Reprimand ☐ ≤1 Year ☐ ≤18 Months ☐ 2 Years ☐

4 Years ☐ Life ☐ Don't Know ☐

5) What is the maximum sanction that would follow a positive drugs test for a first offence involving the use of a contaminated supplement?

Reprimand ☐ ≤1 Year ☐ ≤18 Months ☐ 2 Years ☐

4 Years ☐ Life ☐ Don't Know ☐

6) Who would you turn to for advice regarding taking a supplement or substance you were unsure of? *(Please tick all that apply)*

Head Coach	☐	Nutritionist/Dietician	☐	S&C Coach	☐
Team Mates	☐	Medical Staff	☐	UK Anti-Doping	☐
Other	☐	*Please specify*: ……..			

7) Who would you turn to for advice regarding taking medicine that you were unsure of? *(Please tick all that apply)*

Head Coach	☐	Nutritionist/Dietician	☐	S&C Coach	☐
Team Mates	☐	Medical Staff	☐	UK Anti-Doping	☐
Other	☐	*Please specify*: ……..			

8) Which of the following Rugby League players are subject to Anti-Doping regulations?

Professional Players	☐	Non-Super League Professional Players	☐
Amateur Players	☐		

Notes:

……
……
……
……
……
……
……
……
……
……

Thank you for taking the time to complete this questionnaire

Type of Supplement	Brand/Name			
Protein & BCAA's	USN Pure Protein GF-1	MyproteinImpact Whey Isolate	Precision Engineered Muscle & Size Gainer	PhD Pharma Whey HT+ Powder
	USN Whey Protein Premium	Myprotein Total Protein	Precision Engineered Pure Casein Powder	Kinetica Thermo Whey
	USN Whey Isolate	Myprotein Impact Diet Whey	Precision Engineered Whey Protein	Kinetica Whey Protein
	USN Muscle Fuel Mass	MaxiNutrition All In One	Precision Engineered Milk & Egg Protein	Kinetica Natural Whey Protein
	USN Casein	MaxiNutrition Gainer	Holland & Barrett Soya Protein Isolate Powder	Reflex Diet Protein Powder
	USN Muscle Fuel Anabolic	MaxiNutrition Promax Lean	Maximuscle Progain Extreme Powder	MetRx Supreme Whey Powder
	USN Hyperbolic Mass	MaxiNutrition Promax	Maximuscle Progain Powder	Optimum Nutrition Complete Protein Powder
	USN Enduro Carbs	MaxiNutrition Cyclone	CNP Pro Mass Powder	Myprotein BCAA
	Myprotein Impact Whey Protein	MaxiNutrition Progain Extreme	CNP ProPeptide™ Powder	USN BCAA Powerpunch
	USN BCAA Syntho Stack	Myprotein iBCAA	Precision Engineered Amino 1500mg Tablets	Optimum Nutrition BCAA 5000 Powder
	USN BCAA Amino Gro	Myprotein L Leucine	Reflex Branched Chain Amino Acids Capsules	Precision Engineered Branched Chain Amino Acids Capsules
	Nutrition X Ultimate	Nutrition X Mass X	Nutrition X BCAA Plus	Nutrition X Maximum Recovery Matrix
Energy	USN Hyperdrive	USN Sports Ener-G	Maxifuel Viper Boost Tablets (herbal)	Kinetica Fuel Gel
	USN Muscle Matrix	Maxifuel Recovermax	Optimum Nutrition Platinum Hyrobuilder Powder	Kinetica ProRelease
	USN Anabolic Nitro X	Maxifuel Viper Boost	Lucozade Sport	Kinetica 100% Energy
	USN Cytopower HP	Maxiraw Carb Impact 3kg	Lucozade energy	Nutrition X Energel+
	USN Hyrator Fizz	Maxiraw Primary Caffeine	Gatorade Performance	Nutrition X Xplode Shots
	USN Vooma Energy Gel	Gatorade Prime	Monster Energy	Nutrition X Hydra 10
	Monster Energy Shot	Red Bull	Monster Ripper	5 Hour Energy Shot
Minerals & Vitamines	USN Multiplex capsules	Myprotein L Glutamine	Holland & Barrett Vitamin C with Wild Rose Hips Caplets	CNP ProGlutamine Powder
	USN Amino Pro Nano Stack capsules	Myprotein Beta Alanine	Holland & Barrett Omega 3 Fish Oil Concentrate Capsules	USN CLA 1000
	USN EFA Triple Omega	Myprotein Maltodextrin	Holland & Barrett Grapeseed Extract Capsules	USN CLA Green Tea
	USN Active Joint Plex	Myprotein Dextrose	Holland & Barrett Hydrolysed Collagen Caplets	USN CLA Thermo
	HMB 10000	Myprotein Vitamin C Powder	Holland & Barrett Radiance Multi Vitamins & Iron	Kinetica Joint Support
	USN Pure Glutamine Powder	Maxifuel Viper Active	Holland & Barrett CoEnzyme Q-10 Capsules	Kinetica Essential 4
	USN 19 Anabol Testo	Maxifuel Sports Vitamins	Holland & Barrett High Strength Glucosamine & Chondroitin	Holland & Barrett ABC
	Myprotein Instant Oats	Holland & Barrett Cod Liver Oil Capsules	Holland & Barrett Raspberry Ketones Tablets	
Creatine	USN Creatine X4	Myprotein CEE capsules	Precision Engineered Creatine Capsules	Maximuscle Creatamax Extreme Powder
	USN Creatine Transport	Myprotein Creastorm	Precision Engineered Creatine Powder	CNP ProCreatine E2 Creatine Ethyl ester Capsules
	USN Creatine Monohydrate	Myprotein Kre-Alkalyne	Precision Engineered High Performance Creatine Powder	CNP ProCreatine Powder
	USN Crea-x4	MaxiNutrition Creatamax Extreme	Reflex Creapure Capsules	MetRx Pure Creatine Powder
	Myprotein Creatine Monohydrate	MaxiNutrition Creatamax 300	Precision Engineered High Performance Creatine Powder Grape	Nutrition X Creatine Monohydrate
	Myprotein Creapump	Maxiraw Creatine Charge	BioSynergy Creatine Plus Strength Capsules	
Other	USN ZMA capsules	MusclePharm Z-Core PM	Novex Biotech Growth Factor-9	Supreme Sports Enhancements Humanotropin
	MET-Rx ZMA	Universal Nutrition ZMA Pro	Beverly International GH Factor	iForce Nutrition Out Cold
	JYM Alpha JYM	NOW Tribulus 1000	Applied Nutriceuticals HG4-Up	Xyience XNGF
	BPI Sports A-HD Elite	Universal Nutrition GH Stack	Betancourt Nutrition Bullnox Androrush	Healthy 'N Fit Advanced GH Enhancers
	NOW ZMA	iForce Nutrition ZMA	Applied Nutrition And Science DVS RAW	Xtreme Couture Athletic Pharmaceuticals IGF Blast
	Nutrition X Hypnos	Berocca Effervescent Tablets	Wellman Sport	Tesco Milk Thistle
	Berocca Boost	Body Volt Energize Boost	Vitabiotics Wellman Boost	Ransom Detox Juice
	Universal Nutrition Animal Stak	Controlled Labs Blue GrowtH	O.R.S Blackcurrant Flavour Soluble Tablets	Kalms Day capsules

