

LEVEL 7 ASSESSMENT SPECIFICATION

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Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

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This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
	25	
2. Knowledge and Understanding Skills		
	25	
3. Cognitive and Intellectual Skills		
	30	
4. Practical Application Skills		
	10	
5. Transferable Skills for Life and Professional Practice		
	10	9

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		%
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Introduction

Sports and sports performance is a field that is ever evolving and growing, with more and more money and a lot of long-standing scientific research going into this field (Taks et al, 1994). The pressures of financial reward and accolades have long resulted in athletes striving to scientifically gain a physical advantage, reaching back into the 20th century, whether it be by training methods, nutrition, recovery methods and many other methods (Brotherhood, 1984; Daniels and Scardina, 1984; O'Shea, 1985; Tiidus and Shoemaker, 1995). This desire to enhance performance has brought rise to the use of ergogenic aids. Ergogenic aids can be defined as a technique or, more contentiously, substance used to enhance performance (Thein et al, 1995). The use of substances to enhance sports performance is an area of much discussion with both doping and substance/supplement efficacy both being highly controversial issues related to this area (De Hon et al, 2015; Williams, 2005). Once seen as only used by hardcore bodybuilders, consuming substances like protein powders, creatine and amino acids have become common place in the general population and in athletes (Atkinson, 2007; Maughan, 2013). Over the course of a 15-year period between 2004 and 2019, google searches have shown an upward trend in terms of supplements, showing that supplement use is reaching wider than ever before (Kaminski et al, 2020). It is easy to see why supplement use has risen to popularity, with claimed enhancement of performance and health coupled with the little effort in planning and consumption required, as well as how easily they can be accessed (Jawadi et al, 2017). Dietary supplements are used to provide one of the following four benefits: managing micronutrient deficiencies, supplying an easy form of energy and/or macronutrient, direct performance enhancement and indirect enhancement of benefit through training support. Sport-specific supplements are typically aimed to enhance performance directly and indirectly, with only supplements like caffeine, creatine, some buffering agents and nitrates having a good evidence base (Maughan et al, 2018). Despite there being strong science around some products, The International Olympic Committee (IOC) stated that there are a limited number of sport specific supplements that have efficacy as an ergogenic aid (Lopez-Samanes et al, 2022).

Efficacy

As previously stated, the use of supplements as ergogenic aids in all sports is extremely prominent, none more so than in rugby union (Bradley et al, 2015). However, several of the

supplements that sporting individuals consume lack scientific evidence relating to their efficacy in improving physical activity, with some of the claims potentially unsubstantiated (Porrini and Del Bo, 2016). Many experts state that optimising an athlete's diet should be the number one priority, but more and more research is showing that there is a place for dietary supplement consumption in athletes, when the substance has scientific evidence (Garthe and Ramsbottom, 2020). Garthe and Maughan (2018), stated that in some instances 100% of athletes will be taking supplements, depending on the sport and the level of competition. The issue with such high supplementation is that it may not always yield a benefit and will carry risks such as contamination causing doping violations, health risks and serious adverse effects. Patterns and behaviours around supplementation are relatively unknown, with little investigation gone into this area. Protein powders and multivitamins are the most popular supplements, however, outside of these little is known about supplement behaviours and whether athletes are using supplements with efficacy due to sports nutritionists rarely being the main source of information, even at an elite level (Baltzar-Martins et al, 2019). Due to coaches, family and friends/teammates being the primary source of information, as well as supplements primarily bought online, Baltzar-Martins et al (2019) stated the critical need for more research in this area to avoid the use of "black market products" and products that lack efficacy. With the supplement industry worth an estimated 104 billion US dollars in 2013, growing year on year, it is easy to understand why the industry wants to develop more and more products to keep this upward trajectory in sales, whether there is strong science or not (Knapik et al, 2016).

The quality and quantity of sources that are influencing an individual's decision making as to what supplements to use is a major issue, with a lot of potential sources spreading misinformation. The fitness industry is now a highly lucrative one, with gyms, health-food stores, fitness magazines and websites all heavily profiting from people buying their supplements, effective or not (Sheeshka et al, 2012). A study by Blendon et al (2013), stated that individuals' perceptions often drive their supplement use, rather than scientifically proven efficacy. This results in individuals' behaviour being hard to change despite the presence of scientific studies clearly illustrating a lack of effectiveness in certain supplements. Sports nutritionists/dieticians have been found to be underutilised, with only 30% of athletes using them as a source of information in some cases. Outside of sports nutritionists/dieticians, the internet, coaches and friend/family as primary sources of

supplement information and have been found to have more influence than nutritionists/dietitians (Denham, 2017; Malinauskas et al, 2007; Nieper, 2005).

Barriers to Recommendations

Though this study was conducted in males, there is a call for research in females in a sporting context. Despite making up almost half of sports participants, female specific recommendations around health, performance and supplementation are lacking (Holtzman and Ackerman, 2021). It may be hard to make recommendations in terms of taking supplements in conjunction with others, due to the potential for some supplements potentially doing the same job, or others cancelling each other out. On the other hand, some supplements may complement each other. Naderi et al (2016) stated that co-ingestion of supplements is common practice. An example of effective co-ingestion is in sodium bicarbonate and creatine, which has been found to give superior mean power output in testing as compared to creatine or sodium bicarbonate alone (Sarshin et al, 2021). The co-ingestion of creatine and beta-alanine has also been found to have added benefits to endurance performance than supplementing creatine or beta-alanine alone (Zoeller et al, 2007). Conversely, Vandenberghe et al (1996) there is evidence that caffeine may blunt the ergogenic effect of creatine supplementation. It would be highly beneficial for further research to explore how supplements interact with each other, potentially enhancing or blunting the effects of co-ingested substances.

Study Considerations

This study will focus on supplements outside of macronutrients, with the view to giving more guidance for the use of supplements that are directly performance enhancing, ones that claim to have benefits that may be too good to be true or ones that provide a benefit that you are unable/unlikely to get from diet alone.

Whey protein has long been a supplement that has been used to aid gains in lean muscle and muscle recovery (Volek et al, 2013). It is unlikely that the population in this study will not be using whey protein shakes, or at least know the benefits of whey protein. Carbohydrate supplementation in the form of carbohydrate drinks have also long been used to enhance sporting performance, by delaying fatigue and reducing perceived exertion (Davis et al, 1997). The popularity of carbohydrate-based sports drinks is still as big as ever, initially rising to prominence in the 1960s (Galaz, 2019). Again, it is unlikely that the population in

this study isn't aware of the efficacy around sports drinks and isn't already using them to their benefit.

The literature suggests that supplement varies greatly between sports, increases with level of competition and age, is higher in men and is strongly influenced by the social norms (Garthe and Ramsbottom, 2020). People's motives for supplement use can usually be divided into two categories; those who supplement for health reasons, with performance improvements coming secondary, or those who supplement to improve and maximise performance (Garthe and Maughan, 2018). Performance and overall health are two things that go hand in hand and a vital part of aiding that is optimal nutrition (Holtzman and Ackerman, 2021). In general, healthier athletes that have better sleep routines, diets and hydration perform better on recovery biomarkers, with Van Rosen et al (2017) stating that both sleep and diet quality directly affect injury incidence (Lee et al, 2017). This study will assess whether the prominence of individuals using supplements to aid health and sleep, short-term performance, long-term performance and recovery and body image/body composition.

Outside of pure performance, there are also several other pressures on athletes which result in supplement/substance use. The pressures on athletes to be lean and muscular, both from a performance and an aesthetic point of view, are now greater than ever. This is another factor that has resulted in athletes, especially young athletes, consuming more and more supplements, with purported claims to have beneficial effects on performance and body composition (Sheeshka et al, 2012). Male rugby players have also been found to consume a lot more sport specific supplements, with 77% of males compared with 49% of female rugby players consuming sport specific supplements (Lopez-Samanes et al, 2022). Supplement use is generally more prominent in male athletes, with young male athletes in particular taking supplements with the intention of improving performance rather than health (Schofield and Unruh, 2006; Petroczi et al, 2008). Athletes who are more open to supplement use and that are using more supplements have been shown to be more likely to dope. Through the "gateway" theory, there is data to support the theory that those who are more open to performance enhancing substances that do not violate doping rules are more open to substances that do breach doping rules (Garthe and Maughan, 2018). Attitudes towards supplements that are batch-tested will be discussed in this study and attitudes around doping control will be assessed in this study.

Kreider et al (2010) demonstrated an effective way to categorise sport supplements. The following categories are an effective way to be able to make recommendations in the conclusion around supplement use:

Apparently Effective- Supplements where most of the research is effective and safe in relevant populations.

Possibly Effective- Supplements where there is theoretical rationale however, there is need for more performance specific studies.

Too Early to Tell- Supplements that have logical theory but has not been reinforced by scientific study.

Apparently Ineffective- Supplements that do not have clear scientific rationale and/or have been shown to be ineffective.

Doping

Doping has long been a problem in all sports, with the sporting world plagued by state backed doping programmes in East Germany, state backed doping programmes in Russia and sophisticated doping practices by the US Postal Service Team in the Tour De France to name but a few high-profile cases since the 1970s (Noland, 2016; Bell et al, 2016). In recent times, rugby union in the UK has become a hotbed for doping, with 49 rugby players breaching anti-doping rules between 2009 and 2015. A disproportionate amount of these breaches was in Wales, with 12 cases coming from the Welsh Premiership and Championship alone (Whitaker and Backhouse, 2017). Doping in Welsh rugby at a sub-elite level is quoted as being ‘off the scale’. According to data from UK anti-doping data (UKAD) in 2020, out of the 61 reported active sanctions, 26 were from rugby union, with 10% of all sanctioned athletes coming from sub-elite rugby union in Wales (Cox et al, 2022). Cox et al (2022) highlighted three main issues with doping in Wales: perceived lack of testing doping test frequency, perceived lack of testing efficacy and coaches pre-warning athletes about doping controls. Outside of testing and intentional doping, athletes are encouraged to use products that are subject to third party testing for quality assurance, such as Informed Sport, which reduces the risk of the ingestion of banned substances via supplement consumption (Garthe and Ramsbottom, 2020). Third party testing is necessary due to supplements having very

little regulation, with many supplements found to be contaminated with various substances that would result in a doping violation, including anabolic steroids (Kaminski et al, 2020; Maughan, 2005).

Another potential issue with the use of supplements is doping violations. The World Anti-doping Agency (WADA) has strict rules and regulations around doping that countries' governing bodies must adhere to in most high-profile sports (Garthe and Ramsbottom, 2020). These rules and regulations become a problem as supplements have relatively little regulation (Kaminski et al, 2020). Many supplements have been found to have various contaminants, including anabolic steroids which, if found in an athlete's sample, will result in a failed drugs test (Maughan, 2005). Though the risk can never be completely eliminated, many supplement companies use third-party testing, for example Informed Sport, to batch test their supplements for contamination (Garthe and Ramsbottom, 2020). All athletes that participate in sports that adhere to WADA testing procedures should only use supplements tested by a third party, normally Informed Sport. This study will assess the perceived knowledge of anti-doping procedures, as the athletes in this study will play rugby union in the Welsh Premiership which comes under the testing of UK Anti-doping (UKAD). One of the main objectives stated in the WRU anti-doping policy is to "ensure all players and support personnel" are able comply with anti-doping responsibilities at all levels of the Welsh game (WRU Anti-doping Strategy, 2019-2022).

Characteristics of Rugby Union

Rugby union is a sport that is based around strength, power and high intensity bouts of anaerobic exercise, involving bouts of physical contact, interspersed with periods of low intensity (Roberts et al, 2008; Posthumus et al, 2021). However, within the game there can be a large variation in terms of body shape and physical demand, with forwards generally being taller, heavier, more muscular and are stronger and more powerful, whereas backs tend to be faster, cover more metres, have more high-speed running and tend to see fewer physical contacts (Duthie et al, 2003). These differences in play style and body shape could result in the players choosing different supplements for different desired effects. Overall, rugby players need to be extremely well-balanced athletes, with athletes needing to balance being as fit, fast, strong, powerful and agile as possible (Darrall-Jones et al, 2015). Compared with other sports, professionalism in rugby is somewhat in its infancy but, due to the physical nature of the sport, there has been a lot of research in rugby in terms of sport science, since

the game turned professional in 1995 (Duthie et al, 2003). This has resulted in rugby players continuously getting bigger, stronger and more powerful. Due to the collision-heavy nature of rugby as a game, achieving the highest momentum possible is extremely important. Relative to the laws of momentum ($\text{mass} \times \text{velocity}$), it is desirable to try and increase both body mass and velocity to achieve a greater momentum and thus players have become bigger (Barr et al, 2014). Sancho-Oliver et al (2020) stated that dietary supplement consumption is as high as 65.3% in rugby union players. It is reasonable to hypothesise that the high number of athletes consuming dietary supplements could be in the pursuit of attempting to increase both velocity and, in particular, mass to achieve a greater momentum throughout rugby matches. The balance between mass and velocity is likely to drive the desire for optimal body composition and gain of muscle rather than just overall body mass. This is consistent with Darrall-Jones et al (2015) and Barr et al (2014), who both stated optimal body composition as a key factor in rugby union players.

