PORTALS TO PROHIBITED PERFORMANCE ENHANCING DRUGS: PREVELANCE, PROFILING & TEAM DYNAMICS

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DECLARATION

I declare that the work presented in this thesis is entirely my own and has been conducted at Kingston University, UK.

This thesis has not been submitted, in whole or in part, for any other degree at this or any other university.

Ricky James

ABSTRACT

Prohibited performance enhancing drugs (PPD) are nutritional supplements which are prohibited from use during competition and training. UK anti-doping projects ensures that UK professional and recreational athletes do not accidently, or intentionally, use PPD's, thus gaining an unfair advantage over their competitors. A study by Winand, (2015) utilised interviews to identify problems with current UK anti-doping strategies. Allocation of funds, relevant information, efficacy of programmes and quantifiable measures, were all areas that required attention. This thesis conducted five studies in order to inform anti-doping programs.

Study 1 compared two indirect prevalence methods which offer protection beyond anonymity. This study highlighted the skewing effect that strategic responding causes when using the 'Unrelated Question Model'.

Study 2 utilised the search engine 'Google' to identify key areas where anti-doping education would most be useful. The study showed 'Google' efficacy in finding key areas where anti-doping programmes could be effective.

Study 3 looked to profile individuals that were thinking about using (TU) PPD's and compared said profiles to current/past users and non-users. After twelve months, TU were contacted to see if they had initiated PPD use. The number of users in the respondents gym social group, and the belief that they couldn't achieve performance goals without using PPD's, were both predictors of future use.

Study 4 assessed the order of supplements prior to PPD use in an attempt to map key stages of supplementation. Creatine and prohormones were identified as key supplements in the process towards PPD use.

Study 5 looked at positional and social circle influences on PPD use. Positions which involve explosive power were identified as high risk, and social circles within a team, were shown to have varying attitudes towards other social circles within the team.

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LIST OF ABBREVIATIONS

AAS – Anabolic androgenic steroids

ADAMS - Anti-doping administration and management system

ABP – Athlete biological passport

ADP – Adenosine diphosphate

AGTS - Individual attraction to group-social

AMF – American football

ATGT - Individual attraction to group-task

ATP – Adenosine triphosphate

BALCO – Bay Area Laboratory Cooperative

BCAA – Branch chain amino acid

BMI – Body mass index

CB – Corner back

CNS – Central nervous system

CU – Current user

DB – Defensive back

DL – Defensive line

EPO – Erythropoietin

FB – Football

FDA - Functional focus doping attitude

FPU – Functional approach to use

FS – Forced response

GEQ – Group environment questionnaire

GIS - Group integration-social

GIT - Group integration-task

HS – Herbal supplements

IADA – International anti-doping agreement

ICT – Item count techniques

INADO- Institute of national anti-doping organisation

IOC – International Olympic Committee

LB – Line backer

LCMPE – Life cycle model of performance enhancement

MBAS – Male body attitude scale

MDA - Morally framed doping attitude

NC – Never considered

NCAA – National collegiate athletic association

OF – Offensive line

PEGA - performance enhancement goal attitude

PNS – Peripheral nervous system

PPD – Prohibited performance drugs

PWM – Prototype willingness model

RB – Running back

RBG – Rule breaking in general

rHuEPO – Recumbent human erythropoietin

RRT – Random response techniques

S – Safety

SDT – Self-determination theory

SNP – Single nucleotide polymorphism

SSC – Single sample count

TE – Tight end

THG – Tetrahydrogestrinone

TPB – Theory of planned behaviour

TU – Thinking about using

UKAD – UK anti-doping

ULC – Unmatched list count

UNESC0 – United nations educational scientific and cultural organisation

UQM – Unrelated question model

VTA – Ventral tegmental area

WA – Whereabouts scheme

WADA – World anti-doping agency

WR – Wide receiver

CHAPTER 1: INTRODUCTION

Sports can play an important role in various social, financial and political aspects of life. Socially, sports can provide a framework by which social relationships can develop (Allen, 2003; Eime, Young, Harvey, Charity, & Payne, 2013). Financially, sports also can generate income in the form of wages, prize money and sponsorship. For instance, Forbes reported Cristiano Ronaldo was the highest paid athlete with an annual turnover of $88 million. This can be particularly alluring to people from underprivileged background (Njelesani, Gibson, Cameron, Nixon, & Polatajko, 2015). Politically, national success in major sporting events provide countries with a level of prestige (Grix & Carmichael, 2012). Sporting benefits can act as major cheating motivator for individuals, teams (Wintermantel, Wachsmuth, & Schmidt, 2016) and more recently, national governing involvement (Platonov, 2016). Sporting framework provides structure in the form of rules and regulation to allow all competitors to compete on a level playing field. Cheating, which is directly observed by officials, can be dealt with according to the sporting guidelines., For example, a fighter, consistently conducting a low blow, will be deducted a point. Cheating that cannot be seen make it difficult for the relevant authorities to identify these individuals and implement relevant repercussions. Prohibited performance drugs (PPD), like erythropoietin (EPO) or anabolic androgenic steroids (AAS), are substances which can be ingested or injected, making it difficult for detection without specialised equipment. Even with specialised equipment, users are finding ways to circumvent these tests, ranging from low level masking agents (Cadwallader, De La Torre, Tieri, & Botrè, 2010), to elaborate business sponsored drugs designed to circumvent the testing procedures (Athey & Bouchard, 2013). In the general population, UK law states, AAS's are considered as class C drugs under the Misuse of Drugs Act 1971. A class C drug in the UK is supposed to carry a maximum sentence of 2 years in jail , plus a fine for possession, yet this does not apply to AAS (Hanley & Coomber, 2016). Although those caught supplying AAS illegally will incur up to 14 years in jail, plus a fine. The sporting community didn't feel it was appropriate to follow criminal law. It looked to establish framework for identification and punishment of PPD use (Hunt, Dimeo, & Jedlicka, 2012). So began a cat and mouse game, where by, cheaters sort to circumvent the rules, via illicit supplementation, and sporting authorities sought to stop them, in order to preserve an ideology of clean and fair sports (Willick, Miller, & Eichner, 2016).

1.1. What is a sports supplement?

A supplement is defined as something that is added to something else in order to enhance or complete it (Dictionary.com, 2016). Sports supplements are substances that individuals can take to 'enhance' their sporting performance. There are various sporting performance attributes which supplements can enhance; power (Stellingwerff, Maughan, & Burke, 2011), strength (Nissen & Sharp, 2008), and endurance (Branch, 2003) are the most commonly supplemented attributes. For instance, a study on the effects of creatine on resistance training, found that after nine weeks of creatine monohydrate supplementation, strength and peak torque significantly improved over the other groups (Bemben, Bemben, Loftiss, & Knehans, 2001).

In the majority of cases, supplementation is in legal form, i.e. anyone can purchase it from a retailer. There are also supplements which enhance performance which are illegal in the general population. Then there are supplements which are legal for the everyday population but prohibited from sports competitions. Various papers classify these in various ways. For the purpose of this paper, we will refer to them as PPD and define them as a legal or illegal substance, prohibited in sporting competitions and whilst training for said competitions. These supplements pose a potential threat to athlete populations as some PPD's are readily available, and without relevant knowledge, athletes could inadvertently break the rules without knowing (Baylis, Cameron-Smith, & Burke, 2001). There also is a potential that these supplements can provide a gateway to illegal PPD's (Backhouse, Whitaker, & Petróczi, 2013; Petroczi, Mazanov, & Naughton, 2011).

1.2. Athletic vs recreational supplementation

It should be acknowledged that athletes and recreational gym users are motivated to use supplements via different means. Athletes tend to utilise supplements which complement their particular sporting performance attributes, (Maughan, Depiesse, & Geyer, 2007). For instance, a sprinter requires explosive speed.

Recreational supplement users are motivated by visual aspects associated with certain supplements (Atkinson, 2007). For instance, 'fat burners' are claimed to reduce body fat via increasing metabolism or energy expenditure thus giving a more lean athletic look (Jeukendrup & Randell, 2011).