APPENDIX TWO

INTERVIEW STRUCTURE TO ASSESS THE KNOWLEDGE OF AND ATTITUDES TOWARDS SUPPLEMENTS AMONGST PLAYER SUPPORT STAFF

Study 2: Supplement use within Rugby League: Prevalence and Understanding of Players and Support Staff

Interview Structure

Introduction
Importance and explanations about this interview (expected time, aims, interview structure and reinforce confidentiality).

Phase 1 – Background and Role within the club
Aims:
To ease into the interview with questions on the background of the interviewee to help get a better understanding of the individual, this could include questions relating to pasts employment, past history within the sport (playing or coaching and academic background. This could then lead on to how they have acquired their current position at the club and questions on the organizational structure of their team.
(Drakulevski et al 2014; Bennie & O'Connoe, 2010)
Questions

1. *Past experience?*
   (Past Playing or Coaching experiences) (Academic History) (Why choose to go into this kind of work)

2. *What is your position at the club and how did it come about?*
   (What is your position and what does it entitle) (How did your appointment come about) (Who do you work with)

Phase 2 – Knowledge and Understanding of Supplement Practices
Aim:
After getting a better idea of the background of the subject, the aim of this phase will be to move more towards their understanding of supplements and where this understanding has come from. This understanding can then be related to current research or policies related to supplement practices and knowledge. This phase will also look at how these current beliefs and attitudes towards supplements have been changes and shaped through past experiences.
This may include questions relating to their past attitudes/beliefs/opinions towards supplements (and where these came from and how they have changed), asking whether they are aware of any external organisations and their work with supplements (UKAD, UKSCA, BASES?, SENR), and finally their view on supplements in relation to their current role/team
Questions

1. *Can you explain your thoughts on supplements and the role they play in sport?*
   (Agree/disagree with them) (Are they important?) (Is your sport to dependant on them?)

2. *Can you identify where these attitudes and beliefs towards supplements have come from?*
   (Past experiences) (Influential others)(Mistakes)

3. *Would you say that your views and knowledge of supplements had been changed/shaped/influenced over time? How?*
   (Who or what has influenced you) (Have your opinions ever dramatically changed) (Looking back to the start of you career, have you changed your attitude towards them)

Phase 3 - Identify Current Supplement Practices in use at the subjects club
Aim:
After identifying current attitudes/beliefs/opinions towards supplements and how these have been shaped, this phase will move towards how they are put into practice. The aim is to look at what supplements are being used, the reasons for this choice and how those decisions are implemented. This will include exploring the working mechanisms and decision making processes within the club with regards to supplement use and to examine the nature of staff relationships and involvement in supplement practices. (Burns et al., 2004; Torres-McGehee et al 2012; Holway & Spriet, 2011)
Questions

1. *What supplements are being used at the club?*
   (Specific supplements)(Individual supplement programs for players)(Decision making process)

2. *How do you implement current supplement practices?*
   (Supplement delivery process)(Games, Training, Camps)(Who is involved in the delivery process)(Does it change throughout the year)