Nutrition overall plays a pivotal role in the optimisation of body composition (Roberts et al, 2020). Supplements that promote gain in lean muscle will likely be one of the most desired outcomes from supplementation. As rugby is such a multiskilled sports, it will be imperative that rugby players balance gains in body composition and improved training with matchday performance (Posthumus et al, 2021). It will be interesting to assess how this balance affects supplementation, whether there will be more of a focus on match-day nutrition or more training and body composition enhancing substances. There will also be a possible difference in supplementation when it comes to the position the individual players. Generally, players are getting bigger and faster, but there is a big difference within the game between backs and forwards, and even more so between positions like prop and half backs. Due to forwards being involved in 68% of all contacts, as well as the bigger collisions, they generally carry more body and muscle mass to be able to cope and dominate the collisions (Lombard et al, 2015). Differently to the forwards, backs have a different play style, where they tend run further, produce more accelerations, perform more sprints and have more high-speed metres (Cunningham et al, 2016). This may result in backs using supplements that enable faster speeds, greater running capacity and delayed fatigue, whereas forwards may try and achieve greater muscle mass and strength through their supplementation (Zemski et al, 2015). Beltz and Doering (1993) attempted a comprehensive review into the efficacy of nutritional supplements as ergogenic aids. The study stated that overall, supplement as a whole lack's efficacy, with them being more likely to contribute more to doping violations than any

potential benefit gained. They also stated that the supplement industry is heavily driven by magazines, health food shops and coaches. Though this is still generally the case with some substances, the opinion that there is little to no efficacy around supplementation is outdated with several supplements shown to have efficacy, many of which will be discussed later in this study. An example of how outdated this study is, is that the supplementation and over-consumption of protein is detrimental to health and that athletes should only consume slightly higher amounts of protein than sedentary people. These claims have since been debunked by Longland et al (2016), with Hector and Phillips (2018) suggesting an intake as high as 2.4g per kg of bodyweight in periods of caloric restriction in athletes. The view of Beltz and Doering (1993) that consuming a balanced diet alone is long outdated and practitioners should strive to make sport-specific recommendations to athletes in terms of their nutrition. Practitioners should also explore the possibility of supplement use in their athletes for potential health and performance benefits, with many of the attitudes that chastise supplement use becoming more and more outdated. This study will attempt to review the current literature to find supplements with strong efficacy or that have promising scientific literature, as a guide for athletes, particularly rugby players. The study will also review supplements that semi-professional seem to be using and assess whether their use is substantiated or whether many of the supplements are a waste of money.

Literature Review

Caffeine

Supplements are now seen as an imperative part of gaining an edge on physical performance. Supplements are generally categorised into supplements that are focused on health outcomes and those that are focused on performance outcomes (Baltzar-Martins et al, 2019). A substance that is supplemented as an ergogenic aid is caffeine. Caffeine has been shown to enhance aerobic and anaerobic, as well as improved peak power output, overall power output and weight lifted (Mielgo-Ayuso et al, 2019a). Caffeine consumption is extremely widespread, with around 80% of the world ingesting caffeine daily, predominantly through coffee (2.25 billion cups world-wide per day) as well as sources like supplements, dark chocolate and caffeinated drinks (Pickering and Kiely, 2019a). Caffeine has recently risen to prominence in the sporting world but caffeine has been a relatively controversial supplement, largely due to it being on the banned list from 1984 to 2004. (Diel, 2020). It is easy to see

why athletes use caffeine as Mielgo-Ayuso et al (2019a), Wilk et al (2019) and Pickering and Kiely (2019a) all stated there is conclusive evidence that it enhanced sporting performance. However, like with any supplement there are some studies that question efficacy, with Paton et al (2001) finding little to no effect on repeat sprint-ability. More recent studies, including a meta-analysis of 34 studies by Salinero et al (2019), have shown conclusive evidence that caffeine enhances single effort power output, repeated effort power output, single sprint velocity, repeated sprint velocity, reduced agility test times, increased in-game running distance, in-game sprint and in-game sprint velocity, making it one of the most effective and versatile supplements available.

The main mechanism that boosts performance is the effect caffeine has on the central nervous system (CNS) but several mechanisms have been proposed as responsible for further performance enhancement (Pickering and Kiely, 2019a; Guest et al, 2021). Caffeine's effect on the CNS is due to caffeine being an adenosine antagonist, binding to the adenosine receptors and thus limiting its fatiguing effect (Wilk et al, 2019). This is consistent with caffeine reducing fatigue index as well as decrease perceived exertion in studies (Mielgo-Aysuo et al, 2019a; Mielgo-Ayuso et al, 2019b). Though evidence is strong around the efficacy of caffeine, there are some issues with its use as an ergogenic aid. de Souza et al (2022) found a number of side effects including negative effects on sleep, increased urination and heart palpitations. Other side effects include jitters/anxiety and increased muscle damage due to higher workloads (Guest et al, 2021; Mielgo-Ayuso et al, 2019b). Therefore, caution should be exercised when supplement caffeine. Guest et al (2021) outlined several of these issues, including the negative effect caffeine had on sleep onset and duration in elite rugby players that supplemented with caffeine in an evening game. Sleep is widely accepted as one of, if not the most important in terms of recovery negatively effecting this process through caffeine ingestion close to sleep, especially on a regular basis, could mitigate any performance enhancement gained by caffeine supplementation (Vitale et al, 2019). Guest et al (2021), also stated that jitters and anxiety would have a negative effect on sports that have a skill element to them, though it can also enhance cognitive performance on this such as reaction times. The Increased muscle damage post caffeinated training is thought to be because of workload, meaning it may also be beneficial to only ingest caffeine before important, high-volume sessions or pre-competition (Mielgo-Ayuso et al, 2019b).

Another consideration in terms of caffeine would be the effects of habitual consumption. Pickering and Kiely (2019) suggested that it may be beneficial to withdraw from caffeine pre-competition, with habitual consumption blunting the ergogenic effects. However, Clarke and Richardson (2020), the ISSN, de Salles Painelli et al (2021) and Carvalho et al (2022) all stated that habitual caffeine consumption will not affect the ergogenic effect of caffeine, though it may take more caffeine to get the same effect. This study also recommended a pragmatic approach to caffeine supplementation, which is consistent with the information discussed above. Caffeine consumption is safe amongst healthy adults, with a dosage 3mg per kilogram, per day (mg/kg/d) a safe amount for habituation (Temple et al 2017; Pickering and Kiely 2019a). Pickering and Kiely (2019b) stated that the dosage for ergogenic benefit is an acute dose of 3-6mg/kg/d for most people, though some studies have used higher doses as the effects of caffeine are individualised. Higher doses of 9-11mg/kg/d have been experimented with but have been shown to have minimal positive effect or even have a detrimental effect upon performance, again with effects being highly individualised (Wilk et al, 2019). A relatively low dose, the amount of caffeine found in 1 to 2 cups of coffee, is enough to produce a similar stimulus to higher doses (Grgic et al, 2019). This reiterates the previous point that caffeine is an effective ergogenic aid but should be used with caution in terms of dosage.

Creatine

Creatine is another supplement that is widely used in a variety of sports and has long held efficacy. Discovered in 1892, the study of creatine and its benefits as an ergogenic aid is well established (Balsom et al, 1994). Kreider (2003) found that that over 70% of the 300 studies they assessed showed statistically significant increases to athletic performance after creatine supplementation, with none finding any drawbacks. A naturally occurring substance, creatine is similar to an amino-acid and is generally consumed most commonly through the consumption of seafood and red meat (Jagim and Kerksick, 2021; Hall and Trojian, 2013). The reason for creatine's use as a nutritional supplement is its vital role in skeletal muscle metabolism (Balsom et al, 1994; Kreider, 2003). Creatine supplementation increases intracellular creatine concentrations which has been shown to increase muscle strength, endurance, high intensity exercise performance, recovery, thermoregulation, heavy training tolerance and even concussion (Kreider et al, 2017). These characteristics make it an ideal supplement for team sports, particularly rugby, and its use is said to be widespread in the sport (Chillibeck et al, 2007). The ISSN even described creatine as the best ergogenic

nutritional supplement available (Kreider et al, 2017). Creatine has been a relatively controversial substance, with some sports media sources and scientific communities stating that creatine can cause liver and kidney problems, muscle cramping, muscle fibre rupture and gastrointestinal discomfort. These claims have been said to be propaganda, spread through several anecdotal accounts, poorly designed questionnaires and misinformation published on the internet (Kreider et al, 2017). Kim et al (2011) concluded that creatine is safe to consume in healthy individuals. This has received further backing by the ISSN, who deemed creatine does not have a detrimental effect on factors such as kidney health and that it is safe to consume and may even have therapeutic benefits (Davani-Davari et al, 2018; Kreider et al, 2017).

Method of supplementation with creatine varies, with several studies recommending different dosages to increase intracellular creatine content. Bemben and Lamont (2005) used a loading phase to saturate intracellular creatine, initially consuming 20g each day for the first 5 to 7 days, followed by a maintenance phase of 3-5g per day for up to a 6-month period. This dosage was reiterated by Wax et al (2021) who suggested the exact same method. Hall and Troijan (2013) and Pluim et al (2006) both suggested a slightly different approach, with a loading phase of 0.3g/kg/d for 5-7 days and then a 0.03g/kg/d maintenance phase. This may be more appropriate as it will ensure larger, more muscular athletes in sports such as rugby union will have a big enough dose. Though Pearson et al (1999), Lamontagne-Lacasse et al (2011) and Ramierz-Campillo et al (2016) also agreed with an initial 20g per day loading phase, the studies offered an alternative method of a straight 5g per day, stating that it also showed a significant improvement to physical performance. Despite the ISSN deeming creatine safe to consume, smaller dosages may be beneficial as some studies have suggested that loading dosages can affect kidney function and cause gastrointestinal discomfort (Andres et al, 2017; Hall and Troijan 2013). Though creatine has long been seen as a potent performance enhancing supplement, recent research has shown that it may have several other benefits. Creatine has been found to have beneficial effects on the brain. Creatine can be used to attenuate the effect of sleep deprivation, allowing elite athletes to better perform repeated skills in times of sleep deprivation such as when jetlagged and events that span multiple days (Cook et al, 2011). Gill et al (2013), Glaister and Rhodes (2022) and Antonio and Ciccone (2013) all conducted rugby specific studies into creatine supplementation. Gill et al (2013) found that creatine consumption improved repeat sprint ability, which may carry over into rugby due to the nature of the sport. This was further confirmed by Glaister and Rhodes

(2022) who found an improved performance for repeated sprints. Antonio and Ciccone (2013) found an improvement in strength, power and fat-free mass. These findings potentially make creatine one of the most potent ergogenic aids available for rugby players, with repeat sprint ability, strength, power and fat-free mass all contributing to vital aspects of the game (Posthumus et al, 2021).

Buffering Agents

As previously stated, the supplement industry is now a very big industry that is still growing (Knapik et al, 2016). This has brought rise to several new supplements on the market, with some potentially lacking efficacy but others have shown promise. One such supplement is beta-alanine, a non-proteogenic amino acid that converts to carnosine in the body and may have performance and health benefits (Varanoske et al, 2019). Trexler et al, (2015) stated that the International Society of Sports Nutrition (ISSN) conducted an extensive review of the available literature. They found that four weeks of consuming a daily dose of 4-6g significantly increased muscle carnosine concentrations, and thus acted as an intracellular pH buffer. Consequently, exercise performance was improved, particularly in bouts of exercise that last 1 to 4 minutes. The ISSN also stated that beta-alanine is safe to consume in healthy individuals at this dosage, though it can cause a tingling sensation which is usually mitigated by spreading consumption over the course of the day. Perim et al (2019) suggested a dosage of 0.8-1.6g at a time, spread over 3 to 4 hours. Evidence around the efficacy of beta-alanine is becoming more substantial with the findings of Varanoske et al (2019) also consistent with the findings of the ISSN, that bouts of exercise lasting 1-4 minutes were increased. Beta-alanine's ability to improve bouts of exercise lasting 1-4 minutes could hold some promise for rugby union players, though the findings of Smith et al (2019) found beta-alanine to have no effect on body composition, muscular endurance and intermittent sprint performance in rugby players. Kelly et al (2017) stated that though some rugby players would benefit from the buffering effect of beta-alanine, a well-constructed sprint intervals programme is far more beneficial to performance.