There is a level of overlap between athletic and recreational supplementation. A supplement that increases muscle strength is more than likely to change the visual composition of said muscle (Hayashida, Tanimoto, Takahashi, Kusabiraki, & Tamaki, 2014). Research has shown PPD use is not necessarily motivated by sports participation. For instance, a study of 1955 adult males found that sport or professional body building did not motivate them to use PPD. Rather, use was for the substance's specific actions (Cohen, Collins, Darkes, & Gwartney, 2007). Increasing muscle mass, increasing strength, and looking good were the top three motivators for PPD's use. This suggests that it is the functionality of the substance which attracts users. Although, there are apparent similarities to recreational and athletic PPD use, athletic users have additional risks with use (Dilger, Frick, & Tolsdorf, 2007). As well as potential health implications, (Pärssinen & Seppälä, 2002), athletes also risk fines, social humiliation up to a global scale, and risk a ban from their sport. (Whitaker & Backhouse, 2016). It should be noted that it is common for recreational gym users and athletes to train in the same vicinity (Crossley, 2006). Athletes who associate with users pose a higher risk of PPD use, as associate PPD users can provide first-hand experience (Lentillon-Kaestner & Carstairs, 2010) and even access (Grogan, Shepherd, Evans, Wright, & Hunter, 2006).

1.3. The illegal PPD health concern

PPD use is increasingly becoming a public concern as well as a sporting one. For instance, males will take AAS in order to achieve a muscular athletic look, otherwise achieved through rigorous lengthy training, in reduced time frames (Peixotolabre, 2002). The variety and the severity of the side effects exhibited from use are the main drivers for concern, in both the public and athletic communities (Tokish, Kocher, & Hawkins, 2004). Side effects are dependent on the form and amount used. For instance, supra-physiological doses of androgenic anabolic steroid have exhibited signs of suppression of the hypothalamicpituitary-testicular axis, cardiac trauma and even death (Birzniece, 2015). The most common cause of these cardiac events is concentric cardiac hypertrophy, dilated cardiomyopathy, fibrosis and myocytolysis, with significantly lower left ventricular ejection, fraction, and diastolic dysfunction (Birzniece, 2015). The primary function of AAS is to increase the size and strength of muscles, yet it still requires contraction (concentric or eccentric) of the muscle in order for the adaptions to be made. Even before the introduction of anabolic steroids to a training program, research had shown that left ventricle thickening can occur in extreme resistance power lifting programs (Dickerman, Schaller, Mcconathy, & Words, 1998). The introduction of AAS has the potential to further compound this phenomenon. Growth hormone, (GH) another commonly used anabolic agent, manipulates protein synthesis pathways, conserving protein whilst conducting physical activity and can stimulate cellular growth (mediated by IGF-1). Abusers of GH run the risk of muscle weakening, fatigue, myopathy, hypertension, risk of diabetes, malignant neoplasm, cardiac, and articular complications (Birzniece, 2015). These two are the most commonly discussed forms of PPD's in recreational users (Pineau et al., 2016) and are also used by athletes to gain an advantage over others (Berning, Adams, & Stamford, 2004;

Birzniece, 2015). GH and AAS are anabolic in nature, thus suiting sports where muscular strength and power are paramount to success. Endurance athletes are more likely to use erythropoietin due to the fact it increases the oxygen carrying capacity of the blood (Robinson et al., 2006). This is achieved by elevating haemoglobin and haematocrit, which in turn significantly increases endurance. Adverse effects include; elevated blood pressure, nausea, headaches, dizziness, arthralgia, and allergic and anaphylactic reactions, and more seriously, an increased risk of thrombosis, myocardial infraction, or a stroke (Tokish et al., 2004). These apparent health risks should dissuade PPD use, yet individuals still will partake in this type of behaviour. Hence, the reason researchers have dedicated increasing amounts of time in an attempt to understand the influencing factors associated with PPD behaviour.

1.4. Measuring prevalence

In order to establish the extent of the problem behaviour, it is important to ascertain the prevalence as accurately as possible. PPD use is generally associated with cheating, mainly due to their misuse during professional sporting competitions (Ehrnborg & Rosén, 2009; Fitch, 2008; Petróczi, 2013). In sport the use of PPD's is called doping, this behaviour sets to taint the image of a 'sound mind in a sound body' and is considered against fair play or taboo in not only sporting circles but in recreational gym users too (Ehrnborg & Rosén, 2009). For instance a study which took every day gym goers and assigned them a vignette describing them as a competitive athlete PPD user or recreational PPD user (Dawes & Dukes, 2011). Competitive users were considered as someone who should be ashamed and should be punished in some way or another. As use of PPD's in a sporting sense is considered taboo, it makes it difficult for researchers to gain accurate prevalence data (Gucciardi, Jalleh, & Donovan, 2010, 2011; Maycock & Howat, 2007; Petróczi et al., 2011). Social desirability in a research, refers to a bias which encourages respondents to answer questions in a way which may seem favourable to others. As athletes run the risk of life time bans, social exile, potential legal ramifications as well as health risks they are more likely to deny use of PPD's, when self-reporting. This response bias skews prevalence data thus reducing the accuracy and potentially giving a reduced prevalence rating (Petróczi et al., 2011). Prevalence ratings, in athlete populations, have been shown to range from between 1.2% and 21%, with variation attributed to not only social desirability but sample selection, country of research, sample size and most importantly the assessment method utilised (Sagoe, Molde, Andreassen, Torsheim, & Pallesen, 2014). By not taking into account sampling some studies had mixed samples (male and female), males have been shown to be at a higher risk than females, to drugs that can affect their social standings and self-image (Moon, Hecht, Jackson, & Spellers, 1999). By not segregating the samples, females may reduce prevalence results. Also, not all sports will benefit in the same way (or at all) from PPD use, a PPD which increases muscle size may benefit a sport like rugby or American football. Yet a PPD which greatly increases endurance would more than likely benefit a long-distance cyclist. The relevant PPD's must be matched to the sport in order to obtain a clear prevalence rating in the context of the sport. Sagoe et al., (2014) highlights, assessment method as significant predictor of prevalence as various methods can elicit variations in results. Below are various methods utilised to obtain prevalence of PPD use:

1.4.1. Self-Reporting Direct Methods

Surveys are the cheapest and most convenient tool, in assessing PPD prevalence. Costs usually equate to paper, pens and if they are hosted on the internet, site costs. A drawback to this method, is when self-reporting requires the respondent to be truthful, about something that will frame them in a negative way. It has been shown that respondents will be less forthcoming in these situations (Holtgraves, 2004). Being less than forthcoming on sensitive subjects has been said to stem from ego defensive or impression management reasons (Fisher, 1993; Tourangeau & Yan, 2007). If an athlete is found to be using PPD, they may be labelled as a cheat (Erickson, McKenna, & Backhouse, 2014; Vorstenbosch, 2012), even if that isn't the motivation behind their use. Research has suggested that athletes may not be morally motivated but functionally, in that use isn't to gain an advantage, but as part of a process of learned behaviour (Petróczi, 2013). Yet socially, PPD use is considered immoral, which influences respondents to answer sensitive questions, in a more socially acceptable manner. This phenomenon is called social desirability and is the primary problem when collecting data on sensitive subjects (Fisher, 1993; Gucciardi et al., 2010; Joinson, 1999). One of the proposed solution has been to providing respondents with forms of perceived anonymity (Liu, 2017). By providing respondents with a sense of anonymity, it reduces the chance of judgement.

1.4.2. Increased Anonymity methods

The two most common tools used to combat social desirability, is firstly to disguise the identity of the respondent (Whelan & Carolina, 2007) and secondly to disguise the response to the question. Disguising an identity, involves respondents anonymously completing surveys or providing a code which is not identifiable but can link data (Whelan & Carolina, 2007). This type of method may increase true response rates, as long as respondents feel they are never going to be linked to their responses. Online surveys would further benefit from this method, as there is no face to face interaction. Whereas surveys conducted using pen and paper may still require low level interaction between the researcher and the respondent (Joinson, 1999). These procedural manipulations on the part of the researcher, can further increase the sense of anonymity. For instance, a study on 82 students found that respondents who completed a survey via the Internet, scored significantly lower on a social desirability scale, over pen and paper (Joinson, 1999).