3. *What are the reasons behind the current supplement Practice in place?*
   (Brand of Supplement)(Reason for those specific supplements)(Who decides who is on what)(Reason for those involved to be involved)

Phase 4 – Player and Staff Education
Aim:
To look at the communication with players with regards to current supplement practices, to examine current levels of education services available to players regarding supplements (Erickson et al 2015; Maughan et al., 2007)
Questions

1. *Do you think that your players know enough about supplements?*
   (supplements they use)(risks involved)(anti-doping perspective)

2. *Do you think that your staff know enough about supplements?*
   (supplements they influence)(risks involved)(anti-doping perspective)

3. *Do you think the educational resources around supplements on offer to the athletes are good enough?*
   (*Do you inform them)(are they aware of educational recourses)(Do you encourage them to learn more)(Do you think enough is being done to educate athletes and make them aware of the potential risks)*

End of interview
Clarification and appreciation for their time and knowledge.

APPENDIX THREE

CONTENT ANALYSIS TABLE OF RAW INTERVIEW DATA

Content analysis Table 1: Knowledge and understanding of supplement practice		
Raw Data	**Higher Order Themes**	**General Dimensions**
P2: “Supplements shouldn’t replace what you are currently eating, however, due to the demands, and obviously the physical capability of both sport in general and elite sport, there is a time and place” P3: “they have certainly got their place” “certainly as a recovery aid, supplements have probably got quite a key role to play” “they have certainly got a key role in recovery, yeah definitely have a key role to play in sport, any sport” P4: “we can take supplements to get the added extras” “certain supplements we implemented this year in the winter months” “there are certain supplements that can be useful” P5:“they’re good just to make sure that your meeting those protein requirements of what you need as an athlete” “I can see and understand that it is more convenient and easier to just take a shake” “supplements can probably play a big part in sport” P7: “if there are certain things that a player can't get or struggles to get from their diet, that’s when you could maybe look at supplements to help meet those dietary requirements” “As for needing supplements to be successful, I don't think they are vital but I do think they can help if used correctly” “the marketing involved in the supplements industry has not only made it easy to access supplement but has also made it more acceptable as a part of sport at the top level” P8: “I do think that they have a role in sport, and I think it’s more to do with recovery than anything else” “I think that you can do it without them, I think it would be easier to be successful with them if I’m being honest”	The positive role of supplements in sport	The role supplements play in sport

“I think it's a lot easier to take a shake after training than eat because it's a convenience thing and obviously the research says that it get broken down quicker in your system and you start recovering quicker” P9: “I think they are good for convenience” “If people are prepared, and put in the hard work with their nutrition then no I don’t think there is a need for them, but I know that every athlete isn't perfect and they are used for convenience		
P2:“I think that supplements are exactly that, they supplement what you are currently doing, they are by no means a replacement for what you should be having, first and foremost, my views always have been and always will be whole food first.” “there is no substitute for the nutrients that you get through whole food” P3: “players need to understand is the fundamentals of movements, the fundamentals of lifting and predominantly the fundamentals of eating and nutrition and diet and learning the absolute basics of carbs and proteins and fats” “if they get those basics right, they are going to give themselves a real good chance to progress before needing the supplements” “word supplement to me means missing from your diet, so it’s something that you have to take additionally” P4: “unless you have got a solid fundamentally sound basic diet then what is the point in supplementing on top” “the first thing that you’ve got to control and make sure is right 100% is a balances diet” “unless that diet that they are consuming is 100% sound then I don’t think there is a need to go anywhere near supplements” P5: “if you are doing everything else right (meaning diet) then there’s no great need for them, and at the same time, you don’t need to worry about those little one percenters if 60% of your diet is shit anyway” “I see supplements as, not one percenters as I said but as small little add-ons as opposed to the main source of proteins and nutrients you know, lets get the macro nutrients right first before we start looking at those”	Where supplements fit into a diet	

P7: “I think that supplements are just that, I think that they should supplement a good diet” “I think it's important that people know what they can get out of the right food before looking to take supplements” P8: “you can’t mask a good diet with a supplement plan”		
P4: “on the whole, athletes take supplements when they probably shouldn’t be worrying about supplements” P5: “when you sit down with players and we do the one to ones and talk about food, its blaintently obvious that there’s bigger problems to tackle that just turning straight to supplements” “masking a bad diet with supplements” “you come to the realization that they are miles of what they need to actually be eating” “usually from about 16 plus, that they’ve just been masking a bad diet with supplements” P6: “I think there is a general consensus that an athlete is given supplements and not really told why they are given it or what exactly it is or how it can benefit them or you know the risks of taking something” “they don’t have to think” “I think there to relaxed about some of the things, you know, everything is given to them and they don’t really have to go out of their way to know anything” P7: “I wouldn't say dependant, but what I would say is that, people can become set in their ways a little bit” P8: “I don't think that you’d necessarily need supplements to be a top level athlete”	Negative views regarding supplements	
P2: “I don’t think that maybe some athletes maybe do become a little dependant on them. It’s that sort of, I can’t really be bothered cooking a meal so I’ll just have a protein shake or protein bar”	Dependency on supplements	