Substances that can raise pH in the body have been extensively researched to assess their potential for supplementation in sports. The rationale behind this research is that substances could buffer the effects of metabolic acidosis which is a key factor in fatigue during anaerobic exercise. Beta-alanine is a supplement that comes under this category. Another such substance is sodium bicarbonate, which has become a far more popularised in the past

10-15 years but was featured in literature as far back as the 1930s (Peart et al, 2012). More commonly known as baking soda or bicarbonate of soda, is a substance that is most commonly used in cooking or baking and plays a vital role in biological and chemical processes (Casey, 2006; Cheng et al, 2020; Madeswaran and Jayachandran, 2018). The mechanism responsible for the performance enhancing effect is its ability to buffer hydrogen ions (H^+ is acidic) in the blood and thus limits intracellular acidity which contributes to muscle fatigue (Burke, 2013).

Despite some very promising literature towards the performance enhancing qualities of sodium bicarbonate, its use has been somewhat limited in practice. A high proportion of athletes reported gastrointestinal discomfort when ingested close to competition. As per Burke (2013), a loading phase over several days of sodium bicarbonate may be a savvy way to consume it for performance purposes as well as trialling its use in high-intensity training sessions over several weeks (Burke and Pyne, 2007). Sodium bicarbonate supplementation has been said to be effective for sports with high rates of anaerobic glycolysis and may be useful in sports that are intermittent in nature or that have sustained periods of high-intensity efforts (Burke, 2013). Miller et al (2016) found that an acute dosage 0.3g per kg of bodyweight resulted in an improved total workload during a repeat sprint protocol, and thus, improves repeat sprint ability. For these reasons, it would make it an appropriate supplement to try and implement and use in rugby players, particularly in games.

Sodium bicarbonate is a supplement that needs a lot more research. Strategies to ensure that gastrointestinal discomfort is limited, which sports would most benefit from its supplementation, if chronic supplementation is beneficial and whether use during training sessions will increase intensity and thus improve long term performance (Burke, 2013). Both Fitzpatrick (2012) and Cameron et al (2010) both found that an acute dose of sodium bicarbonate did not improve rugby specific performance, despite having the desired effect of attenuating the drop in blood pH. Both suggested that gastrointestinal discomfort may be negating any positive effect that sodium bicarbonate may have on performance. This reinforces the need for further research in this area, particularly around dosage and the optimal way to load. In terms of dosage, 0.3g per kg of body weight seems to be the amount that is most commonly used but as previously stated, may cause gastrointestinal discomfort (Siegler et al, 2016; Miller et al, 2016; Cameron et al, 2010; Burke 2013). Durkalec-Michalski et al (2018) found that a dosage of 0.1g per kg of bodyweight for 10 days pre-

testing did not cause any gastrointestinal discomfort but had very little effect on performance, with only time to peak power under fatigue showing any improvement. A dosage of 0.1g per kg of bodyweight is likely to be a good starting point for any future study as it has been shown not to cause any gastrointestinal discomfort. From there, studies may be able to find a sweet spot where the performance enhancement from the buffering effect is present but there is limited gastrointestinal discomfort. Miranda et al (2022) also stated that sodium bicarbonate seems to have ergogenic effect through buffering, but that further research into chronic consumption needs further study.

Nitrates

One of the most promising supplements on the market, with promising scientific literature is dietary nitrate. Nitrate supplementation has risen to prominence over the past 10 to 15 years (Baranauskas et al, 2020). Nitrate is generally consumed naturally in the diet, with the best sources of dietary nitrate being lettuce, celery, beetroot and spinach (Thomson et al, 2007). Nitrates have been a source of much debate, with World Health Organisation (WHO) setting an upper limit for its consumption in 1962. This was largely down to it being associated with methemoglobinemia in infants in the 1950s and has since been associated with a higher risk of developing gastrointestinal cancer. Both these associations have since been largely debunked, with its association methemoglobinemia being down to poor scientific studies where other contaminants were present, as well as the cancer association being from animal studies, but no association has been found in human trials (Katan, 2009). Hord et al (2009) also added that the benefits from the consumption of foods with naturally occurring nitrates far outweighs any potential risk.

In a sporting context, nitrate supplementation is usually done by drinking concentrated beetroot juice, particularly using Beet-It-Pro Elite Shot, James White Drinks Ltd., Ipswich (Lopez-Samanes et al, 2022). Nitrate supplementation has been shown to improve endurance exercise performance by improving the body's ability to use oxygen, and thus, increase muscle efficiency. It has also been shown to improve muscle power and exercise performance due to it enhancing skeletal muscle contractile function (Jones et al, 2018). Dietary nitrates benefits have been described as improving endurance events involving large muscle groups combined with the improvement of maximal force production as quickly as possible (Baranauskas et al, 2020). This description fits perfectly alongside Darrall-Jones et al (2015)

description of rugby union as a game for all-round athletes, with a good base of aerobic and anaerobic fitness combined with strength, power and speed.

Lopez-Samanes et al (2022) found that ingestion of beetroot juice (12.8mmol dosage of nitrate) showed little improvement in 10m and 30m speed and endurance performance (Bronco Fitness Test) in female rugby players. However, this study did find a significant improvement in counter movement jump performance and stated that menstrual cycles and dosage may have affected results. The dosage was only one 12.8mmol dosage of Beet-It-Pro Elite Shot 2.5 hours before testing. The study also suggested that there is a need for research into game-specific effects of nitrate in-game rather than hypothesising gains in performance from non-game specific tests.

Thompson et al (2015) found that ingesting beetroot juice at a dosage of 12.8mmol resulted in improved repeated sprint performance and attenuated the decline in cognitive function, particularly reaction time, that can occur during long periods of intermittent exercise. This suggests that it would be an ideal supplement to enhance performance in a game of rugby and may be more suited to intermittent exercise rather than continuous bouts of exercise like the Bronco Test. The main difference in this study when compared to Lopez-Samanes et al (2022) was a prolonged consumption of a dose per day for 7-days. This suggests that continuous consumption or a pre-competition loading of dietary nitrate would have performance improving effects rather than an acute dosage pre-competition.

Vitamin D

Vitamin D is a substance that plays a vital role in supporting bone health and immune system functionality. More recent discoveries suggest that due to a vitamin D receptor in skeletal muscle, athletes could gain potential benefits to muscle function and muscle protein synthesis with vitamin D supplementation (Morton et al, 2012). Vitamin D status is a relatively underutilised tool in the health of all populations, with insufficiency and deficiency said to be a worldwide epidemic (Larson-Meyer & Willis, 2010; Holick & Chen, 2008). Though Vitamin D can be consumed through foods like mushrooms, cheese, yoghurt, eggs, dark chocolate and fortified cereals, it is unlikely that individuals will get the appropriate amount of vitamin D through diet alone. The primary source of vitamin D is through the skin's exposure to ultra-violet rays (UV), primarily through sunlight (Benedik, 2021; Black et al, 2012). This dependence on skin exposure to sunlight is a significant problem in vitamin D

status, particularly in the UK where 50% of population have insufficient vitamin D levels, with 16% of the population classed as severely deficient in winter and spring months. Factors (other than season) that should be considered when assessing potential vitamin D deficiencies are: location even within the UK status is worse as we travel further north; and skin colour, with darker skin pigments not as efficient in synthesising 25-OHD from sunlight (Larson-Meyer and Willis, 2010; Pearce and Cheetham, 2010). Status is assessed by testing the amount of 25-OHD in the bloodstream, with a concentration of 30-70ng/ml found to have health benefits (Pearce and Cheetham, 2010; Pludowski et al, 2018; Cannell and Hollis, 2008). However, these levels are unlikely to be achieved through sunlight and diet alone, leading to Pludowski et al (2018), Cannell and Hollis (2008) and Cannell et al (2008) all suggesting supplementation as a solution to deficiency rather than artificial UV due to its potential skin cancer risk. Supplementation of vitamin D₃ has been found to have far more beneficial effects on blood 25-OHD status rather than vitamin D₂ and should be the chosen supplement. Holick and Chen (2008) suggested a dose of 20-25µg/day to reach a blood level of 30ng/ml, though this may be quite conservative, especially in scenarios with extremely little UV exposure. Pludowski et al (2018) suggested an upper limit of 100µg/day to avoid hypercalcemia and hypercalciuria and avoid toxicity that occurs at 200ng/ml of 25-OHD in the blood (Vieth, 1999).

Though it is likely that vitamin D₃ supplementation would be beneficial for all populations, identifying particular risk factors will be imperative. One consideration that is likely to vary sport specific is that obese individuals have been reported to have poor vitamin D status due to hampered bioavailability due to vitamin D being deposited in their fat mass (Wortsman et al, 2000). Though Body Mass Index (BMI) is a poor determinant of whether a rugby player is obese, Cunningham et al (2016) shows that vitamin D status should definitely be a consideration in rugby, primarily in front rowers, due to their body composition (Hind et al, 2015). Vitamin D levels in sports is likely to be highly dependent on factors such as outdoor training in sunlight, skin pigmentation and geographic location (Larson-Meyer and Willis, 2010). Though unlikely to be a major factor in semi-professional rugby, rugby being professional is likely to mean several players will be living in countries that do not suit their skin pigmentation, and thus, it will be imperative that supplementation of vitamin D₃ is recommended to these athletes (Libon et al, 2013). Though rugby is predominantly an outdoor sport, Aydın et al (2019) reported a high prevalence of vitamin D deficiencies in both

indoor and outdoor athletes, though indoor athletes returned much higher deficiency with over 90% of dancers and basketball players seen as deficient.

In athletes, it is vital that Vitamin D is optimal primarily to ensure that the athletes are healthy. Vitamin D is key to several health factors but ones that are appropriate for athletes are its role in innate and adaptive immunity and bone health (Bikle, 2009; Holick and Chen, 2008). Athletes avoiding potential bone fractures as well as avoiding illness will be imperative to ensure they are able to train, compete and recovery efficiently. This has become of particular interest in recent years due to the COVID-19 pandemic, with vitamin D shown to significantly reduce infection in humans (Meltzer et al, 2020).

Cannell et al (2009), reported that optimal vitamin D status, in a general sense, is performance enhancing. More recent studies suggest that optimal vitamin D status may improve maximal oxygen consumption, improve muscle strength and, as stated above, play a vital role in muscle protein synthesis (Moran et al, 2013). Fairbairn et al (2018) found that vitamin D supplementation had very little performance enhancement in rugby union players, with only pull-up performance having significant improvement. Despite the lack of performance enhancement, athletes were already at a sufficient vitamin D status, and thus, strong performance enhancement is likely to happen in those who insufficient or deficient. Though there has been call for more investigation into whether vitamin D has performance enhancing qualities, it is likely that the main benefits from athletes ensuring they have sufficient vitamin D is its vital role in bone health, muscle growth, immune function/infection prevention and its inflammatory modulation (de la Puente Yagüe et al, 2020).

As many as 62% of athletes based in the UK have been found to be vitamin D deficient in the winter. A supplementation of 125µg per day of vitamin D₃ has been shown to be performance enhancing, showing significant improvements in vertical jump height, 10m sprint times and showed evidence of improving bench press and back squat 1 rep max (Close et al, 2013). Todd et al (2015) concurred with this hypothesis, stating that vitamin D deficiencies and insufficiencies are performance limiting rather than it being performance enhancing.