Indirect questioning, enables researchers to disguise the response to question answers. When all data is collated, prevalence can be estimated using probability calculations. These techniques, manipulate the respondents into answering sensitive questions, without fear of repercussions (Lensvelt-Mulders, Hox, & Van Der Heijden, 2005). This also would reduce social desirability biases, stemming from interaction between researcher and respondents. Random response techniques (RRT) was proposed by Warner, (1965), to help combat biases arising from social desirability (Striegel, Ulrich, & Simon, 2010; Ulrich, Schröter, Striegel, & Simon, 2012). The technique utilised known probability devices, like flipping a coin (50% probability), to direct respondents to the questions to be answered, the expression they use to answer the question or give a predetermined response (Blair, Imai, & Zhou, 2015). It is suggested that the noise created by these methods provided the respondents with a sense of anonymity.

These techniques, have been previously used to ascertain doping prevalence in recreational users. A study on 500 individuals, from 49 different fitness centres, estimated that when using RRT, 12.5% of the sample were using drugs of some form (Simon, Striegel, Aust, Dietz, & Ulrich, 2006). The technique's educated estimations, are considered more accurate than direct questioning, yet it should be noted that the mechanisms which give these techniques power can also act against them. RRT's which utilise probability to direct respondents between an innocuous question and a sensitive question (Moshagen, Musch, Ostapczuk, & Zhao, 2010), provide two opportunities for respondents not to tell the truth. The first being untruthful about the sensitive question and the second being untruthful about the randomiser, which directs the respondents to either question. The randomiser usually has a known probability i.e. there is a 50% a coin is heads or tails. This can have an effect on the calculation and skew the resulting prevalence score.

1.4.3. Implicit measures

Surveys and questionnaires can be categorised as an explicit measure. Explicit memory, can be recalled and can be considered conscious and open to manipulation, in cases where social desirability is high (Gucciardi et al., 2010; Holtgraves, 2004; Tourangeau & Yan, 2007). Implicit memory, on the other hand is considered unconscious. Implicit cognition, works on the premise that our knowledge is stored in memory as an associative network, in the form of nodes (Brand, Wolff, & Thieme, 2014). Activating individual nodes, automatically activates other nodes associated with the original node being activated (Brand et al., 2014). An example of this would be a child learning to ride a bike, not riding a bike for years and then still able to ride without relearning the skill. Implicit measures are thought to assess subconscious and uncontrolled thought process, as it doesn't require respondents to make explicit connections or evaluations (Bertram Gawronski, Hofmann, & Wilbur, 2006). Yet recently, it has been suggested that implicit doesn't necessarily mean subconscious or automatic, as nothing about implicit measurement procedures guarantees that respondents are unaware of their responses (Fazio & Olson, 2003; Bertram

Gawronski et al., 2006). In cognitive psychology implicit memory, from a previous event is recalled when it is evident this task has influenced a current task in some way (Fazio & Olson, 2003). It is also still relatively unknown, as to what exactly implicit test measures. Some have said it is important to view implicit measures as not an attitude, but more of an estimation of attitude by indirect means (Fazio & Olson, 2003). Implicit tests are typically time-based, forcing the respondents to answer without specifically thinking about their answer. It involves sorting target constructs, along a polar continuum. For instance, PPDS along a 'ME' or 'NOT ME' continuum. Sorting takes longer if there is a conflict between the target construct and one of the poles. For instance, someone who has a negative attitude towards PPD's may exhibit a conflict between PPD's and 'ME'. Implicit/explicit correlations are typically low, the higher the sensitivity of the target construct (Fazio & Olson, 2003). A study by Petróczi et al., (2010) found contrasting explicit and implicit scores, when the respondents self-reported they were not users but biological testing proved otherwise. Proof of PPD use was assessed using hair samples (Gaillard, Vayssette, & Pépin, 2000) and compared against explicit and implicit measures. Respondents who self-reported PPD use, exhibited high attitude and social projection scores (Petróczi, Mazanov, Nepusz, Backhouse, & Naughton, 2008), which correlated with implicit measures towards use. Whereas PPD users, who self-reported non PPD use, exhibited low attitude and social projection scores, which did not correlate with implicit measures. This suggests that implicit measures may have the ability to give a better insight as to whether or not a respondent associates PPDs in a certain way. It may also be used to validate explicit measures.

Even though these results suggest a more robust testing method, research has shown that implicit testing can still be manipulated (Fiedler & Bluemke, 2005; Schindler, Wolff, Kissler, & Brand, 2015). By slowing down the compatibility trial block, respondents were able to reduce, the difference between the associations. For example, a user, in a PPD me/not me scenario, would slow down the responses to PPD and me association. This would mimic a conflict between PPD and me associations, thus reducing the latency differences the two trials. Although researchers are unsure as to what implicit methods measure, they may be useful in validating the accuracy of explicit measures.

1.4.3. Data Mining

Data mining is the search for useful patterns and relationships, within large datasets (Jun Lee & Siau, 2001). Data mining software utilises advanced algorithms, to sift through mass amounts of data to produce valuable information. Data mining can be utilised to analyse areas, where mass amounts of individuals engage around a domain of a particular substance. For instance, with the emergence of chat rooms and social media platforms, individuals congregate on these platforms to share information. With the increased perceived anonymity provided by online activity (Lee, 2006), individuals are more likely to discuss subjects surrounding PPD use and other sensitive subjects (Skitka & Sargis, 2006). Currently prevalence doping data mining, research strategies are limited to data obtained from direct blood and urine testing. The anti-doping administration and management system (ADAMS) was developed so that collected steroid profiles, from doping control samples can be utilised by labs worldwide and compare them to tested athletes (Geyer, Schänzer, & Thevis, 2014). The ADAMS project contributes to the identification process, thus providing a view of prevalence within these profile guidelines. A major issue with this is that it only can provide prevalence through known profiles, any new PPD's or processes, which haven't been identified may slip through. Langenbucher *et al.,* (2004) utilised the internet to analyse online conversations of 500 AAS users, key findings of the study were aspects of their regime, history of use and use regardless of risk (Skitka & Sargis, 2006). Some data mining tools also have the ability to provide trends and geographical data. A study utilised data mining techniques on various internet sources, in order to identify trends about legal highs (Deluca et al., 2012). The study was able to identify geographical concentrations, of various trending compounds across the world. To this authors knowledge no studies have used data mining to obtain trends and geographical concentrations of PPD drug use. The ability to obtain regional data on PPD users would allow for anti-doping efforts to become more focused.

The internet is arguably the largest data source in the world, with the ability to log forums conversations, social media, website traffic, web searches as well as location and other personal data.

The benefit of collecting this type of data, is that users are more likely to be more forthcoming when speaking on or engaging in sensitive behaviour. Again this is due to the sense of anonymity that the internet can provide (Lee, 2006). Researchers can utilise this data, to gain an insight into phenomenon's which are usually sensitive, to traditional data collection methods. It is important to note that the data source used, may be specific to the region being mined. For instance, China predominantly uses Baidu as a search engine, whereas the rest of the world uses Google (Vaughan & Chen, 2015). There may be potential by incorporating these techniques to gauge national and international interest in PPD's.

1.4.4. Physical testing

Physical testing involves biomedical analysis of compounds or biomarkers of the compounds in either the blood or urine. Urine testing was largely introduced in the 1976 Montreal Olympic Games. The analysis method used, was radio-immunosassy analysis (Ayotte, Goudreault, & Charlebois, 1996; Dugal, Dupuis, & Bertrand, 1977; Saugy, Cardis, Robinson, & Schweizer, 2000).

As technology advanced analysis is now conducted, using a chromatography-mass spectrometer (Saugy et al., 2000). The process involves solid-phase extraction of urine, enzymatic hydrolysis of the glucuro-conjugates, liquid to liquid extraction to basic pH and finally trimethylsilyl derivatization (Saugy et al., 2000). The test aims to find PPD compounds or its metabolites. It should be noted that this form of testing isn't without its flaws, ranging from false positives (Kohler & Lambert, 2002) to cross contamination of nutritional supplements (Geyer et al., 2008).