P3:“Yeah I definitely would say, coming through that, especially, you know, in a younger athlete, certainly, their mind set and view is that they need to be on absolutely everything to be able to catch senior players” P6: “I think they are depending on it”		
P2: “doing a sports science degree was an eye opener as to what supplement s where and how they could be used” “I am also a current ambassador for a current supplement company as well, which again, gave me another insight into what goes into the product” “I have compared that myself through trial and error, nothing study wise” P3: “if you find out that certain clubs use certain things you are always going to pay a little bit of attention to what it is but you need to know the full story” P4: “education through the John Moores under my two supervisors, who are both very well respected within their arena so yeah, definitely from an education standpoint” P5: “the biggest thing for me is when you just sit and talk to the players about their diet” P6: “I did a nutrition course that was a diploma in advanced nutritional weight management” “I mean, when I first started, I was given supplements that I didn’t, you know, why was I giving those at those certain times, so I just wanted to educate myself further” P7: “I did the 100% me course about 3 or 4 years ago now” “to be the person in charge of the distribution of supplements at the club, there is a bit of a weight, a bit of a burden that comes with that” P8: “Not really if I’m honest, for me, its just my past experience that made me realise the risk and consequences that are involved with supplements	Academic and educational background	Major influences on supplement beliefs

P9: “I’m actually a national trainer for UK anti-doping” “I do a lot of CPD events with UKAD and I guess a lot of that shapes my views supplants”		
P3: “coaches, players and conditioners over here felt that if they are taking those supplements in the NRL, that these must be the best thing to take, these are the way forward, if we do this we are going to be something like them” P4: “the big one was Lance Armstrong recently” “I think that it opened the world of doping to a whole new level” P6: “Some of the athletes from years ago, and they are redoing the tests and things, and it saying that a lot of them were taking something they shouldn’t” “Lance Armstrong and things like that” “I think, it’s so easy to do it and not be found out to be doing it” P7: “recently around the athletics scene and previously the cycling scene, that shows that there is always sort of a cloud of doubt around supplements and the legitimacy of, first of all what they are and then whether they are safe to take from a sports persons view point” “being involved in rugby league, you see certain people that get the bans and everything else and you know, a lot of it does come from the people themselves that have been misinformed, or there has been a genuine mistake that's happened” P8: “I have been banned from the sport for 2 years for one of my players testing positive” “I was a bit blasé to it all before that happened” “I certainly wasn’t at strict on the testing myself as what I needed to be”	Sporting influences	
P2: “I that that in the current day, there are so many different brands available with so many different versions of one type of supplement if you like, there is a lot available” P3: “you can easily be fooled by the adverts and the things that you see on TV that make you believe that this is going to give you all of the mass, all the power	Uncertainty towards supplements through marketing	

and all of the brutality that other athletes have got, but obviously, there is a lot more to it than that" P4: "There are 100's of companies out there that advertise themselves as, the best gram of protein per serving, let's put on lean mass. I think the marketing for these companies are very, good, they are very clever at what they do" P6: "it just seems that it's a very natural thing that every club has a supplement sponsor and they are given a certain amount of supplements each day to take" P7: "the marketing of supplements has made it a massive industry and people have, in a way, forgotten about the nutritional side of things with their diet." "supplements have grown massively in the past few years due to marketing and social media" "so many different brands of supplement out there at the moment, all with massive ranges of products, not only that but there seems to be a supplement for everything these days and they use pictures as a kind of evidence" P8: "I don't like how they are advertised, I think it creates an illusion, that if you take x supplement or if you take x drink, it will make you into an x athlete" "it's all great marketing, but the truth is, unless you've got a really good balanced diet, and unless you train hard, you aren't going to do anything just by taking supplements" P9: "I do think it is more down to marketing"		
P2: "in reality, it shouldn't be necessarily be down to the athlete" P3: "I think supplements are obviously, quite a minefield is probably my current form of thinking" "What is probably missing there is, well obviously there's a lack of education, but certainly an understanding of what supplements actually do" P4: "for the uneducated athlete they get drawn in very quickly and unfortunately this is where you see athletes becoming banned, because they are not aware of substances that might be in the product"	The lack of supplement knowledge amongst athletes	Risks relating to supplement use

P5: “you build a bit of a relationship and they open up and you come to the realization that they are miles of what they need to actually be eating, and you begin to realize that they’ve had no real education coming up as a youngster” P6: “commercial body building is everywhere, you know commercial gyms where you can get anything you want really. It’s just too easy” P7: “you can buy these things without knowing what it is really” “I don't think it's something that the players even think about until the day that the testers come in” P9: “I think, because UKAD do have that presence online, they have the clean sport apps and all of that kind of stuff, but there isn't anyone there signposting it to the athletes or the players”		
P3:“in a younger athlete, certainly, their mind set and view is that they need to be on absolutely everything to be able to catch senior players and to be as big as them” P5: “I have worked with the academy, so that’s lads around 16 to 19 years old, and one of the first questions they ask you is “what supplements should I be taking?” P6: “youngsters really, our academy, they’ve had that same one meeting, and, well they are, they could quiet easily be taking something or be interested in taking something” “that’s my avenue, that’s how I’m going to make it to first team because at the present time I’m too light or I’m not strong enough” P7: “the young lads within sport will be doing everything they can to increase their chances of becoming successful and make it at the top level, and if being bigger and stronger helps to increase those chances then you can see why they look to supplements when these adverts promise the results they need”	The risk to younger athletes	