Testosterone Boosters

Testosterone is seen as a vital, if not the most vital hormone in sporting performance due to its anabolic nature. Higher levels of testosterone results in increased lean body mass, reduced levels of body fat, increased strength and power, superior cardiovascular and respiratory function and an increased all-round physical capacity (Hilton and Lundberg, 2021). This clear sporting advantage brought rise to scientists trying to increase the anabolic status of the body,

which resulted in the widespread use of anabolic steroids and testosterone supplementation as early as the 1950s. This resulted in several athletes from the Soviet Union and East Germany using such substances to gain an unfair advantage, and thus, the International Olympic Committee banned all anabolic agents by the latter half of the 1970s (Kicman and Gower, 2003). In more modern times, science is still trying to get the benefits from elevated levels of testosterone or hormone optimisation but from a more natural way, that does not violate doping regulations. This has resulted in the exploration of several different substances called “testosterone boosters” which are usually a natural substance that does not contain any anabolic agents of testosterone (Lazarev and Bezuglov, 2021). Many supplements in this area use multiple ingredients, making it hard to pinpoint which ingredients have efficacy and whether you are in fact buying expensive supplements where some of the substances actually lack efficacy. Melville et al (2015) stated that several commercially available testosterone boosters lack sufficient research and efficacy to support their use. One ingredient that may hold some efficacy is Tongkat Ali, a herbal medicine, usually taken from the root of the plant, which has been used as a natural remedy in South East Asia for hundreds of years. It is said to improve physical and mental energy, improve libido, balance hormones, improves body composition and improves sporting performance by increasing free testosterone, and thus, optimising testosterone and cortisol balance (Talbot et al, 2013). Tongkat Ali is said to help increase testosterone levels by stimulating the production of luteinizing hormone, which in turn signals the testes to produce more testosterone (Ismail et al, 2012). Additionally, Tongkat Ali has been shown to help reduce the levels of sex hormone-binding globulin, a protein that binds to testosterone and reduces its bioavailability. By inhibiting sex hormone-binding globulin, Tongkat Ali may help increase the levels of free testosterone, which is the form of testosterone that is readily available for use by the body, giving it its hormone optimising qualities (Henkel et al, 2013). There is some promising literature that this hormone optimising quality results in the purported benefits, though the substance is mainly studied in older populations (Lazarev and Bezuglov, 2021). Talbot et al (2013), finding that though a dosage of 200mg/day did not improve body weight or body fat percentage over a 4-week period, it did however have the desired hormonal response by increasing testosterone and decreasing cortisol, and thus, improved hormone balance, as well improving mood. Talbot et al (2013) recommended its use, particularly in aging populations, periods of stress, calorie restriction, sleep deprivation and periods of intense exercise. Research suggests that Tongkat Ali may help increase the production of adenosine triphosphate (ATP), which is the primary source of energy for muscles during exercise (Talbot et al, 2013). This may result in

improved endurance and delayed onset of fatigue, allowing athletes to perform at a higher level for longer durations which would be a very beneficial quality to have in rugby players. Furthermore, Tongkat Ali has been reported to possess anti-inflammatory and antioxidant properties, which may aid in reducing exercise-induced inflammation and oxidative stress and promote faster recovery post-exercise (Talbot, 2019). This may be particularly beneficial for athletes engaging in high-intensity and repetitive training and competition, as it may help reduce muscle soreness and aid in recovery.

Method

Rationale

The primary aim of this study was to collect data around the observable behaviours in semi-professional rugby players relating to supplementation. Several aspects will be assessed in this study such as which supplements are being used; where the athletes get their information; whether age relates to a change in primary reason for supplementation; and behaviours around informed sport supplements and doping procedures. The gathered information will then be used to give recommendations based on the results, whilst relating back to the literature around efficacy, where best to share information and how to improve behaviours for supplementation. Participants were asked to state their position in keeping with other studies that divided participants into backs and forwards (Johnston et al, 2019; Cunningham et al, 2016).

Participants

This study has gathered data through a questionnaire survey and focus groups, therefore, will be using a mixed methods approach. Participants were 30 male rugby players (13 backs, 17 forwards) aged 25.5 ± 4.8 years old, who are currently playing semi-professional rugby in the Welsh Premiership. Participants that participated in the focus groups were 3 forwards aged 26, 27 and 33 years old and 3 backs aged 23, 26 and 18 years old. To ensure themes that were discussed in both cases were broader, one group was 2 forwards with 1 back, and the other 2 backs with 1 forward.

Study Design

Qualitative and quantitative research will both be conducted via a questionnaire survey, consistent with the statement of Williams (2007) that this is an effective way of conducting research. Questionnaire surveys are a strong, non-invasive way of collecting data and have previously been used in semi-professional rugby players. Hitendre et al (2022) is a good example of this, with their Attitudes, Perceptions and Challenges questionnaire being used to develop the questionnaire for this study. Hitendre et al (2022) was used as a basis for the method, combined with a questionnaire by Baltzar-Martins (2019) which was conducted in athletes. This allowed the study to develop which categories supplements would come under, though this study categorised supplements into 3 groups rather than 5 to ensure that it aligned more with the specific outcomes of this study. Individuals were also asked to outline what

their primary reason was for taking supplements and what sources of information they use to assess their efficacy, to be able to assess why individuals are using certain supplements.

Questionnaire

Similarly to Baltzar-Martins et al (2019), supplements were categorised depending on their purported benefits. Differently to Baltzar-Martins et al (2019), this study will use 3 categories rather than 5. The reason for the adaptation was that Baltzar-Martins et (2019) were quite simplistic in their categorisation of supplements that do not have a comprehensive scientific backing. Deciphering the literature as to what may have potential to be an effective ergogenic aid and what does not from the feedback that is received from the questionnaires is one of the main components of this study. They also separated supplements into immune health, micronutrients and recovery & injury management. The questionnaire was conducted on Microsoft Forms, which allows for anonymisation of the data, efficient and discreet collection of data via a website link, easy data compilation and allows data to be stored in a secure place. Data was then downloaded onto Microsoft Excel for the quantitative data to be input and analysed by SPSS to find if there are any statistically significant results, as well as making graphs. Pearson Correlation test was used to find whether there was any correlation between age and number of supplements being used. Independent Samples T-tests were used to assess whether there was a significant difference between the number of supplements used by backs and forwards, and whether there were significant differences between primary reason for supplementation and age.

Focus Groups

Consistent with the recommendations by Hopf (2004) and Gill et al (2008), further qualitative data was gathered using focus groups. Cheng (2014) stated that there is no standard size for a focus group, with larger groups potentially producing more diverse data but have the potential to lose data due to some participants not being able to give their opinions. Groups of 3 were selected in this instance to allow all participants to have ample opportunity to speak, as well as the time constraints on participants due to them being working full-time and playing semi-professional rugby. Due to the nature of the subject, there was limited opportunity to be able to give opinions and interviews were more of a fact-finding exercise to be able to elaborate on and discuss themes that were found in the questionnaire. Due to the nature of the subject, participants may also feel more comfortable to discuss themes around

doping in smaller groups. Vaughn et al (1996) stated that focus groups combined with quantitative data enable researchers to make an extremely compelling argument.

Questions were similar to the questionnaire but allowed participants to give more detail in their answers, allowing quotes and themes to strengthen the data from the questionnaire. Focus groups were conducted in person in a secure office at St Helen's Rugby and Cricket Ground. The interviews were recorded using Evernote on a secure phone and were later transcribed to ensure all data was effectively collected. These answers were then sorted and coded into themes through thematic analysis as per the recommendations of Braun and Clarke (2006). Data was sorted into 3 main themes, 2 of which had 3 sub the Interviews were conducted as 2 groups of 3 participants, done in a focus group style.

Ethical considerations

Ethically, the questionnaire posed little ethical risk due to it being voluntary, with participants reserving the right to withdraw at any time and were all asked for consent as part of the questionnaire. Data was anonymised to ensure that participants privacy was not compromised. However, during the focus groups there could have been factors that could have been ethical grey areas. Interviews were confidential and participants were anonymised in the transcription, however had there been any disclosures of doping, it may have compromised the study due to an obligation to report any doping as per the WRU Anti-doping Policy 2019-2022.

Results

The main aim of this study was to assess what supplements semi-professional rugby players are using and whether their reason for using them is consistent with the choice of supplement. Other outcomes that the study aimed to address were the prevalence of the use of supplements tested by Informed-Sport, whether age or position had any bearing on the type and number of supplements used, and which sources the athletes are getting their information from.

Questionnaire

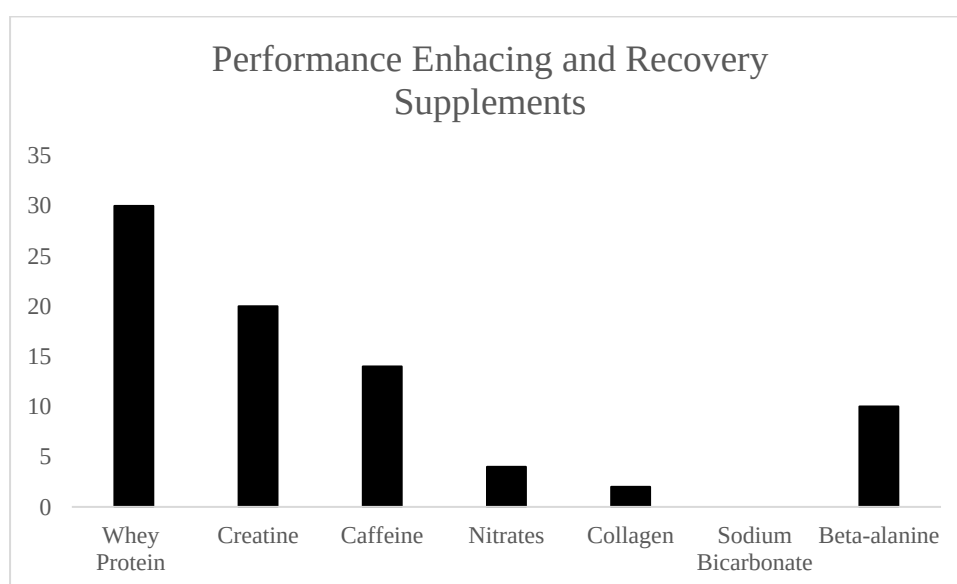


Figure 1: Number of participants that have taken each performance enhancing and recovery supplements.

As expected, the vast majority of athletes are using or have used a whey protein supplement, with 30/30 (100%) athletes in our study reporting to have used whey protein at some point. Even excluding whey protein, 100% of athletes have taken a dietary supplement at some point in their career. Creatine and caffeine use was lower than whey protein use, with a reported 20/30 (67%) and 14/30 (47%) of athletes using these supplements, which is also quite a high prevalence. 10/30 (33%) of participants used a beta-alanine supplement. Supplements that weren't used much were nitrates, collagen and sodium bicarbonate, with reported number of athletes at 4/30 (13%), 2/30 (7%) and 0/30 (0%) respectively. From this it is easy to see that the supplementation of whey protein, creatine and caffeine is quite widespread.

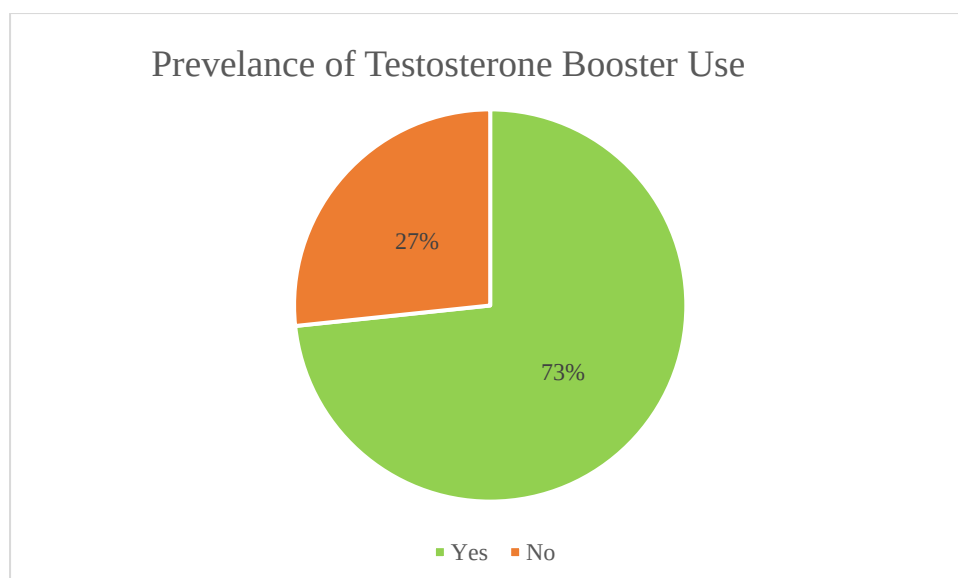


Figure 2: Prevalence of testosterone booster use

Overall, the use of testosterone boosters is high in semi-professional rugby players, with 73% of participants using this type of supplement at some point. In terms of substances, 21/30 (70%) of participants used D-aspartic acid, 3/30 (10%) used tongkat ali and 3/30 (10%) used ashwagandha. No participants reported the use of Tribulus or fenugreek.