In the 1970's it was highlighted that haemoglobin concentration and total haemoglobin, when altered positive enhancements to aerobic capacity even in trained athletes (Lundby, Robach, & Saltin, 2012). Since, various blood doping methods have been developed in order to abuse these findings. Erythropoietin (EPO) is a glycoprotein hormone involved in haematopoiesis (production of mature cells in the blood). EPO is produced mainly in the kidneys but also in the liver and the brain in small amounts (Robinson et al., 2006). Recombinant human EPO (rHuEPO) is a synthetic form of EPO which was available in Europe in 1987 and was later banned in 1990 (Robinson et al., 2006). Testing was developed to analyse indirect blood markers (haemoglobin concentration and volume) of use as well as direct detection of rHuEPO and its metabolites in urine. Its expense, sensitivity and handling requirements are huge disadvantages to the process (Robinson et al., 2006).

1.4.4.1. Circumventing testing

As detection techniques have advanced, so have methods to circumvent these tests. For instance, diuretics have been utilised to circumvent testing by increasing urine volume, thus diluting detectable compounds or their metabolites (Cadwallader et al., 2010). It is for this reason, diuretics are also on the WADA prohibited list as a masking agent and are also analysed for (Thevis & Schänzer, 2005). Athletes have gone as far as, using a fake penis with a pump, that releases untainted urine (Squires, 2013). More recently, elaborate schemes have been developed in order to aid large groups of PPD users. For Instance, a company called Bay Area Laboratory Cooperative (BALCO), developed and distributed a PPD that was undetectable to doping analysis techniques (Athey & Bouchard, 2013). By providing athletes with an undetectable PPD, the company is essentially removing the risk of being caught. The company was only identified because someone approached officials with the compound (Athey & Bouchard, 2013). It may have gone undetected for some time if no one had come forward.

Government States, as well as companies have been accused of circumventing testing. Politics has been described as a complex and elusive concept of power (Houlihan, 2000). Sport has been used by states as: a punitive tool, to exacerbate political relations, bring old enemies together (Murray, 2012) and show superiority over political enemies (Hunt, Dimeo, Bowers, & Jedlicka, 2012). Rising powers, like Germany, China and Russia have all been accused of being involved in state sponsored doping cover-ups. For instance, political influences in sport have been documented all the way through the cold war (Cottrell & Nelson, 2011). From 1970s the German Democratic Republic ran a hugely successful state-sponsored doping program in order to win medals and ultimately show superiority in the east (Hunt, Dimeo, Bowers, et al., 2012). Other nations have also been accused of state sponsored doping (Carstairs, 2003; Wintermantel et al., 2016). In the 1990s groups of female swimmers from China tested positive for steroid derivative, dihydrotestosterone and HGH. In the 1998 games, it was widely believed that not only the swimmers but the majority of the Chinese team where involved in state sponsored PPD use (Carstairs, 2003). More recently the Russian athletics federation, has also been involved in masking their doping athletes (Noland, 2016; Platonov, 2016). Grigory Rodchenkov, the former head of the Russian anti-doping centre was involved in creating doping mixtures, organising their administration and sample falsification. It is unclear how widespread the corruption was, but some believe that the corruption went all the way up to President Vladimir Putin (Pound, McLaren, & Younger, 2015). States which are shown to endorse PPD use, by aiding its athletes by masking use, not only help circumvent testing but provide an environment by which doping can thrive. Yet the International Olympic Committee (IOC) is emerging as powerful actor, able to impose sanctions which curb state behaviour (Cottrell & Nelson, 2011).

In order to tackle some of these advancements, WADA has sought to, not only make advancements in their testing, but to introduce procedural changes in the form of the Whereabouts and Biological passport:

1.4.4.2 Whereabouts scheme

PPD's are mainly used out of competition, as users would less likely be detected (Saugy et al., 2000). In order to combat this, WADA developed the whereabouts scheme (WA). The WA scheme requires athletes to inform testing officials, on their location, for a period of time every day (Filosofía et al., 2013; Hanstad & Loland, 2009; Valkenburg, de Hon, & Van Hilvoorde, 2014; Ivan Waddington, 2010). This is thought to reduces the likelihood of out of competition PPD use, as athletes won't know when they are being tested. Missing three WA tests in an eighteen month period will incur a suspension from the sport (Valkenburg et al., 2014). Even though this testing procedure is fairly robust, athletes are still finding ways to circumvent the procedure via sophisticated team doping (Danylchuk, Stegink, & Lebel, 2016), organisational aided doping (Alexander, 2014) and state sponsored doping, previously discussed (Erickson, Backhouse, & Carless, 2016).

1.4.4.3. Biological passport.

Advances in biotechnology, make it difficult to keep up with new drugs on the market which may not be pick up by direct testing methods (Athey & Bouchard, 2013; Sottas, Robinson, Rabin, & Saugy, 2011). The athlete biological passport (ABP) utilises biomarkers in an attempt to view any changes over time. Biomarkers have previously been used in testosterone epi-testosterone ratios, haemoglobin concentration and haematocrit levels (Sottas et al., 2011). In 2009 WADA published guidelines designed to instruct anti-doping programs, on how to implement biological passports. The guidelines cover three main categories of PPD use, blood doping (for instance, use of erythropoietin), anabolic agents (for instance, use of AAS) and growth factors (for instance, use of growth hormone). The ABP's strengths, lie in its potential ability to detect use that may have been missed by traditional testing and even detect PPD's that haven't been discovered yet. This is done by assessing biological changes outside of the normal range (Sottas et al., 2011). In 2008, the international cycling union launched an ABP program, collecting over 850 ABP's (Zorzoli & Rossi, 2010). The study showed cases of extreme reticulocytes percentages (indicating potential PPD use) reduced after the implementation of the program. APB data has yielded prevalence results of between 1 – 48% (Ntoumanis, Ng, Barkoukis, & Backhouse, 2014).

1.5. Transition to use

In order to impart relevant interventions to PPD behaviour, it is important to ascertain how offenders develop and be influenced into said behaviour. To date doping researchers have sought to utilise modelling framework to explain and identify influencing factors on doping intentions and behaviour (Chan et al., 2014; Hauw & McNamee, 2015). Some researchers focus on cognitive processes, which may influence the decision to partake in said behaviour. For instance, rewards, beliefs, attitude, self-efficacy, morality, progressive behaviour as well as the interaction between these influencing factors. Some models focus on environmental processes which can influence behaviour like socialisation, team norms, access, sporting and training environment. Others focus on situational processes, like influencing major life changes.

1.5.1. Rewards

When an athlete decides to dope, there must be some level of reward, otherwise what would be the point in taking the risk? Individuals can be intrinsic and extrinsic motivated. In behavioural science intrinsic motivations, refers to the act of engaging in behaviour for pleasure, satisfaction (derived from accomplishment) and sensation seeking activities. Whereas extrinsic motivations are external rewards. These are traditionally thought of as medals and financial rewards (Bilard, Ninot, & Hauw, 2011) but also include public admiration, identification, avoid punishment (Vassilis Barkoukis, Lazuras, Tsorbatzoudis, & Rodafinos, 2011). In the self-determination theory (SDT) these motivations are considered along a continuum, with intrinsic motivation representing high levels of self-determination, extrinsic motivation representing intermediate levels of self-determination and amotivation (absence of awareness between action and outcome) representing low self-determination. A study by Barkoukis et al., (2011) found that individuals who were intrinsically motivated reported lower scores in past and future PPD use. Yet the methods used to collect past and future use were self-reported and potentially subject to social desirability. The study did test for social desirability and it was shown to have a significant effect on past use.