P8: “young kids want to come in at 16 and start taking protein shakes and start taking all of bits that are added on like creatine etc., because joe blogs down at my local amateur club has told me to and he’s heard people at other super league clubs are doing it” P9: “UKAD provide a good education program and they cover a lot of athletes with that, but its not so much in the younger athletes”		

Content analysis Table 2: Identify Current Supplement Practices in use at the subjects club		
Raw Data	**Higher Order Themes**	**General Dimensions**
P2: “We are currently with [a supplement brand] (through sponsorship)” P3: “we get sponsored by a company called [a supplement brand]” P4: “[a supplement brand] its fantastic” “one of the reasons is there supporting the PHD as well so they part fund the PHD so Widnes and [a supplement brand] came into partnership at the start of this season” P5: “we’ve got a local supplement company that sponsors us and it doesn’t give us overly much” “we have never paid for supplements since iv been at the club” “we probably make a mistake really going with this local company which has resulted in us being a little bit more laid back” P6: “we are sponsored by [a supplement brand]” “they give us quiet a hefty amount of money each year on a budget sort of thing” P7: “we are with [a supplement brand], and the main reasons for that are financial, they're one of our biggest sponsors” P8: “we use [a supplement brand]” “it’s a sponsor as well” P9: ”we have a sponsorship with [a supplement brand]” “comes down to sponsorship and at the moment there are no other suppliers that will give us that amount of sponsorship, and believe me, I have tried to get that changed”	Financial benefits associated with sponsorship	Supplement brand influences
P2: “they are also a company that deals with the individual, to them you are not just another number, with them there is a very personal contact and it very personal connection in terms of the support they provide”	Long standing and successful working relationship	

“I think it was recent studies or recent testing that they did which shows that if it says that its 90% whey protein isolate then it is 90% whey protein isolate, it is exactly what it says on the tin” P3: “we’ve had that affiliation with that company for probably the last 3 or 4 years” “familiarity breeds a certain amount of respect, and reliance upon that company” “everybody has been tested whilst using that companies supplement and they haven’t failed, then you start to feel quite confident in what products that company gives you” P4: “as players are taking what I give them and nothing else in and around that then their safe, there’s not going to be any risks of contamination or doping scandals” “it’s all evidence based straight from sorts Science research, so that’s why I use [a supplement brand]” P6: “they come down and do presentations” “It’s a certain part of the site, so whatever money they give us each year, we can’t go onto another part of their website to buy anything, we can only buy the stuff off this certain section” P7: “get a really good deal with them and we have got a really good working relationship” P8: “the things that we use are all tested by informed sport and that so that was one of the big deciders”		
P2: “although it’s an area that I [Head of Strength and Conditioning] have looked at and researched and worked closely with [a supplement company] , we tend to have the overall say but I will always listen to what others think and listen to their opinions, I by no means, think that I have read ever study available whereas some of the people who I work with might bring it to my attention” P3: “we haven’t actually got a performance nutritionist at the club” “myself [Head of Strength and Conditioning], the assistant strength and conditioner, and even with the 19’s conditioner as well, we will all chip in”	Personnel involved in the decision making process	Decision making process regarding supplement practice

“there is certainly more that we would like to do, but again, it comes down to the time, and with all of the other things that we have to do as S&C coaches it’s not a priority with all of the monitoring involved in making sure that players are doing exactly what you tell them, you know, it’s a full time job on its own, it’s just very difficult” P4: “my line manager at the club is the head of strength and conditioning so a lot of the stuff that I [nutritionist] do I will present to him firs to make sure he is happy before we then roll it out” P5: “just down to me[Assistant Strength and Conditioning Coach] and the head of conditioning” P7: “it's mainly me [Head of Strength and Conditioning] but as I mentioned before, all of the staff at the club work closely together really, plus we have a student working with us from Chester university who will come in and help with the nutrition and supplement side of things” “he's a nutritionist currently studying a PhD at Chester university, he's only on a consultancy basis but he will come in and look at the information” P8: “there is me [Head of Strength and Conditioning] and there is my assistant” P9: “Its myself [nutritionist] and the S&C coach” “the head off athletic performance, but, it’s kind of a negotiation between the player, S&C and me”		
P2: “everyone across the board will have to do some sort of wellbeing” “we take a weekly weight log” “we will tend to categorise them into players who we think need to lose a bit of weight, player who we are happy with so they need to maintain and also players who may need to gain some weight” P3: “we tend to probably try and do our own research as much as we possibly can to try and find out the things that we are wanting to give the players” “look at the recommendations for the weight and mass that the actual product companies say themselves”	Factors that influence supplement practice	