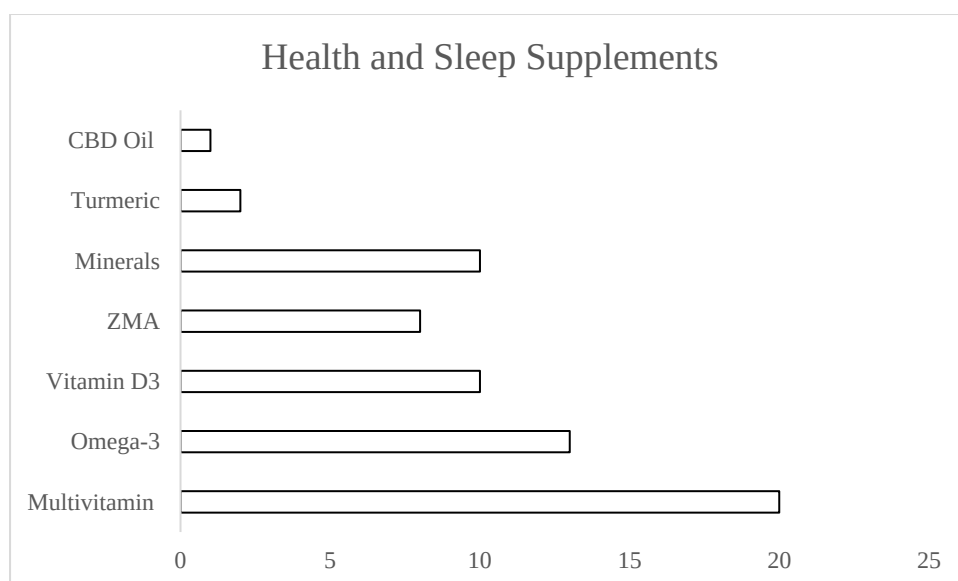


Figure 3: Number of participants that have taken each health and sleep supplements.

The majority of the participants have used a multivitamin supplement, with 67% (20/30) having used one. 33% (10/30) of participants took vitamin D3 alone. Minerals, omega-3 and ZMA also had reasonably high levels of use, with levels of use at 33%, 43% and 27%

respectively. Less popular supplements included Turmeric and CBD oil with 3% and 7% of participants reporting use respectively. Participants were also asked to report any other supplements that they have used and L-carnitine, probiotics and branch chain amino acids (BCAAs) were reported.

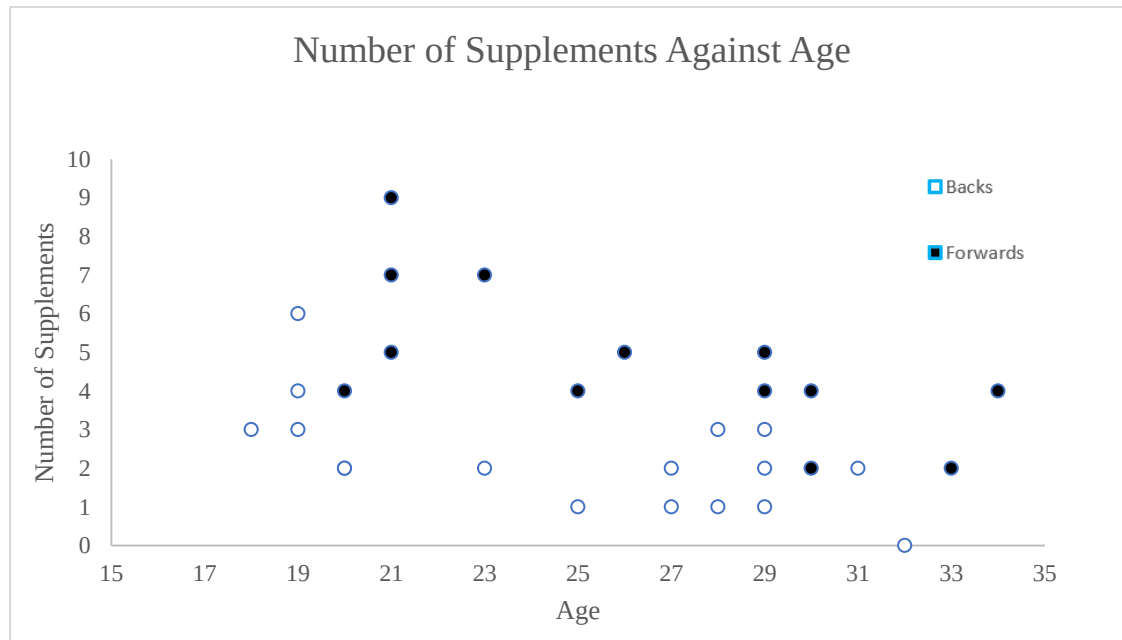


Figure 4: Number of supplements against age, with position via colour code.

On average the prevalence of supplements that the rugby players are currently using is 3.3 supplements. Current habitual use of supplements also varies greatly between position with Forwards on average being shown to use more supplements, using 4.8 supplements per athlete whereas backs only use 2.3 supplements per athlete. There is also an upward trend towards younger athletes using more supplements, meaning as athletes get older, they tend to use less supplements. The highest supplement use of 9 supplements was from a 21-year-old forward and the lowest supplement use was 0 supplements in a 32-year-old back. There is also a statistically significant negative correlation between age and number of supplements used ($p=0.022<0.050$, Pearson Correlation= -0.417). In simple terms, as athletes get older, they are using significantly less supplements. There is also a highly significant difference between the number of supplements that forwards use compared with backs, with forwards using more ($t=-5.405$, $p=0.001$). This is also easy to see in Figure 4, and when comparing means (forwards using 5 supplements per participant and backs using 2 per participant).

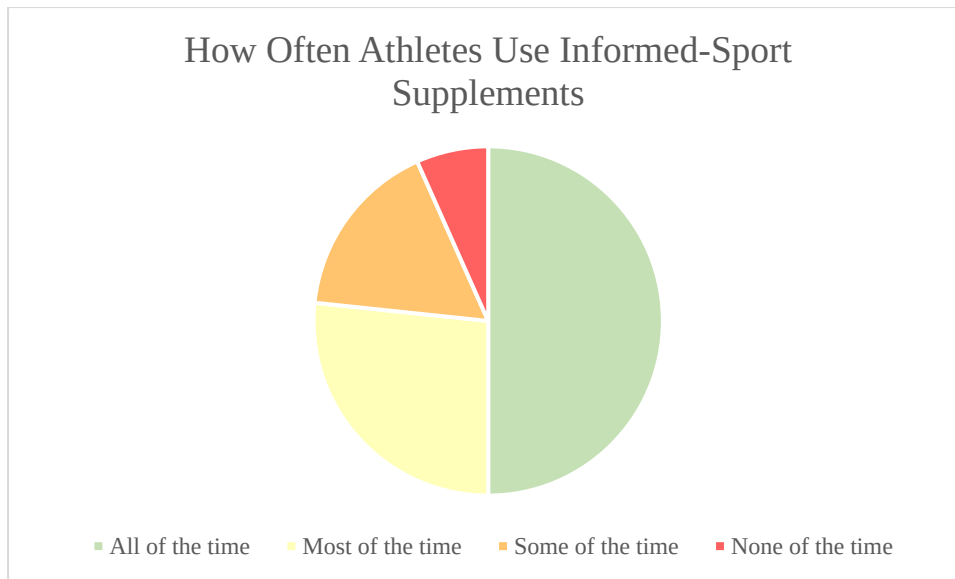


Figure 5: How often athlete use informed-sport supplements.

In terms of how often the rugby players use supplements that are batch tested by Informed-Sport, 50% (15/30) of participants only use supplements that have been batch tested. A further 27% (8/30) use batch tested supplements most of the time. On the other hand, 17% (5/30) only use batch tested supplements some of the time and 7% (2/30) never use supplements that are batch tested by Informed Sport.

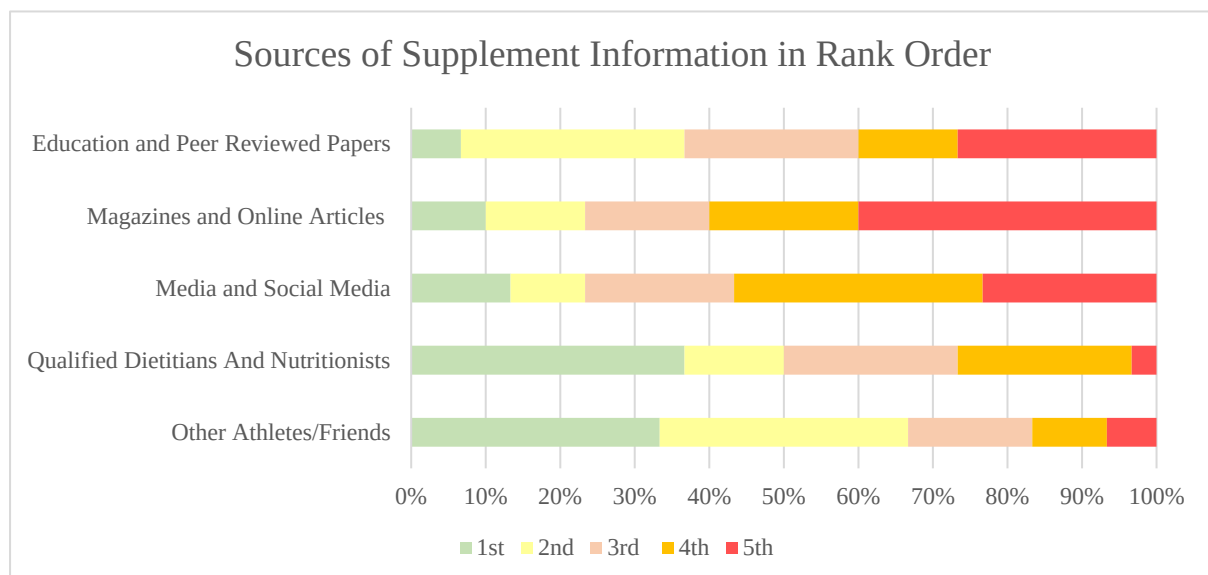


Figure 6: Sources of supplement information in rank order.

Participants were asked to rank their sources of information around supplements from 1st to 5th. In terms of primary source qualified dietitians and nutritionists were the highest primary

source used, with 37% of participants ranking this as primary source. Other athletes/friends was a close second in terms of primary source of information, with 33% ranking it first. Other athletes/friends was also had the most 2nd ranks in terms of information source, meaning 67% of participants reported that other athletes and friends have a substantial influence on which supplements they are using. Interestingly, their own education and peer review papers had the second most 2nd rankings, meaning many athletes have either had some element of supplement education during their own studying or are going directly to the source of information when looking at which supplements to use. Magazines and social media have little influence in terms of the supplements that the participants are using with 40% of participants ranking this as the least likely source. Media and social media also had little influence on the supplements that the rugby players were using, with 57% of participants ranking it in their bottom two.

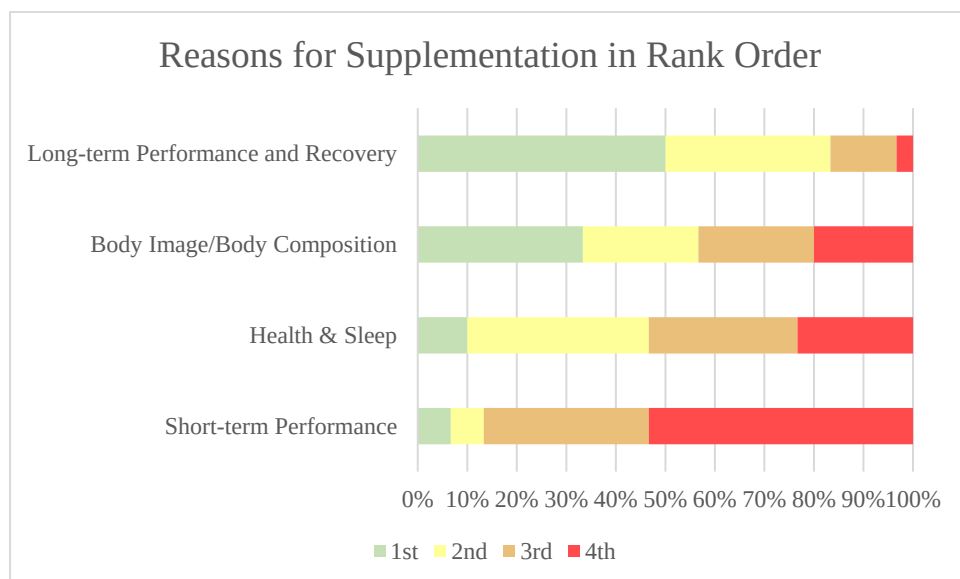


Figure 7: Reasons for supplementation in rank order

Participants were also asked to rank their reasons for taking supplements from 1st to 4th. Long-term performance and recovery was the most common reason for supplementation, with 50% (15/30) of participants ranking it as the primary reason and 83% (25/30) ranking it as their primary or secondary reason for using supplements. 33% (10/30) of participants ranked body image/body composition as their primary reason for supplement use, as well as a further 23% ranking it second, making it the 2nd most common benefit that individuals are using supplements for. Short-term performance is the least likely reason that individuals are supplementing, with 53% (16/30) of individuals ranking it bottom and only 7% (2/30)

ranking it as their primary reason. Those who are using supplements for health and sleep reasons are significantly older than those who are using them for body image/body composition ($t=2.542$, $p=0.034$). The average age of those who are using supplements for health and sleep is 30 whereas the average age for those who are taking supplements for body image/body composition is 25.