Previous researchers have also utilised aspects of game theory, to describe how an athlete may be influenced to cheat, for rewards (Shermer, 2008). Game theory looks at the decision-making processes, involved in whether to cheat or not. The prisoners dilemma, a form of game theory posits four scenarios, by which individuals weigh up the benefits and consequences of cheating, in comparison to others. In a doping context; in scenario 1 the athlete and the competitor complies with the rules, therefore there is a level playing field and no chance of consequences. This yields a 'high payoff' as everyone is playing at a level playing field. In scenario 2, the athlete follows the rules but their competitors cheats, therefore their competitors has an advantage over the athlete, but also risks consequences. This yields a 'sucker payoff', which is less than the 'high payoff' due to the competitors advantage. In scenario 3, the athlete cheats but their competitors don't, reversing the advantages and consequences seen in scenario two. This yields a 'temptation payoff', which is the highest payoff of all of the scenarios, as there is a larger chance of the athlete winning, accompanied by a minimal risk of being caught. Lastly in scenario 4, both athlete and competitor cheats, thus levelling the playing field but with a risk of consequences. This yields a ‘low payoff’, the lowest of all of the scenarios, as there is no advantage over competitors but a risk of being caught. In this context the financial accolades associated with winning, can potentially incentivise athletes to use PPD’s, especially individuals from impoverished backgrounds (Tamburrini, 2006). Using semi-structed interviews, Tunisian athletes have been shown to believe that athletes cheat for money:

> "*...the athlete who wants to get a better result does it for the money," adding "...most athletes dope for money rather than for performance*."
>
> (Takta, Takta, & Shephard, 2013, p. 86)

It should be noted that there is a trade-off between benefit and consequence. As the financial benefit increases at some point it might outweigh the potential risks. For some athletes this point may be lower than others. Gender, age and economic factors can all influence this trade-off. Financial gain is more likely to influence male athletes than females as the gap between top earning males compared to females is vast (Humphreys & Ruseski, 2011). As athletes get closer to retirement age, lengthy bans that might otherwise act as a PPD discouragement (Maquirriain & Baglione, 2016) become less so (Maquirriain & Baglione, 2016). Also, an athlete from an impoverished background may be willing to cheat at a lower financial benefit, as it may benefit them more than someone who wasn't. Yet at some financial level it may be tempting to all, Lance Armstrong, a Tour de France cyclist, made over $218 Million over a six year period (Levinson & Novy-Williams, 2013). He is arguably the most successful and profitable doper in history, winning seven titles. He only admitted to his deception, when the statute of limitation enforcement action had past, thus securing the majority of his wealth (McNamee, 2012).

What game theory doesn't consider is a financial gain, from allowing competitors to cheat. It has been suggested that cyclists have been offered money to let others win (Schneider, 2006). This would provide a financial gain from losing, yet it still carries a risk (Hill, 2010). Although this is less likely to be applicable to cheating via doping.

1.5.2. Cognitive Processes

Belief and attitude based models highlight attitudes and beliefs as major influencing factors as to whether or not one will partake in PPD behaviour. For instance belief, attitudes and norms are central to the theory of planned behaviour (TPB) (Ntoumanis et al., 2014) and has been adopted by doping researchers, due to its widely used framework in health related behaviours. The TPB is an evolved version of the theory of reasoned action (TRA), which posits that intentions (the extent to which one plans to engage in behaviour) leads to behaviour, these intentions are made up of attitudes (evaluations of events, ideas, objects or people) and subjective norms (attitudes and behaviour that is considered typical of a group). An individual who has a positive attitude towards PPD use and a belief that they cannot achieve their goals without it is more likely to partake in the behaviour than someone who has a negative attitude towards PPDs. Various researchers have utilised cognitive models for their framework with relative success, for instance Goulet & Valois, (2010) conducted a study on the intensions of 573 athletes to use PPD's. 25.8% admitted to prior use of a PPD with multiple regression identifying behavioural intension (β = 0.34) as the primary predictor of PPD behaviour.

Some believe that PPD users have a win-at-all-costs mentality, thus positively shifting attitudes towards PPD use (Ehrnborg & Rosén, 2009) and potentially causing moral disengagement (Kaye, 2012). Moral disengagement allows for athletes to endorse transgressive acts like PPD use. This is done by reducing accountability (e.g. contaminated substance), distorting the consequences or blaming the victim (e.g. false consensus effect). In a study using the SDT model, moral disengagement was found to be the strongest predictor of positive attitudes towards PPD use (Hodge et al., 2013). Win-at-all-cost mentality feeds into concepts of hyper-masculinity, perpetuated by modern day sport (Stewart & Smith, 2008).

TPB also has beliefs and attitudes at its core but sought to extend the principles of the TRA by adding a perceived behavioural control element (Belief of the amount of control they have over their environment) which also feeds into intension (Chan et al., 2014). Impairment of behavioural control has been said to lead to negative behavioural patterns (Shaw, 2012). The most influencing factor of behavioural control is ones belief in one's ability, otherwise known as self-efficacy. Self-efficacy is an individual's belief in their ability to achieve specific tasks or traverse situations (Bandura, 1977). Arguably PPD use stems from a belief that without using PPDs, individuals lack the natural ability to achieve their goals (Bandura, 1977). Self-efficacy is said to be governed by; performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal (Bandura, 1977). PPD behaviour has the ability to be influenced all four of these aspects (Monroy Anton & Saez Rodriguez, 2011). For instance, an athlete whose performance suggest they lack the ability to compete at high level, may use PPD's to increase their performance to the required level. This can be seen when athletes are transitioning from an amateur to professional level (Lentillon-Kaestner & Carstairs, 2010).

From a very young age there is a belief that PPD use can provide individuals with the ability to achieve their performance goals, regardless of its morality (Monroy Anton & Saez Rodriguez, 2011). A study on 216 adolescents found that even if they hadn't used AAS, they rated the effect it would have on their performance as very high. Perceived AAS use was also shown to increase performance related self-efficacy and positively influenced confidence to compete against other teams as well as contribution to their teams goals. Perception of ones deficiencies plays a large part into ones self-efficacy evaluations. In the context of performance aided enhancement, an athlete may perceive a deficiency in their performance, thus motivating them to seek assistance from methods or substances.

A belief of the importance of supplementation can develop and potentially progress to the point of PPD use. Illicit drug taking has been demonstrated as a product of progressive behaviour in various substances (Beenstock & Rahav, 2002; Kandel, 1975; Kandel, Yamaguchi, & Chen, 1987; Van Ours, 2003). It involves the process of one substance leading to an illicit one. Traditional gateway hypothesis posits that drug use occurs in a chronological order by which one drug leads to another (Hildebrandt, Harty, & Langenbucher, 2012). The gateway theory is underpinned by three principles:

1. "*there is a developmental sequence of involvement with different classes or categories of drugs*"
2. "*use of a drug earlier in the sequence is associated with an increased risk or likelihood of use of a drug later in the sequence*"

3. "*the use of a drug earlier in the sequence, such as alcohol or tobacco, causes the use of a drug later in the sequence, for instance, marijuana.*"

(Karazsia, Crowther, & Galioto, 2013, p129).

Professional athletes who train at high intensities require high levels of nutrients in order to aid development and recovery, legal supplements provide a quick efficient way for athletes administer these nutrients. In a gateway context legal supplementation may lead to future PPD use. PPD researchers have supported these principles, positing that PPD use may stems from an analogous progression of legal supplements (Backhouse et al., 2013; T. L. Dodge & Jaccard, 2006; Hildebrandt et al., 2012; Karazsia et al., 2013). Dodge & Jaccard, (2006) was one of the first to research this phenomenon, the study showed a significant positive relationship between legal supplements use and future PPD use.

It is thought that positive experiences with legal supplements, reinforce supplement behaviour, in a form of positive reinforcement seen in other illicit drug behaviour (Wise & Koob, 2014). This is also supported by Hildebrandt et al., (2012) who demonstrated from a 201 male/female sample, that individuals who used fat burning and muscle building supplements had the strongest beliefs in AAS efficacy and safety. It is important to note, in this study PPD user was required to influence these beliefs. Also not all nutritional supplements can lead to PPD's but ones that exist in the same domain as the intended PPD. Positive experiences from supplements that aren't in the same domain as PPDs, are less likely to influence future use as the experience may not be relatable. Backhouse et al., (2013) study showed, nutritional supplement users reported PPD use, 16.9% higher than non-supplement users did. Nutritional supplement users also had a significantly more positive attitude towards PPD use and belief in the PPD's effectiveness. The study discusses how positive experiences from legal supplements potentially encourages further and progressive use to the point where they use PPD's.

It is important to note that attitudes, beliefs subjective norms and perceived behavioural controls are measured using direct methods thus they are also subject to response biases associated with self-reporting. It is also suggested that this individualistic approach can be limited in that, behaviour is considered without bodily experience, situational factors are considered secondary and the approach fails take into account individuals who unknowingly administer PPD's via contamination or otherwise (Hauw & McNamee, 2015).