“we will probably try and give most players a stack in the pre-season” “we will probably have some players that are trying to gain more mass than other players, so they might have more carbohydrates” “players who are trying to lose more weight than some players, so they might have more dietary products in there, CLA’s and those types of products” individualise but overall, 80% of the products are, all the boys are going to go through the same, hard kind of volume of training, so overall they are getting very, very similar products” “injuries which will dictate it again” P4: “players can come down the university and have a DEXA scan” “we have in house skin callipers and I am trained as an ISAK Level 1” “it’s not solely based on body composition in terms of individual body composition, it’s also based on the research out there” “heavier players, then we would reduce their carbohydrate intake in and around training so that meant those certain players that where trying to reduce a lot more body fat, they were on a different supplement to those that were trying to bulk up” P5: “speak to them on a one-to-one basis and get them to do diet diaries” “have a look at body composition, we do skinfolds quiet frequently” “that will depend on the type of role that they play within the team, their position, their age” “we do a lot more individual stuff” “get them to do diet diaries out and have a look that way and then we might say look, you might benefit from having this protein shake or maybe a casein protein before bed or something like that” P6: “We will go on, positional needs, as well as what the head coach says as well for that positional need, as well as the skin fold data” “what we do is we split the groups into three main areas, so we have a gainer, a maintainer and a loser” P7: “it's all individual hear at the club” “I will sit down with each player and have a one to one meeting to discuss what supplements they will be on and why they are on those specific supplements”		

“we use body composition through the use of skin callipers” “we also look closely at their diet as well” “we will ask the players to complete food diaries” “we have 3 main groups of who needs to gain weight, lose weight or just maintain weight” “within those groups we will have sub groups depending on what vitamins they take or any extra supplements they need” P8: “it’s all down to their individual needs and what we are looking to achieve with them physically” “We do try and educate them” “we do sit down with them” “they get handouts with information and things like that” “increase lean mass or increase bodyweight, decrease your fat mass or maintain what you’ve already got, so depending on where you sit on that will decide what you get from us supplements wise” “we don’t really differ to much from what we give people really” “it’s the carb intake that differs between players” P9: “mainly from knowing their diets because iv collected so many diet diaries” “looking at research as well”		
P2: “we [strength and conditioning staff] make them up fresh every morning” P3: “At least in the daytime we can kind of control and regulate and see that they are done but you’re not with the players 24 hours a day and you can’t police what they’re taking, you can only hope that they have taken the advice that you have given them and they follow the procedures that you’ve put on them” P4: “I’m there on sight then I will look after the boys in terms of supplements” “to discriminate between pre-season and in season, and probably the injured athlete as well” P5: “we relaxed our supplement policy really during this last year”	Preparation of supplements	Supplement delivery

“we told them that we are not going to make it up for them this year, because when we did make it up for them in previous years, you know, there was a lot of wastage” P6: “So we make it in the morning” P7: “we print that list off and it is then down to the younger players who are just breaking into the first team squad to deliver the supplements” “before training, between them they will make up everyone’s shakes, vitamins and anything else according to the list” P8: ”we do it for them” “it sound awful, but you can’t trust them, you can’t trust them to do it themselves” “there is me and there is my assistant Jamie who is just down there, we pretty much do it all” P9: “an intern does all of that for us, so he will make up and put out all of the supplements for all of the players in the morning” “they will always have breakfast provided by the club, and for 3 out of 5 training sessions they will have a meal provided by the club as well”		
P2: “in a pot which will have their name tag on, everyone will have an individual shaker which will have their name on and we will keep that here at the club, and we will distribute them every day” P3: “we will create like a little fact sheet for each player or groups of players and say this is how you take them products, this is when you take them products” “they don’t just take things randomly, everything is kind of given at a certain time” “tend to cycle some products” P4: “educating the boys that every 2 to 3 hours they need a good quality source of protein” “I have 4 hours a day with the boys, there is still 20 hours of the day left, so it is down to the boys to take accountability of their meals”	Delivery procedure	

P5: “the players are given a protein shaker at the start of the year and if they want protein after weights or after field or whatever, its there for them to use” “we ended up just saying listen, if you want that protein, it’s there for you” “but as far as, you know sitting down and making sure they drink it or whatever, we don’t do that, we can’t do that” P6: “every player has their own shaker with their name on it” “made in the morning for them and they can take it as and when they want it” P7: “as soon as training is finished its they're ready” “whether it's before training, after training or after a gym session, their supplements will be ready and waiting” P8: “ready for them when they’re finished” “every player knows why they take supplements and every player will know what each supplement is and why we want them to take it” P9: “the first team has their supplements put out for them, so during pre-season, creatine, multivits, cod liver oils and that kind of stuff, is all put out for them by the intern.		
P2: “unless we give it to you there is nothing else you need to be taking” P4: “if a player orders something that isn’t from the nutrition X range, I make sure that they can go on websites like global dro, and the LGC website where they can actually check the batch numbers” P6: “if a player came to and said look, I’m thinking of buying something, we would straight away go no, and we would then look to give them an alternative which we know is tested and that we know is safe” P8: “they know that it has to be informed sports tested, and if they do get anything that is out of our, kind of, jurisdiction, and out of my protein, then they have to run it by us first”	Self-purchase guidance/advice	Supplement risk management strategies