Interviews

Qualitative analysis was also conducted with a sample of the participants to further support the information that was gathered by the questionnaire. The aim was to provide more insight into behaviours around supplementation rather than just knowing what supplements were consumed.

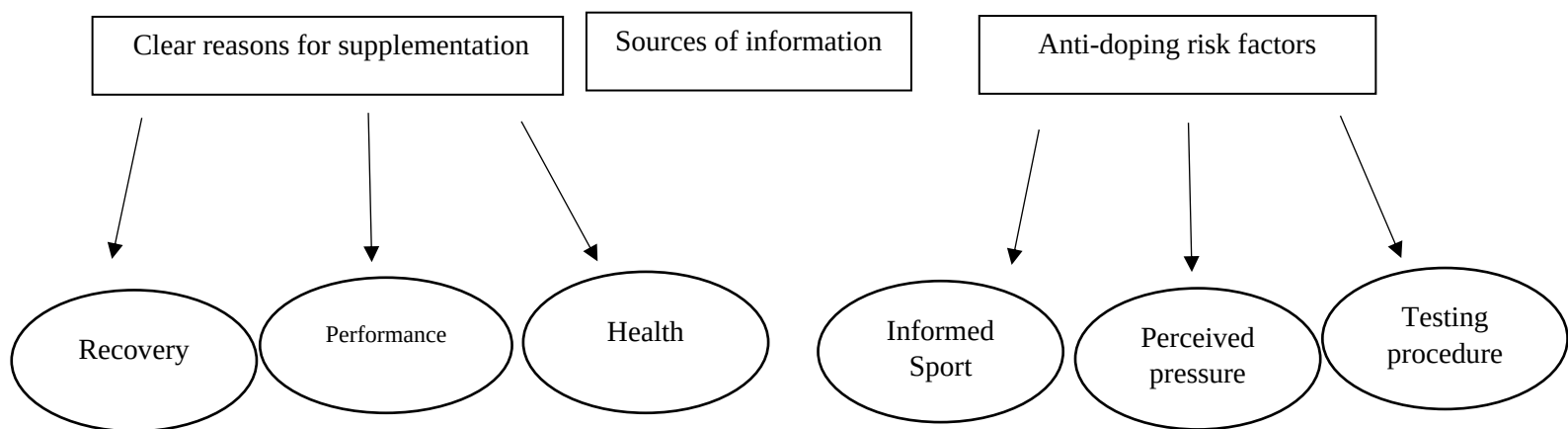


Figure 8: Thematic Analysis of Interview Information

The information gathered through interviews was thematically analysed and 3 main themes were found. The first theme that was found was that each participant had clear reasons for using supplements. The second theme was that each participant, though at a low level, were showing some risk factors around doping procedures. The third theme that was identified was that both previous themes were affected by the sources of information that the athletes were using for their information, mainly around the use of what supplements they were using, and whether these supplements were on Informed Sport.

Clear reasons for supplementation: - Reasons around supplementation were clear to each participant. Performance seemed to be the primary reason for supplementation in this sample of athletes. Recovery was also a significant factor in their choice of supplement. Supplements like whey protein were used to ensure that they were recovering adequately from games,

training and gym sessions. Creatine was used for strength and power purposes, though creatine supplementation was relatively inconsistent. Despite performance being the primary reason for supplementation, individuals did not generally place much emphasis on pre-match caffeine supplementation, with only one athlete saying he used a caffeine supplement before every match. Though all participants stated that they have or currently use supplements for health reasons, the two oldest participants showed the greatest interest in supplementation for health reasons. They also stated that their attitude has changed since they have gotten older towards using more supplements to aid health and recovery rather than performance. Though body composition and body image were not discussed as a primary reason for supplementation, every participant reported the use of testosterone boosters, in particular, AGF-1 by Pro Athlete Supplementation. Body composition is one of the primary reasons for optimal testosterone levels so it may be reasonable to say that this is quite a high priority too.

Anti-doping risk factors: - Though at a low level, all participants showed behaviours that could result in doping violations in the future, either directly for them, or that their perceptions reflect a wider issue at that level of rugby. One risk factor is that individuals do not always use supplements that are batch tested by Informed Sport, though this is at varying degrees between participants. All participants stated that if they do not use batch tested supplements, they use supplements that are made by a reputable company and will research the substances they're taking to ensure they aren't on the prohibited list. Their reasons for not using batch-tested supplements were the higher price and lack of choice/availability in products. Every forward reported that they at some point had felt under pressure to put weight on and be as big as possible, as well as each back stating though they have never been pressured, they are aware it is desirable for rugby. The final risk factor was the perceived lack of testing, with varying levels of testing between each participant. Though they had been present when doping control had been present at training, half of the participants have never been tested despite two of them playing at this level for around 15 years between them. One other participant had not been tested in 9 years before being tested twice in 2 weeks recently. Each participant also stated that they are subject to an anti-doping talk each preseason.

Sources of information influence: - The final theme was that the above themes seemed to be influenced by sources of information that the participants were using. Most of participants reported that they generally use supplements that have anecdotal evidence and word of mouth from teammates. Online was also reported as a source of information, with articles and

certain researchers prominent in choices. The participants that had been to university seemed to look at peer-reviewed articles as a source of information, whereas those who didn't were happier to listen to word of mouth.

Discussion

The use of supplements as ergogenic aids in all sports is extremely prominent, none more so than in rugby union, with 77% of male rugby players have been found to consume supplements on a regular basis (Lopez-Samanes et al, 2022; Bradley et al, 2015). In this study, 100% of athletes had consumed supplements at some point in their career, with 97% currently taking at least one supplement on regular basis. Consistent with Kaminski et al (2020), there seems to be an upward trend in the desire to take supplements, with this study reporting higher prevalence of supplementation than previous studies such as Lopez-Samanes et al (2022). Garthe and Maughan (2018) stated that in some sports up to 100% of athletes will be consuming supplements, and it is no surprise that figures in Welsh semi-professional rugby are extremely high, much higher than the 65.3% of rugby union players reported by Sanchez-Oliver et al (2020). It is easy to see why supplement use is so prevalent amongst rugby players, with body composition being such a key factor, as well as the intense and combative nature of the sport making the players want to recover and maintain joint/bone health (Lombard et al, 2015; Darrall-Jones et al, 2015; Barr et al, 2014).

Performance and Recovery Supplements

As expected and consistent with the statements made by Baltzar-Martins et al (2019), consumption of whey protein was widespread, with 100% of participants having used a whey protein supplement at some point and 100% of the interviewed participants stating that they use it on a regular basis. Whey protein's efficacy is long standing, so it is easy to see why it is so widely used as a dietary supplement (Colker et al, 2000). A high proportion of the athletes also used creatine, with 67% reporting that they had used creatine at some point. Again, it is easy to see why creatine use is widespread due to long established efficacy and it even being called the best ergogenic aid available (Balsom et al, 1994; Kreider et al, 2017). Due to such strong evidence around efficacy and no found detrimental effects on health, it would be wise for the 33% that did not report having ever used it to explore its use (Kreider et al, 2017). During the interviews it became apparent that even though many participants had used it habitually in the past, they were not currently using it. There are several overarching barriers that arose in this study around supplementation which will be discussed at a later stage. A specific reason for not taking creatine habitually was that two of the interviewed participants had read that it is associated with premature hair loss. Hair-loss in men has been shown to affect self-confidence, self-image and generally feel more negative towards themselves

(Budd et al, 2000). Van der Merwe et al (2009), found that creatine increased levels of dihydrotestosterone (DHT) significantly, a hormone that is associated with male pattern baldness. One participant in particular had done their research in this area, quoting that “it raises levels of DHT”. As Van der Merwe et al (2009) was also conducted rugby players which is likely the reason its findings relatively well known about in this community. Antonio et al (2021) has since dismissed the theory that creatine can cause hair loss, with them finding 5 studies that have little to no increase in DHT, and thus, will not lead to male pattern baldness.

Caffeine is another supplement that has long had efficacy, showing benefits to aerobic and anaerobic endurance, peak power, power output and total weight lifted (Mielgo-Ayuso et al, 2019a). These characteristics make it the ideal supplement for rugby players. 47% of participants have used a caffeine supplement, which could be seen as a relatively low amount considering the strength of efficacy. During the interviews it became apparent that much of the participants didn't think they necessarily needed a supplement because much of their caffeine consumption comes from coffee. This is hardly surprising, considering as 2.25 billion cups of coffee being consumed per day worldwide (Pickering and Kiely, 2019a). Caffeine supplementation seems to be as and when individuals perceive they need an “extra boost” on game day or training, with one individual reporting he does not consume it habitually and does not feel he needs it. Caffeine is another supplement worth trying for those who feel they cannot get enough caffeine through coffee only, due to its beneficial effects on performance as well as the fact that an acute dosage has significant effects which is a huge positive. Those who are new to caffeine supplementation should be wary of it possibly causing jitters and anxiety (Guest et al, 2021). Caution should also be exercised during evening games due to it affecting sleep (Mielgo-Ayuso et al, 2019b).

Though not as prominent as creatine and caffeine, beta-alanine use was also quite prominent, with 33% of individuals reporting its use. Beta-alanine's efficacy is promising, though not as conclusive as creatine and caffeine. Its buffering properties make it a promising supplement for rugby players due to the anaerobic nature of the sport (Trexler et al, 2015). Those who reported its use in the interviews were unsure of its efficacy in terms of their perceived benefits but reported that they stopped taking the supplement due to the tingling sensation caused by the supplement. Individuals were surprised to learn that the tingling can be mitigated by a dosage of 0.8-1.6g every 3 to 4 hours, as per Perim et al (2019). Kelly et al

(2017) stated that there was a lack of compliance in beta-alanine consumption over a 28-day period in rugby players. Despite evidence of some efficacy, beta-alanine may be a supplement that's side effects may outweigh its efficacy, meaning it may not be the best supplement to push as an ergogenic aid. Nitrate use was not widespread with only 13% having used a nitrate supplement. Science is relatively new around nitrate supplementation, though it is showing promising benefits in repeated sprint performance and fatigue induced cognitive decline when taken habitually (Thompson et al, 2015). There are not many sports specific nitrate supplements, with supplementation usually done through Beet-it Sport shots, with several companies using this product in their study. These beetroot-based shots are used at an overwhelming rate in terms of studies but are both expensive and not very palatable. (Lopez-Samanes et al, 2022; Mosher et al, 2016; Thompson et al, 2015; Moreno et al, 2023; Tometi and Plaisimon et al, 2018). No participant in the current study has consumed sodium bicarbonate as an ergogenic aid. Despite promising scientific literature, interviewed participants were shocked to discover that sodium bicarbonate has potential as an ergogenic aid (Miller et al, 2016). This may be due to few studies overall, with even fewer recommending sodium bicarbonate, particularly due to gastrointestinal discomfort, and the lack of quality supplements rather than buying the substance as a foodstuff (Burke, 2013; Grgic et al, 2021). Sodium bicarbonate supplementation may become more popular as more studies are done to find more about limiting gastrointestinal discomfort and more sport-specific supplements become available.

Health Supplements

One supplement that was not discussed in the literature review but has been used by 7% of the participants in this study is collagen. Much of the research in this area is very new, but several papers have found that the daily intake of collagen peptides at a dosage between 5-15g per day has been shown to have significantly decreased long-term joint discomfort (Khatri et al, 2021; Zdzieblik et al, 2017). This will be highly desirable in rugby due to the nature of the game and the high injury occurrence. During the 2015 world cup, 4.8 joint injuries were reported per game, showing that joint health and recovery is an imperative aspect for rugby players to consider. This issue is becoming a more pressing issue because there is an upward trend in injury numbers and severity in rugby union, likely due to players getting bigger (Fuller et al, 2017). Though Lis et al (2021) has shown that collagen improves rate of force development in the lower limb, and thus performance, collagen is more of a

health and recovery supplement, and it could be argued that it should have come under the health category rather than performance and recovery in the questionnaire for this study.