1.5.2.1. The athlete mindset: Moral or Functional

It has been proposed that the athlete mindset may consider PPD use as functional and not moral (Petróczi, 2013). Doping in sports is against the rules but is it viewed like that by athletes? Doping is framed as a moralistic action, i.e. if you use PPD's, you do it to circumvent the rules. Yet when striped down, it is just another form of performance enhancement. Sports provides a ridged moralistic framework by which increases in competition level causes an increase in imposed limitations. Athletes experience substance aided training and competition way before being involved in PPD testing. It is this experience which can potentially feed into the PPD mindset. This mindset is linked to the incremental model of doping (IMD). It posits that PPD use is a product of incremental learning, influenced by vulnerability factors, (e.g. injuries, increasing competition level etc.). These factors are controlled by internal and external inhibiting factors, and moderated by social, economic, political and cultural environmental constituencies (e.g. access to PPD's, group norms etc.). Petróczi, (2013) paper highlights that supplement use was seen to align with PPD use estimation more than recreational drugs were, thus highlighting that PPD use exists in the same domain as supplement use. The paper argues that the consideration of PPD's as a functional ergogenic aid may override the notion of it being illegal.

In an athletic sense, PPD use is cheating by using a substance that all other competitors deem as prohibited (Vorstenbosch, 2012). In a personal body building sense, use of PPD's can be considered un-natural, un-healthy and un-sportsmanlike (Filiault & Drummond, 2010). Supplementation, on the other hand, is functional, in that users tend to select supplements which help fulfil their current needs (O'Dea, 2003). Supplementation is continually used and progressed to the point where legal supplements no longer fulfil the needs of the users. It is at this point where conflict may arise between morality and functionality. Up until this point users will progress along a path of identifying their needs and satisfying them over and over again, all the while learning and reinforcing the notion that my body needs something, so I should supplement it. The point at which PPD's become relevant may be seen as just an extension of their past behaviour and not cheating at all.

1.5.3. Environmental processes

Researchers who have had an environmental approach to PPD use, typically focus on the external influences that may influence PPD behaviour. It is not necessarily the building or the setup of the environment but the fact that the setup attracts potential and current users. By creating an environment where potential PPD users can feel comfortable and accepted for their deviant behaviour (Boardley & Grix, 2014). A study has even found that PPD's can be provided by gym staff (Hanley, Coomber, Santos, & Coomber, 2016). Moreover a study highlighted that moral health-related and legal objections could be neutralised by socialising with groups from the same drug culture (Monaghan, 2002). PPD use in some sports is so wide spread it almost becomes a part of the culture of the team and even the sport. For example:

> *"When he [a former professional] said I should go to X [a coach], he told me: 'You choose X or Y, I will give you two numbers. X is one of the best coaches around, but he will*

> *also give you something if you are strong, but you'll have to pay. However, Y [another coach] is very ethical.' (Third team model);"*
>
> (Ohl, Fincoeur, Lentillon-Kaestner, Defrance, & Brissonneau, 2015, p. 875).

Although this interaction may occur, it should be noted that it is dependent on how the team socialises, as well as the type of interaction with senior athletes (Ohl et al., 2015). The interactionalist theory, attempts to explain the social elements of environment. It acknowledges the influential power that individuals have in one's social group and vice versa. Beliefs, identities and values are influenced and developed through social interactions and further on, mould behavioural actions. Actions are not considered right or wrong but are social prescribed in order to strengthen cohesion (Monaghan, 2002). A non-user entering a positive PPD environment, may not only experience reduced social stigmas, but potentially an increased pressure to fit in and conform to the new social norms. In team situations norms, supplement considerations and habits are shared, thus perpetuating an environment where peers influence how the team progress as a unit. This peer guidance may reduce the need for external supervision (i.e. coaching guidance) thus allowing athletes more control and even potentially undermining anti-doping frameworks. Using this approach has unearthed that PPD use occurs in specific cultures (Ohl et al., 2015) and/or community of practice as well as a sequential observation of performance aspirations (Strauss & Yesalis, 1991), career progression and beliefs regarding substance use. Ohl et al, (2015) have specifically highlighted the influence that senior team cyclist have on various aspects doping. In less supervised teams entry points into doping were discussed with the abuse of ‘authorization of use for therapeutic purposes’ a suggested starting point.

If an athlete, who may be against the use of PPDs, enters an environment where a team or group of athletes predominantly utilise PPD’s, they may feel pressure to follow suit or be outcast (Dimeo, Allen, Taylor, Robinson, & Dixon, 2014). Interviews on doping five athletes found that systematic doping within their team sometimes made it ‘unbearable’ and pressured some of them to dope (Kirby, Moran, & Guerin, 2011). Yet for some it wasn’t pressure, it was purely to fit in. Certain sporting cultures and environments promote and perpetuate PPD use. For instance, distance cycling events, like the Tour de France, require athletes to cycle over long distances. For years cyclists have demonstrated how PPD's can be used to circumvent the rules by using various doping methods (Christiansen, 2005) to the point that a sophisticated doping network has been utilised by a group of athletes and support staff (Bell, Ten Have, & Lauchs, 2016). It is this behaviour which leads athletes and even spectators to believe that PPD use is a part of the culture of the sport (Ohl et al., 2015; Schneider, 2006). Past PPD users can provide potential users with information on successful substances and how to circumvent the rules (Ohl et al., 2015). The more team athletes involved in PPD use, the larger the potential pressure to conform to PPD norms of the group (Ohl et al., 2015).

The social circle can even influence access. Various countries have different laws regarding the legality of PPD's. For instance, in the UK, AAS are a class C drug (Misuse of Drug Act, 1971). Some countries like: Mexico, Bahamas, Columbia, Costa Rica, Egypt, Dominican Republic, Greece, India, Puerto Rico and Thailand do not have strict PPD laws and allow consumers to purchase AAS over the counter without a prescription (Hanley & Coomber, 2016). Access to PPD's can be considered a major transitional marker. Ordinarily, an individual may be motivated to exhibit PPD behaviour, but without access, the behaviour cannot be initiated. PPD 'distributors' are individuals with direct access to the drug, who can then distribute it for profit (Kraska, Bussard, & Brent, 2010), to people in their social group or to teammates (Stilger & Yesalis, 1999). A study on 873 student athletes found that forty-nine percent of them could obtain AAS from people in their social group (Stilger & Yesalis, 1999). These included teammates, other athletes, physicians and coaches. Distributors can also provide information on various aspects of PPD use, i.e. administration, side effects, polypharmacy, getting over stigma (Maycock & Howat, 2005). In the past, athletes with distributers in their social circle would have been the only form of access. Gaining and providing access has inherent risks. The risk for an athlete, is attempting to obtain PPDs from someone who could expose their intensions. Whereas the risk for the distributor could mean criminal chargers. Antonopoulos & Hall, (2016) describes a process of trust-building between distributor and buyer. Distributors were witnessed information sharing and mentoring on aspects of training, nutrition and supplements, prior to selling as well as during use. It is important to note with the emergence of online drug markets, with discreet delivery methods, access to PPD's is becoming a lot easier (Cordaro, Lombardo, & Cosentino, 2011; Inciardi et al., 2010; Pirola et al., 2010) and anyone can gain access as well as become distributors.

1.5.4. Situational processes

Various situations have been investigated, which may further exacerbate individual and environmental processes. The situated dynamic approaches look to explain, how situations may influence PPD use. It is underpinned by three principles: Firstly, that behaviour is displayed in a context, secondly, it should be observed in relation to major life changing events and thirdly, justification for behaviour isn't interpreted by cognitive or drive processes but is observed as an interaction between action and situation. In a sporting context a major life change may be a potential sponsorship and or an increase competition. This approach is utilised to observe the respondents in their social environment in order to identify potential situational triggers to PPD action. It should be noted that social elements like providing access, credible information, support, team norm play a role in exacerbating potential use. For instance, as previously described monitory gains can increase the likelihood of PPD use. A study by

Mazanov, Huybers, & Connor, (2011) not only supports this notion but rationalises it as transitional situation. It is believed that PPD use would be discontinued with the initiation of sponsorship, so in order to secure it, there is a potential for use. Conversely the study also proposes scenario by which PPD use might be employed as to maintain sponsorship. If the performance requirements to maintain a competitive level is perceived to be out of reach for the athlete, it can amplify feelings of pressure (Grogan et al., 2006; Lentillon-Kaestner, 2013). Competition can come from within a team for positional places (Smith, 2015), or other pressures associated with competitive sports (Baric, 2011). This pressure to perform can further be amplified if the athlete perceives those in direct competition with them are using PPD's to circumvent the rules (Ehrnborg & Rosén, 2009). This type of situational pressure may influence the athlete to use PPD's to alleviate any perceived short comings in performance.