P9: “I’ve done workshops with all of the players around checking their supplements” “it is recommended that they buy through the club but if they don then they check it with us first”		
P3: “their all tested and all regulated” P4: “Nutrition X is now registered on the informed sport programme so that every single raw ingredient that they have, sell and produce is now tested” P5: “we make sure it’s all batch tested” P6: “we can only buy stuff from them which has been batch tested” P7: “Their tested range isn't massive but they are interested in working with us to try and improve that” P8: “its informed sport” P9: “that isn't actually a batch tested product for the public, it gets tested for the club, its great that ours gets batch tested”	Batch Testing	

Content analysis Table 3: Player and Staff Education		
Raw Data	**Higher Order Themes**	**General Dimensions**
P2: “even though that list is available online a lot of players and a lot of people in general need spoon feeding” “they know 100% what they are taking” P3: “we would always tell them and suggest to them to go on Global DRO, go on these sites and try and look for the ingredients yourself” “anything you’re not sure of, bring it back in, let the physio have a look, let myself have a look, let the doctor have a look” P4: “they have to run it through me” P5: “they’re not always seeking professional peoples advice” “There isn’t that level of education I don’t think, and there is no set education” “we have a doctor who will talk to them about the 100% me” “there’s a part of the RFL who come in and talk to the players about taking supplements and drugs” P6: “I think the players, like we’ve said, just go on what you give me, I believe or, it’s a trust thing” “there was a big chat that we did do and it was about the fact that everything we give them has been batch tested” “As for the education, it’s something that we are constantly trying to continue to build” “when we did the presentation with [a supplement company] together, we chatted about it, and we covered the fact that a supplement on the street can be made in a factory with various other supplement or with other ingredients and are at risk from cross contamination” P7: “within the club we will sit down with the players and discuss their diet and then go through what supplements they might use and the reasons for that” “it’s left to the lads really to a large extent to deal with it themselves” “one of the things we do as a club, is that the club doctor delivers a workshop on prescription drugs and we tie that in with a little bit of the anti-doping”	In-house supplement education	Player education

“30-minute slot, that in a 12-month programme isn't really a lot” P8: “they are aware of it, but, there is not much education around it if I’m honest” “a lot of the boys now follow some of the nutritional experts on twitter and things like that” “I also think that there has to be an education programme for the players to just get a realisation really of what can happen and the consequences really of one bad decision” “one of the big things from my past experiences is that the boys didn’t even know how to fill a recording form in when they had a drugs test”		
P2: “we do make them aware of the risk, but again, going back to the previous question, the could be more done externally, and saying that, there could be more done internally as well” “I know that they have done something toward the back end of last year with the academy systems” P3: “they will all have a little knowledge of the different supplements from their different clubs” “it is really important to talk to all of your players about what they are taking, the better relationship I can get with them, at least that way, whether I can control what they are taking or not” P4: “I think that the RFL does an ok job, probably not the best job” “is it down to the RFL or is it down to the clubs themselves” “I think it’s, clubs should definitely take accountability and look after their players in terms of player education maybe” “additionally I think that, an RFL board should have an interest in educating player” P5: “they might just be speaking to a big bloke at the gym who’s been on steroids for 15 years” “people come from all other clubs, you know, we get a load of new players every year from all over the place, and they’ve all got different little pieces of knowledge”	External educational support	

P6: “we have optimum come down” “(RFL talk) well we only had it once this year, and I just think that it’s not enough” “the RFL don’t want anybody to be looking in a bad way at rugby league, and they need to offer their support” “I think they should come down a couple of times a year, do the same things, do the presentations, and just reinforce the importance of not taking those supplements” “when they (the RFL) came down and did the chat, they went through the websites and how you can check yourself” P7: “As for the education programme that is rolled out buy the RFL is ok but, it's just a one off and it seems to be a bit of a box ticking exercise” “It’s sort of the same thing every year, it's almost like, once you had that 20 minutes or half an hour talk on the potential dangers around supplements then that’s it really” “the minimal 20 minutes to half an hour a year that they get on the education from another voice other than ourselves at the club is probably not adequate in my opinion” “I just don't think that the recourse out there are hi lighted enough. I mean they might be there but players might not really know how to find them.” P8: “I think, there just needs to be a bit more honesty about it all” “we don’t get experts coming in, we don’t get guys who have been in supplement companies and we don’t get guys who have been at the fore front of nutritional interventions” “We sometimes get past players who have had some involvement or potentially been banned or we just get a kind of, RFL employee who starts off with “look, I know nothing about supplements” and that loses the boys straight away” “they are going to listen to guys that have been on the cold face and know things about it and have worked or played in elite sport” “they lose a little bit of interest when a guy shows up and starts with I know nothing about drugs really I’m just going to read you this”		
P2: “the group we have are pretty inquisitive” “I don’t think that a player would bat an eyelid” P3: “you see players eyes open as to the things that they are hearing”	Perceived player attitude towards education	