Baltzar-Martins et al (2019) stated that multivitamins are also one of the most popular supplements. Again, this study agreed with this statement, with 67% of participants having used a multivitamin. Though Baltzar-Martins et al (2019) stated that multivitamins are one of the most commonly used supplements, Garthe and Maughan (2018) stated that sports dietitians/nutritionists should strive to enable athletes to meet their needs through a food-based approach. A well balanced and varied diet will be able to provide all the vitamins (with the exception of vitamin D) that the human body requires, which should be easier to achieve in athletes due to their higher caloric needs lending itself to consume more food and therefore more micronutrients. However, the reported lack of access to sports dietitians/nutritionists at this level may result in poor nutritional outcomes. Hitendre et al (2022) found that there is a lot of room for improvement in diet and nutritional knowledge in semi-professional rugby union players. There are also significant barriers to contend with as semi-professional athletes have other commitments, for example finding time to plan, prepare and cook meals. A multivitamin may bridge the gap in the nutrition of semi-professional athletes to enable them to balance their sport and other commitments. Omega-3 fish oil was also quite common amongst our participants, with 43% having taken an omega-3 supplement. Though there is little literature in terms of sports specific benefits of omega-3 supplementation, there are several general benefits that would likely carry over to sporting performance. Bauer et al (2014) found that omega-3 supplementation has been found to improve neurocognitive function, for example reaction times, in adults between 20-34 years of age. A meta-analysis by Goldberg and Katz (2007) found that omega-3 supplementation has a positive effect duration of morning stiffness and number of painful and/or tender joints due to anti-inflammatory qualities. Both factors will be desirable for rugby players in terms of performance and recovery. In terms of factors that directly impact sports performance, Omega-3 has even been found to improve endurance performance by reducing the oxygen cost of exercise (Philpott et al, 2019).

Only 33% of individuals had taken a vitamin D₃ supplement. This is a worryingly low amount due to Close et al (2013) stating that deficiency can be as high at 62% in the UK winter months. This is a concern due to vitamin D₃ shown to improve strength and power metrics as well as preventing illness and bone injury (Bikle, 2009; Holick and Chen, 2008;

Close et al, 2013). Though every athlete in this study should consider the supplementation of vitamin D₃, this may be mitigated by the higher presence of multivitamin use, which are likely to contain vitamin D as an ingredient (Weiler et al, 2021). In terms of mineral supplementation, 27% of participants reported the use of zinc magnesium aspartate (ZMA), as well as 33% taking minerals in general. ZMA is generally seen as a supplement to optimise hormone status and thus body composition, strength and muscle injuries during sleep. These claims are unsubstantiated, with Wilborn et al (2004), Cerqueira et al (2021) and Rezaei Zonooz et al (2022) all finding a lack of evidence to support this. In general, supplementing minerals has not been found to enhance performance in any way. Well-nourished athletes with good diets will not need to supplement minerals to aid performance, with the potential exception of females supplementing iron due to menstruation (Williams, 2005).

One individual in this took Cannabidiol oil (CBD oil). CBD oil's popularity in sport has skyrocketed in recent years due to WADA taking it off their prohibited list for both in and out of competition use in 2018 (Gamelin et al, 2020). Due to WADA removing it from the prohibited list, there has been an upturn in scientific research in this area. Preliminary studies have found CBD oil to have anti-inflammatory, neuroprotective, pain reducing and anxiety reducing qualities, as well as potential to protect gastrointestinal damage and healing from traumatic skeletal injuries (McCartney et al, 2020). These qualities give CBD oil excellent qualities as a supplement for athletes, particularly rugby players. The current limitations around CBD supplementation are in the lack of strong evidence due to it only recently being removed from WADA's prohibited list. Informed Sport do not currently allow any CBD containing products to have their certification though this is under review whilst they review and conduct scientific studies (Informed Sport FAQ). McCartney et al (2020) stated that there is much need for more scientific research around CBD to support efficacy. Hazekamp (2018) stated that CBD oil is a highly unregulated substance with the long-term side effects unknown as well as some products containing psychoactive cannabinoids. Though CBD has potential for supplementation in athletes, it is likely to be beneficial to wait for stronger evidence around efficacy and for Informed Sport to start batch testing these products to ensure that they will not result in a doping violation.

Testosterone Boosters

A high proportion of participants used testosterone boosters, with 73% using them. Every person that reported the use of testosterone boosters reported the use of the substance D-aspartic acid (DAA). When discussing testosterone boosters, it became apparent that one particular product whose primary ingredient was DAA was extremely popular, with every participant having used it. AGF-1 by Pro Athlete Supplementation (PAS) was used by every person in the interviews and is likely the product that most of the participants got their source of DAA from. Despite its widespread use, DAA seems to have very little efficacy.

Willoughby and Leutholtz (2013), Lak et al (2022) and Melville et al (2015) all found no significant increase to testosterone levels, with no improvement in strength or body composition. Even in the product description the study that is used as an example of efficacy is somewhat misleading, with the description disclosing that there is a lack of efficacy in resistance trained men (PAS Nutrition). AGF-1 is a multi-ingredient testosterone booster, much like the products mentioned by Lazarev and Bezuglov (2021). The second main ingredient that is present is L-carnitine, meaning every person that consumed AGF-1 also consumed L-carnitine, as well as one participant who consumed it on its own. The purported benefits of L-carnitine to make it an effective ingredient in a testosterone booster its potential benefits on androgen receptor availability, in addition to reduced muscle soreness, recovery and performance (PAS Nutrition). However, the product description did provide the study names that they have based its inclusion around. Kraemer et al (2006) stated that L-carnitine may increase testosterone uptake and promote recovery, though this was through association rather than strong evidence. However, Lazarev and Bezuglov (2021) stated that L-carnitine supplementation has also been found to have no effect on testosterone. Ho et al (2010), found that L-carnitine supplementation can reduce post-exercise tissue damage and optimise muscle tissue repair and remodelling, though this was in a middle-aged population. However, Ho et al (2010) did state this has also previously been found in a younger population. Mielgo-Ayuso et al (2021) found that L-carnitine improved high-intensity exercise but did not improve moderate exercise, suggesting a dosage of 2-2.72g per day of L-carnitine, or an acute dose of 3-4g ingested 60 to 90 minutes before exercise. The final study that was provided was Ozer and Guzel (2014), who found that ingesting L-carnitine can delay blood lactate formation, and thus, delays fatigue in athletes. This effect on blood lactate is likely why it did not improve moderate exercise, where blood lactate may not have been present to the same amount, if at all. A meta-analysis that was not quoted in the product information is Koozehchian et al (2018) who were in agreement with Ozer and Guzel (2014), also finding that L-carnitine supplementation enhanced exercise performance by attenuating blood lactate

and oxidative responses. There seems to be strong evidence for L-carnitine use for high-intensity exercise improvement, but there seems to be little evidence that L-carnitine will have positive effects on testosterone, as purported by AGF-1. Other ingredients include minerals, which, as stated above, do not have much effect if outside of deficient populations. The final ingredient is phosphatidylserine, which has been found to not have the purported effects on cortisol, nor perceived soreness and markers of muscle damage (Kingsley et al, 2005). Overall, the only ingredient that's shown to have any efficacy is L-carnitine, however, it is not on testosterone levels.

Two other supplements were identified in the questionnaire by allowing athletes to state any other supplements they had used that were not an option in the questionnaire. Both BCAAs and probiotics were reported. Though Shimomura et al (2004) found BCAAs to have efficacy around being able to stop muscle catabolism, exercise-induced muscle damage and promoting muscle-protein synthesis, Tambalis and Arnaoutis (2022) stated that BCAAs can naturally be obtained through consuming animal proteins meaning it is likely a high protein diet will mitigate the need to supplement with BCAAs. Jager et al (2020) and Leite et al (2019) both stated that probiotic use may be warranted in sporting populations for gastrointestinal and immune health, however, it is currently hard to make recommendations around forms of administration and dosage.

Herbal Supplements

There seems to be a trend towards using supplements derived from plants, though this is at a low level in this study when compared to other supplements. Sellami et al (2018) stated that there has been a large increase in their use in recent years. This is likely due to the trend towards ancient herbal medicines which have purported benefits, hailing predominantly from Asia (Vickers and Zollman, 1999). As previously stated, one such substance is Tongkat Ali, with 10% participants having used it. Though literature can be somewhat equivocal, Henkel et al (2013) and Talbott et al (2013) have demonstrated it does optimise testosterone and cortisol balance. Talbott (2019) also found it to have anti-inflammatory and antioxidant benefits, lending itself to post-exercise recovery and reduced inflammation. It is likely more research needs to be done to assess whether Tongkat Ali's properties translate directly to body composition and recovery enhancement, but it seems a better option than DAA at this point. One limiting factor around Tongkat Ali is there are few available supplements that are batch tested by Informed Sport, especially in the UK (Informed Sport). Another such

supplement is Ashwagandha, again with use at 10%. A meta-analysis by Bonilla et al (2021) stated that there seems to be some efficacy in Ashwagandha around improvements in strength and power, cardiorespiratory fitness and fatigue/recovery, though more specific studies need to be done in trained individuals. A meta-analysis by Perez-Gomez et al (2020) stated it may improve VO_{2max} in athletes, but again did not make solid conclusions and asked for further study. Mishra et al (2000) stated that studies indicate the reason for Ashwagandha's therapeutic use is due to it possessing anti-inflammatory, antitumor, antistress, antioxidant, immunomodulatory, hemopoietic, and rejuvenating properties. These properties could be beneficial for health, as well as promoting recovery in athletes. Ashwagandha seems to have potential for supplementation in athletic populations, but it seems too early to make solid recommendations. Turmeric was another supplement that arose in the study, with 7% of participants having taken it. Turmeric is said to have anti-inflammatory qualities, and though turmeric has been found to have some potential anti-inflammatory effect on joint pain, Daily et al (2016) struggled to make any conclusive recommendations for its use. Funk et al (2010) also found a lack of efficacy and stated that some turmeric products can in fact be dangerous. Turmeric was also found to have no effect on $VO_{2 Max}$ or lactate threshold and thus, it does not improve endurance performance (Ali and Ray, 2017).

Doping Themes and Risks

As previously stated, doping violations are a big problem related to supplementation, with a particularly high number of violations coming from Welsh Rugby (Whitaker and Backhouse, 2017; Cox et al, 2022). Though 50% of participants reported always using supplements batch tested by Informed Sport, it is worrying that 50% do not. The 7% that never use Informed Sport supplements is particularly alarming, with Whitaker and Backhouse (2017) demonstrating that doping violations have come from athletes naively consuming non-batch tested supplements with the presence of banned substances or cross-contaminated supplements. There was a theme during interviews that though the participants did not always use batch-tested supplements, they would only buy supplements they deemed reputable and would ensure any substance is not on the WADA prohibited list. Though this may safeguard somewhat against doping violations, athletes are still leaving themselves open to using cross-contaminated supplements and therefore are leaving themselves open to doping violations. When asked in the questionnaire what the barriers were to using batch-tested supplements, the strongest theme that was presented was that they were more expensive than regular supplements, with one participant stating "money doesn't grow on trees". Another strong

theme that was presented was that there is little choice in supplements that are batch-tested, which, as previously stated, is the case with supplements such as tongkat ali. The large number of supplements that are being used by rugby players is also a worry. The more supplements athletes are using then the more likely the athletes are to be vulnerable to doping violations, particularly those who aren't using products that are batch tested.

In terms of sources of information that participants were basing their supplement choices off, it is pleasing to see that they rated qualified dietitians/nutritionists as one of their primary sources of information. However, it could be questioned if participants fully understand what being a qualified dietitian/nutritionist is. From the interviews it is clear to see that participants have good support in terms of strength and conditioning, however, 5 out of 6 interviewed participants mostly listen to other athletes' anecdotal evidence and are unlikely to take things that other athletes haven't had good experiences with. The interviewee that had stated that he got most of his information from qualified dietitians/nutritionists has previously been part of a professional team and national squads, so is likely to have had a good footing in sports nutrition. The tendency of listening to friends and other athletes is also shown in the data, with other athletes/friends the most chosen source in the top 2 rankings. This is consistent with the statement by Baltzar-Martins et al (2019), who stated family, friends and teammates to be the primary source of information. The problems that arise from this are primarily a lack of knowledge leading to athletes taking supplements that may lack efficacy, which seems the case in terms of DAA, where the vast majority of athletes have taken it due to anecdotal accounts. Another potential that could arise is that if athletes are listening to their peers and are taking non-batch tested supplements, it could result in several failed tests, as was the case in Whitaker and Backhouse (2017).