Success in sport is also dependent on an athlete's ability to stay fit. In sports, where playable positions are competitive, an injured athlete may lose their position to another. As PPD's can speed up recovery from injuries, athletes have been known to utilise them in these situations in order to return to play faster (Horn, Gregory, &

Guskiewicz, 2009). A study by Beiner et al, (1999) assessed the effects of AAS and corticosteroid, on healing injured muscles, in a reproducible muscle contusion injury model in rats. Using histological analysis, proximal, middle and distal samples of the injured site were analysed at two, four and fourteen-day intervals. Results showed that in day two the AAS sample, the injured muscle was significantly weaker than uninjured muscles in tetanus but not in twitch (both were weaker in the control). At day seven both tetanus and twitch, were not significantly different between the uninjured and injured muscle sites, but this was also seen in the control. At day fourteen the injured muscle in the AAS sample were actually stronger, than that of the uninjured muscle site, yet it didn't reach a statistical significance. It was surmised that AAS seem to counteract the catabolic state hence the significant differences observed at day two. Yes, at day fourteen the muscle was stronger, but this highlights its anabolic effects and not its recovery aspects. This can explain why injured athletes may be motivated to use PPD's like AAS. Yet the rapid adaptation observed in the muscle are not matched by less vascular tendons. This can place an increased risk of injury to the area. A study on 2552 retired football players highlighted this fact (Horn et al., 2009). The study found a potential link between self-reported AAS users, and an increase in ligament and cartilaginous injuries, over their carrier. The use of AAS to increase recovery rate, may aid an athlete in returning back to training faster but may be at risk of further injuries due to the speed of muscle healing not matching ligament

By focusing on social interactions in and around sport, a situated understanding can be developed allowing for interventions to be tailored to different sporting situations.

1.6. UK Anti-doping

The research into PPD behaviour is designed to feed into anti-doping campaigns, by which, results from behavioural studies help develop anti-doping interventions. UK anti-doping (UKAD) was created in December 2009 (previously managed by UK Sport). The company oversees anti-doping education, testing programmes for Olympic, Paralympic and professional sports, scientific research and detecting new methods of doping. In UKAD's first year, it was recognised that continuous in-depth knowledge of up to date doping methods was required in order for UKAD to keep up with perpetrators. In order to strengthen

UKAD's international influence, the company has partnerships with the World Anti-doping Agency (WADA), the United Nations Educational Scientific and Cultural Organisation (UNESCO), the Institute of National Anti-doping Organisation (INADO), the Council of Europe and the International Anti-doping agreement (IADA) (UKAD, 2016a).

1.6.1. WADA's influence on UKAD policy

WADA has the largest influence on UKAD direction by providing a code that UKAD should operate by. The WADA code is an internationally distributed document which outlines anti-doping policies, rules and regulations within sports organisations. The document has five international standards: the prohibited list, testing and investigations, laboratories, therapeutic use exemptions, protection of privacy and personal information (WADA, 2015a). Its aim is to encourage international consistency between anti-doping organisations. The code is supposed to continually develop as does doping methods. Since its implementation in 2004, the code has been revised twice, The first revised code was implemented in 2009 and the most recent revision was in 2015.WADA utilises a Whereabouts Scheme (out of competition testing), competition testing, a reporting hotline, and biological passport (biological profiling).These are in the form of, both a deterrent and education, meant to instil the values of: ethics, fair play and honesty, health, excellence in performance, character and education. It is also meant to instil; fun and joy, teamwork, dedication and commitment, respect for rules and laws, respect for self and other participants, courage, community and solidarity (WADA, 2015b).

Anti-doping education can be tailored to fit the specific needs of sports and can develop as research points to potential interventions. According to a UKAD newsletter, the most significant revisions made to education in 2015 were (UKAD, 2015a):

- Separation of information and education (Article 18 WADA, 2015b).
- Information programmes should provide basic anti-doping information (Article 18 WADA, 2015b).
- Education should focus on prevention (Article 18 WADA, 2015b).

- Prevention should be values based and implemented at school level (Article 18 WADA, 2015b).
- All NADO's International Federations, National Olympic and Paralympic Committees must promote anti-doping education.

1.6.2. UKAD Representatives Attitude Towards Programs

The UK's educational programme is called '100% Me' which has reached over 25,000 UK athletes and over 15,000 children (UKAD, 2015b). They provide workshops which educate athletes on the values of sport as well as the risks and responsibilities associated with anti-doping. These workshops are implemented at key stages throughout the athletes career, starting at the school level, all the way up to the professional level (UKAD, 2015b).

Literature on content, efficiency, and attitudes towards the program are scarce. A study conducted by Winand, (2015) interviewed twelve representatives (anti-doping officers, chairs or performance directors) from various UK sports federations, ranging from national to regional level, in regard to anti-doping programs in the UK. The study highlighted various problems pertaining to the UK doping program. Firstly, anti-doping education provided by UK sports federations is more prevalent with high risk sports and funded athletes:

> "*Anyone that is getting UK Sport Lottery funding, they are our absolute priority*" UKAD (Winand, 2015, p. 22)

Yet it was believed that educating sports at recreational level was a waste of resources, even though it is recommended by the WADA code.

> "*It is extremely, extremely difficult to educate further down the pyramid. They don't see it as an issue. Cheating is not an issue.*" (Participant 11) (Winand, 2015, p. 17)

The main issue which arose was the actual logistics of delivering workshops. For instance, different sports encounter additional problems, e.g. it will be easier to deliver a workshop to a team rather than to multiple individual athletes:

> *"The challenge for us particularly is the logistics. […] we're not a team, we're an individual sport and the individuals train all over the country. Delivering education sessions are logistically a nightmare because they [athletes] do only come together at camps."* (Participant 3) (Winand, 2015, p. 33).

It was believed that educating coaches, as well as athletes, is more beneficial, as coaches are usually employed for long periods. This allows them to reach multiple athletes and would be more likely able to tailor the education to the needs of the sport, making it more interesting and applicable to the athletes:

> "*Evidence suggests that the barrier can be the various levels between us [UKAD] and the athlete, whereby, the information we intend to provide can be dismissed as not relevant, by those other than the athlete themselves.*" UKAD (Winand, 2015, p. 32)

> "*the real thing for us is about educating the coaches because the coaches will be there longer than the [athletes] in many cases.*" (Participant 7) (Winand, 2015, p. 17)

There was also a belief that focus should be on inadvertent doping and not on changing attitudes:

> "*If somebody's deliberately breaking the rules, all that education has no impact at all, it's irrelevant. But what we're trying to make sure – for me, the education side is number 1, it's about making sure that people don't fail their test for something stupid that's avoidable.*" (Participant 2) (Winand, 2015, p. 28)

> "*[anti-doping education] probably prevents the inadvertent kind of drug use which I think is probably the most common anyway, if they're sort of just not aware. […] But […] if somebody's determined to dope, I'm not sure how much education will help them because the bottom line is if they're going to do it, they're going to do it.*" (Participant 12) (Winand, 2015, p. 28)

Worryingly, it has even been suggested that the anti-doping tutors haven't received adequate training to confidently deliver an anti-doping workshop. A study looked the 255 accredited tutors registered on the UK sports database, 19.3% scored between neutral and dissatisfied with the anti-doping training provided to run the workshops (Mottram, Chester, & Gibson, 2008). It is difficult for tutors to quantify the success of schemes that were run.

> "*there are objectives that I set but they're not necessarily quantifiable as such, they're more qualitative.*" (Participant 6) (Winand, 2015, p. 20).

It is important that tutors have quantifiable objectives so that they can assess the success of anti-doping programmes.

In summary, future anti-doping research should focus on educating along the following points:

- Measuring success of anti-doping programs.
- Making anti-doping programmes more relevant to today's supplement climate.
- Utilising anti-doping strategies which can be delivered to individual sports as well as team sports.

1.7. Thesis Overview

The proposed conceptual framework of this research thesis is shown in *Figure 1*. The project is made up of multiple independent studies, which fit into three categorical chapters, designed to inform anti-doping programmes. Each chapter is key to antidoping by aiding identification of individuals who may be 'at risk', or already participating in PPD behaviour, and information which may feed into anti-doping interventions. The chapters are as follows; prevalence, transition and sporting influence.