“you will still have players saying “I thought you could take that” and “I didn’t know you could take that” every single year” “yeah I don’t think that they are aware of, necessarily the contamination, I think that when they see something, and that it says this on the tin, they believe that or that that is absolutely it, so it must be fine” “contamination and cross contamination is probably something that need putting out there because it’s something that’s occurring” P4: “as a professional player, in my opinion, you’ve got to take accountability for yourself” P5: “a lot of players, will take their own supplements regardless of what you tell them, they will have their own preference” “I know for a fact that there are other players that take supplements that probably aren’t batch tested or aren’t, what I would class as a safe supplement” “you talk to them and they don’t always know what it is that they’re taking” “I think if you spoke to any one of our players, they would know what you meant by batch testing, but I also think that they wouldn’t worry about it too much when taking supplements” P6: “players have all had these chats throughout every club and I think that sometimes they just switch off to it and the importance” “if you get on the case when their young, and you educate them enough, about the importance of preventing any problems surrounding this issue, they you can prevent the problem ever happening in super league” P7: “once they have left the room is not really an issue anymore really” “The only other time really, that I can think of, that players will be consciously aware of any presence or anything is when the testers turn up” “some players that will come to you and ask for certain information and do take the steps to learn more, but that's down to them” P8: “at the moment, I just don’t think there’s enough interest”		

P2: “a lot of the staff, they wouldn’t necessarily need to know much” “Could probably be educated a little further, again from external sources in terms of what can and can’t be taken and these are the processes to go through if you’re not sure” P3: “we all had to go away and do our little bits of research to make sure that we all assessed and we were able to give our opinion on supplements” P4: “I think that any member of the coaching staff would benefit, from maybe going on a, not necessarily a course but a, almost having a bible like a fact sheet” “I think everyone would benefit from it and it would be worth educating the whole coaching staff” P5: “I don’t think I’ve ever been to anything that’s been put on that’s told me, no one has ever said to me, this is how you look for supplements for players at the top level” “I’ve just picked it up myself really” “I spoke to my interns, because they’re not always directly involved in it, I think they wouldn’t know half of this stuff” P6: “I think that the more, staff wise, that know what the supplements are and why we are giving them to the players, it can them help us back, so when a player wants to ask questions then we have the support from other staff” P8: “definitely the staff as well, because I bet if you asked any kind of staff member, I bet they wouldn’t realise that they are subject to the same guidelines as their players, so they can get done for drug use”	Perceived levels of knowledge amongst support staff	Perceived level of knowledge amongst staff and potential reasons for this
P3: “this year was the first year I think, but they actually made you, every member of staff had to go through a test this year, it wasn’t just about supplements but it was about social and domestic drugs as well” “it would have been good if someone actually came in instead of actually having to go away and do their research yourself” “you can look through and trawl through whatever you want but, with an expert there, you can ask him and then explain the answers”	Staff education	

“it would be good to have somebody who came in and help to give you that advice” P5: “I think that it’s got to be something by the RFL and for them to get round to every club” “I think there needs to be a bit more control from the rugby league really” P6: “(RFL) I think they should also talk to staff” “if the RFL did all the super league clubs, I don’t think it has to necessarily be the S&C, I don’t think it has to be the nutritionist, it can be anyone who wants it” “even if it’s just for an hour or two hours and they go round to each club and they just sit with all of the staff and give them the right idea, as well as the academy staff” P7: “I just don't think that the recourse out there are hi lighted enough. I mean they might be there but players might not really know how to find them, and it's the same for the staff really” “I don't think enough is being done” “t's a case of the quickest and easiest way of ticking that box” “But having said that I don't think it’s very effective in getting the message across and as soon as its over it in the back of everyone's mind again” P8: “I think more CPD’s for coaches and S&C’s is a big one”		
P2: “they will say to them “go and ask the S&C as I’m not sure”, you know, they won’t take any risks” “They won’t put themselves in that position where they’ve had to give their advice or they have advised someone on something like that because they know that it’s not their area of expertise” P3: “you could always do more” “the whole supplements thing is almost like a little bit of a dirty topic” “I’m the guy that has to administer the products to the players, so me feeling confident that that product is 99.9% clean” P5: “I don’t really know who’s responsibility it is to inform the players”	Staff attitudes towards supplement education	

“I will never say to a player “you must take this”, you know, that’s not my job, my job it to advise them and to try and help them as best I can. But not to say “ you have to have this at this time, 5 times a day” or whatever, I don’t think that’s the right thing to do ethically” P6: “I wanted to [learn], because I’m giving something P7: “i think that on the staff side of things it’s probably an undervalued area really” “It’s just in the back of their mind and I don't think it sort of plays any prevalence in any thought process in what they do and what they need to do as part of their daily role as part of the coaching staff” “crack on and get coaching and its left for someone else to deal with” “to be the person in charge of the distribution of supplements at the club, there is a bit of a weight, a bit of a burden that comes with that” “I think that for both players and staff, it just at the back of their mind and it's not really an issue until something happens, and even then, unless it happens to someone they know or somewhere close, it’s still not really an issue” P8: “you’ve got people who split into two groups, you’ve got people who don’t care about it and are happy to bend the rules as they don’t find out, and number two, the guys who really want to know about it and want to learn and want to be the best coach that they can be so they try to learn off the S&C’s and try to read around the area as well” “I do think that there is a bit of a blaze’ about it in the game, and it needs to be eradicated” “I just think that there needs to be a little bit more, education and willing that we have to be at the forefront of things”		