In terms of reasons for supplementation, long-term performance and recovery was the most desired effect that the participants wanted to obtain from supplementation, with 83% of participants including it in their top 2 reasons. This is not surprising as the standard of rugby is relatively high, with some players having played at or aspiring to play at a professional level. This is also aligns with the literature that states that athletes supplement for performance rather than improving health (Scofield and Unruh, 2006; Petroczi et al, 2008). The findings of this study also align with the statement by Sheeshka et al (2012) that young there is pressure on young athletes to have better body composition. This is likely further compounded by rugby as a sport emphasising body composition as a key performance

parameter (Darrall-Jones et al, 2015 and Barr et al, 2014). There is clearly a big culture around optimal body composition in rugby, with players found to have previously overemphasised body composition in their diet, even at the cost of fuelling for performance (Posthumus et al, 2021). The culture around younger athletes being concerned about their body composition is observed in this study, where the average age of participants that had it as their primary reasons for supplementation was 25 years old, whereas the average age of those that primarily supplemented for health was 30 years old, which is statistically significantly higher. Worryingly, this is likely being fuelled by a culture around being as big as possible, which was observed in the interviews. All forwards in the interviews reported they had been pressured into putting on mass to play rugby, particularly when they were younger. Though the backs interviewed had not ever felt pressured into being bigger, they said it is seen as desirable. This culture could be fuelling the doping culture that is observed in rugby union, with players understanding that they may not be picked if they are not as big as possible, leading to athletes potentially exploring doping.

Short-term performance was seen as the lowest in terms of priority. Though, as stated above, caffeine is one of, if not the most effective ergogenic aid, it does not seem to be a priority in terms of supplementation. Again, it may be because individuals prefer to get their caffeine from natural sources such as coffee, but there is room for further exploration in caffeine use in this population. Other factors that affect overall supplement use is both age and position, with forwards found to use significantly more supplements than backs and there is a moderate negative correlation between age and number of supplements used. The findings that younger athletes are generally using more supplements is consistent with the statements of Sheeshka et al (2012) that young athletes take more supplements. It is also interesting that forwards consume a lot more supplements than backs. This is likely related to two factors. The first is, as previously stated, they are involved in 68% of all contacts, with collisions also being of greater force (Lombard et al, 2015). This is likely to have an influence on supplementation where forwards may strive to get some therapeutic relief from supplements and need greater recovery. The other factor is the pressure on them to be big, which became a theme in the interview as well as Lombard et al (2015) stating forwards need to be bigger to be able to cope with the bigger collisions. Interestingly, the use of testosterone boosters is much higher in forwards than backs, with 46% of backs having taken a testosterone booster compared with 94% of forwards. As reported in Hilton and Lundberg (2021), higher testosterone has positive

effects on body composition, and thus, it is likely forwards are taking these supplements to maximise their physique to cope with the demands of the game.

In terms of doping control procedure, interviewed participants were asked how long they had played senior rugby and for how long they had played in the Welsh Premiership. There were varying accounts of their experience with doping control. Out of the participants in the interviews, only 50% had been tested for banned substances via urine samples. Those of which that happened to be tested were all forwards. Two participants had been tested 3 times over a 9-year period and a 15-year period. The other had not been tested for 9 years but recently had 2 tests in 2 weeks. The others had reported that though they had not been tested over a 9-year, 7-year and 1-year period, they had been present when doping control officers had been present at training sessions or games. It is easy to see why Cox et al (2022) reported that there is a perception that doping control tests were unlikely, as in practice there have not been many tests done in our participants even though the majority have extensive playing experience at Welsh Premiership level. Cox et al (2022) also reported that the aim of UKAD is to act as a deterrent by testing a sample, but that athletes are sometimes prewarned that testers are in attendance, and though testing can happen at any time, rugby players dope in the off season as they are less likely to be tested in this period. Participants also reported that they are subject to talks in preseason informing them to use Informed Sport batch-tested supplements and to check medicines on Global DRO. However, if athletes aren't present at training, these talks are not always followed up, potentially leading to those who missed it or are new to the team having no information around doping and supplements. This is in breach of the targets set out by the WRU Anti-doping policy. It is likely that young athletes will need even more support in terms of doping advice, due their much higher consumption of supplements making them vulnerable to the "gateway" theory proposed by Garthe and Maughan (2018).

Conclusion

This study aimed to assess supplement use in Welsh semi-professional rugby players. Sub-elite rugby in Wales has become a hotbed for doping and the information in this study was aimed to enable amateur and semi-professional rugby players to make more informed choice around supplements, allowing them to better use their limited resources, giving them the tools to get performance gains without risk of doping violations. Participants were found to be using several supplements which lacked efficacy, many of which purported to have desirable benefits that would enhance rugby performance. Beta-alanine, turmeric, DAA, ZMA and mineral supplements in particular seem to currently lack strong evidence to warrant recommending them as ergogenic aids and could be categorised as apparently ineffective. Despite beta-alanine having some efficacy previously, it does not seem that beta-alanine's best suited to rugby players. The culture around supplement choices being based around anecdotes is likely to result in athletes wasting money on expensive supplements that will have little benefit. Multi-vitamins are said to be redundant for those who have an optimal diet but there it may be good practice to supplement with multi-vitamins in this population because of the risk for poor diet quality. It would be reasonable to say that most of the UK should supplement with vitamin D₃ for bone and immune health, with rugby players being no exception.

Creatine and caffeine have long had efficacy and it would be effective for everyone in this population to explore their use and they should be classed as apparently effective. Unfounded concerns around creatine highlights the need for athletes to aim for good quality sources of science when thinking about supplementation. Creatine should continue to be a staple in terms of supplementation in rugby players due to increases in repeat sprint ability, strength, power, fat-free mass and even has promising literature around its effects on the brain.

In future, it may be wise to assess caffeine consumption via natural sources as well supplementation, but caffeine use is a definite tool for rugby players to use due to it improving aerobic and anaerobic output and single effort power efforts and sprints. Nitrate supplementation also seems to have strong efficacy around improving anaerobic exercise, thought this needs more game-specific research. There also seems to be some good literature around supplements such as omega-3, collagen and L-carnitine for recovery parameters, as well as some direct performance enhancement and they can be categorised as possibly

effective. Though, these need more research, it would be reasonable to recommend their use on current literature. There is also promising data around sodium bicarbonate, CBD oil and tongkat ali and could be categorised as too early to tell. However, sodium bicarbonate needs more research to be able to eliminate gastrointestinal discomfort side effects, CBD oil should be delayed until more is understood about the substance, and you are able to purchase Informed Sport versions, and tongkat ali to be tested more in terms of whether its beneficial effects on hormone balance translate to any benefits for athletes.

It is alarming how little the participants have been tested, especially considering that 5/6 participants are well established Welsh Premiership players. It is also worrying that some athletes are not getting sufficient information to be able to make informed decisions. There also needs to be a change in attitudes around body composition in rugby players, particularly in terms of pressuring players to be as big as possible.

Further research should look to further provide insight into the efficacy of some of the supplements above as ergogenic aids. It would also be desirable to test supplements in combination with each other due to the majority of participants taking more than one supplement at the same time. It would be interesting to see which supplements compliment each other and if any nullify the effect of the other.

Word Count: 15910

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Appendix A- Questionnaire

Supplement Questionnaire

1.Your information from this questionnaire will be used and analysed to understand behaviours around supplement use in semi-professional rugby.

Your information will be anonymised and you reserve the right to withdraw at any point. For any further information please contact Matthew Jenkins. Single choice.

I consent

I do not consent

2.AgeSingle line text.

Enter your answer

3.How many supplements are you currently taking? Single line text.

Enter your answer

4.What position are you?Single choice.

Forward

Back

5.Please rank your reasons for taking supplementsRanking.

Body Image/Body Composition

Short-term Performance

Long-term Performance and Recovery

Health & Sleep

6.Please tick which testosterone boosters you have taken. Multiple choice.

Tongkat Ali

D-Aspartic Acid (Including AGF-1)

Ashwagandha

Tribulus

Fenugreek

7.Please tick which performance and recovery supplements you have taken.Multiple choice.

Creatine

Beta-alanine

Caffeine

Sodium Bicarbonate

Nitrates e.g. Beet-it

Whey Protein

Collagen

8.Please tick which health and sleep supplements you have taken. Multiple choice.

Omega-3

Multivitamin

Vitamin D3 alone

2007571

CBD Oil

ZMA

Minerals e.g. magnesium, iron, zinc etc

Turmeric

9. Please state any other supplements you have taken. Single line text.

Enter your answer

10. How often do you use supplements tested by Informed Sport? Single choice.

All of the time

Most of the time

Some of the time

None of the time

11. What would your reason be for not using supplements tested by Informed Sport be? Single line text.

Enter your answer

12. Rank the sources of information according to which ones you use the most. Ranking.

Magazines and online articles

Education and peer reviewed papers

Other athletes/friends

Qualified dietitians and nutritionists

Media and social media

Appendix B- Interview Transcript

Int: First off, why do you take supplements?

P1: Basically, to help with rugby and performance. In the gym, taking protein helps with recovery.

P2: Yeah, way of getting more protein into your diet. Easy way to not have to make another meal. Performance and recovery most important. If I wasn't playing rugby I wouldn't take as many.

P1: Yes, mainly recovery for me I'd say. Make up the holes in my diet.

P3: Performance especially the gym and recovery. Creatine and Protein. Read studies on creatine which is good for what I want, it works and it's cheap.

Int: Would you say you've ever felt under pressure to put weight on for rugby?

P1: Not under pressure no, but it is desirable.

P2: Yes, it's definitely desirable but I've never felt under pressure.

P3: Yes. I'm naturally quite small for my position so I've always felt the need to be bigger.

Int: I'll just ask you a few categories of supplements now. Have you ever taken testosterone boosters?

P2: AGF-1.

P1: Yeah, AGF-1. There's only so much you can take playing rugby in terms of testosterone boosters. I've just started tongkat ali though. It's new but I'm not taking one on informed sport. I think the albomyn binds the protein.

P3: Yes, AGF-1.

P2: I've taken ashwagandha. I don't know much about it though, but I saw it's good online.

Int: Why would you say you've taken them?

P1: Body composition mainly. Particularly in pre-season.

P2: Yeah.

P3: Yeah, I take it because of my size.

Int: Have you ever taken fat burners?

P1: No.

P2: No.

Int: Ever taken anything for strength and power.

P1: Creatine but I stopped because I read that it speeds up hair loss if you're susceptible to it. It increases DHT which is a type of testosterone that can cause it.

P2: Yeah, I don't take it for the same reason but I have taken it.

P3: As I said, I've taken creatine before.

Int: Beta-alanine?

P1: I've taken it as a part of a pre-work.

P3: Yes, but not for a long time. I don't like the tingling feeling

Int: Caffeine before a game?

P1: Yeah but sometimes I get it from coffee. It depends how I'm feeling.

P2: Yeah. I wouldn't normally take a tablet but I get it from coffee mainly.

P3: Yes, I've taken caffeine pre-game sometimes.

P1: I used to take pre-workout before the gym but I found I crashed off it.

P2: Yeah, same. When I first start in the gym but not anymore.

Int: Anything for health?

P1: Vitamin D

P2: Yeah, multivitamin and vitamin D3.

P3: I have in the past but not for a long time. I've taken multivitamins and vitamin C but I forget to take them and I become inconsistent. I've not taken vitamin D alone

P1: Magnesium threonate before bed to help me sleep.

P2: Yeah, I've taken a magnesium product too but I can't remember the exact name.

P1: I've taken CBD too.

P2: I've taken fish oils and omega-3 and that. It depends on your diet doesn't it. If you eat salmon and that you might not need a supplement.

Int: Do you always make sure the supplements are informed sport?

P1: Most of the time but not always. I always look up the substance to make sure it's not banned though. If it looks dodgy I wouldn't take it. I wouldn't risk it with certain supplements.

P2: It should be the same stuff if it's from a good company. I'll research things before taking them.

P1: I think in the lower leagues boys take things to look good on a Saturday night but for us it's different.

P3: Yes, normally. I don't always check everything but if it is from a reputable company like MyProtein then I would use it.

Int: Where would you say you get your information?

P2: Online to be honest. Word of mouth from the boys.

P1: Yeah.

P2: I'd rather hear first hand off the boys if they've had any benefits from it.

P3: Just from being in and around rugby and sort of just like word of mouth, talking to others. I did a little bit of sports in college so my own reading a bit too.

Int: Have you ever had a talk on informed sport supplements.

P1: Yeah but not since covid.

P3: Yes, a lot. A lot. In Hartpury we used to have it twice a year and I reckon about 10 overall.

P2: We had one in preseason.

P1: I must have missed the one in preseason when I was away but they haven't done it since.

Int: Do you have strength and conditioning support?

P1: Yes, we have 2 qualified conditioning coaches.

Int: Final question. How many times have you been tested?

P1&P2: I've never been tested.

P3: 3 times. First when I was about 18 and then most recently a couple of weeks ago so over a 9-year period.

Int: How long have you been playing in the Premiership?

P1: Since 18 so 8 years.

P2: Since 18 so 6 years.

P1: I've been there loads when the testers were there but never been tested. They come about 3 times a year.

P3: Since I was 20.