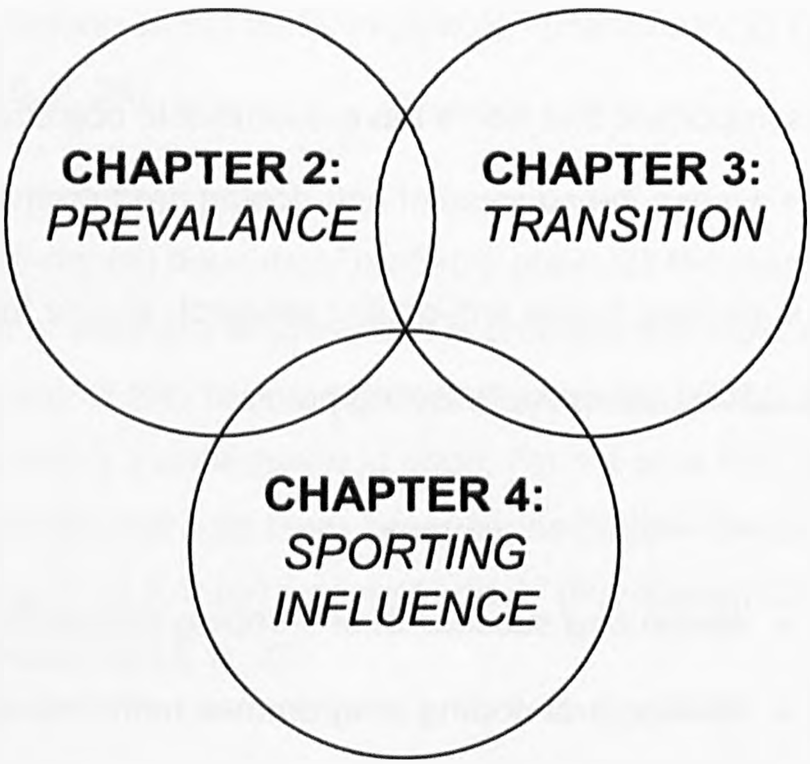


Figure 1. Representation of thesis framework. Each chapter is designed to aid anti-doping movement by accurately identifying PPD use and influencing factors.

1.7.1. Prevalence Chapter: Increasing the accuracy and reach of PPD prevalence measures

The prevalence chapter is intended, to highlight issues regarding current methodologies, utilised to assess prevalence of PPD use. Measuring the prevalence of PPD use helps to identify the extent of the behaviour. Prevalence also provides an overall measure as to the effectiveness of any implemented anti-doping programmes. Therefore, the accuracy of the tools utilised to measure prevalence is paramount to successfully aiding these anti-doping programmes. The following studies are focused on reducing issues surrounding prevalence measures, described in 1.4. Measuring prevalence specifically social desirability biases. In this chapter, the studies will be suggesting and testing potential new methodologies which take advantage of probability measures. In Study 1, will seek to compare the forced response technique, the unrelated question technique against the newly developed item count technique, the single sample count (Blair et al., 2015). Both techniques will be compared against other proven prevalence measures as to ascertain usefulness. Respondents preference will also be assessed, to ascertain which they believe would provide the most protection. Study 2. Will look to utilise the internet based data mining tool Google trends, to ascertain concentrations of interest in the UK.

1.7.2. Transition chapter: Profiling at-risk PPD populations

The mindset of 'at-risk' PPD populations prior to use, can be especially useful to anti-doping projects as it can provide an insight into aspects of cognition prior to use. The following studies will seek to assess elements of transition in order to create, analyse and compare profiles. Study 3, seeks to firstly, identify and profile, individuals at risk of doping, by assessing the similarities and difference, in this population, with the user and non-user communities. Primary focus will be given to social aspects discussed in 1.5.3. Environmental processesperceived deficiencies, perceived barriers, self-efficacy, perceived effectiveness of PPDs discussed in 1.5.2. Cognitive Processesalong with various implicit measures discussed in 1.4.3. Implicit measures Study 4, seeks to map key steps along a path from legal supplementation to PPD use. Transitional gateway theories posit that the use of legal substances can lead to the use of illegal ones (Backhouse et al., 2013). Key supplements as well as drivers will be identified and discussed.

1.5.3. Sporting Influence Chapter: Sporting positional and social influences on PPD use

This chapter intends to highlight, the influence certain sports have on, influencing doping behaviour. Aspects of social network and environment discussed in 1.5.3. Environmental processeswill be the main focus of the final study. Study 5, will look at two different sports (separately) in order to asses team and social hub difference, on various aspects of team, sport and attitude markers. The key areas that this chapter will focus on are; team norms, team cohesion, reporting, pressure to conform and attitudes towards PPD use. The two sports used had largely conflicting cultures in relation to PPDs in sport.

1.8. General Methods

1.8.1. Software and hardware

The Millisecond Inquisit 4.0.9.0 Lab was used to conduct the implicit association testing in chapter 3. Sriram & Greenwald's, (2009) Brief Implicit Association Protocol was modified to measure doping association. Testing was conducted online or on a touch screen HP slate 2 (Intel® Atom™, 1.5GHz processor, 2GB DDR2-SDRAM, using Windows XP operating system). All data collected was moved into Microsoft Word 2010 to be sorted and into PASW 18 (SPSS 18). Meaningful relationships and differences were also calculated using PASWS 18 software.

1.8.2. Anonymity

Due to the sensitivity of the research, participants did not have to disclose any personal information, i.e. name or any other identifiable information. In order to track and match participants, they were asked to disclose the last four digits of their phone number as it was not enough information to identify them, but was memorable enough for the participants to repeat. Participants in study 1, in chapter 3, also were required to provide the first two letters of their residential postcode so that their general location could be mapped.

1.8.3. Compensation

Participants in chapter 2 and 3 were provided with a small token gesture in the form of a £10 voucher (Tesco or Amazon) or a legal supplement. All compensation was expressed when applying for ethical approval. It was offered due to the length of time required to provide data.

1.8.4. Informed consent

Participants in all the studies were fully informed in the form of a printed information sheet or presented on a webpage prior to data collection. Extra emphasis on the level of anonymity was expressed in the information sheet. Before consent was given, participants were given the opportunity to ask questions if anything was unclear or misunderstood. Participants were also informed that they could leave the study at any point. Consent was either directly provided or it was inferred similarly to the Backhouse et al., (2013) study. When consent was inferred, participants were informed that by continuing with the study they would be providing consent.

1.8.5. Ethical Approval

Ethical approval was obtained for each of the studies from the Faculty Research Ethics Committee of the Faculty of Science, Engineering and Computing (Faculty of Science before 2010) of Kingston University, UK (APPENDIX 1. Ethical approvals).

CHAPTER 2: INCREASING THE ACCURACY AND REACH OF PPD PREVALENCE MEASURES

Preamble

Prevalence measures, are notoriously known to be skewed by response bias (Petroczi & Nepusz, 2011). Approaches in this section sets to alleviate this by either, increasing the respondents sense of anonymity in study one, or by retrieving mass data pertaining to the access of PPD's in study 2. Study 1, contains the final version of a manuscript on prevalence estimation models and a potential alternative, which was submitted to Psychology of Sports and Exercise on 18/01/2012 and published 30/08/2016. In this version, PED was changed to PPD to fit the flow of this thesis. Study 1 sets to increase a sense of anonymity by testing various random response models.

Study 2 sets to utilise a global website to acquire location data on individuals wishing to purchase AAS on the Internet. As AAS is the most commonly discussed PPD on Internet forums (Pineau et al., 2016). It has been highlighted that behaviour in online environments may differ from 'real life' behaviour (Joinson, 1999). The most affluent and beneficial difference is that online environments cause users to become disinhibited, thus providing increasing amounts of sensitive information (Joinson, 1999). This study will utilise advances in Internet technology to gain a national view of doping.

STUDY 1. A POTENTIAL INFLATING EFFECT IN ESTIMATION MODELS: CAUTIONARY EVIDENCE FROM COMPARING PERFORMANCE ENHANCING DRUG AND HERBAL HORMONAL SUPPLEMENT USE ESTIMATES

2.1. Abstract

Objectives

This paper compares two indirect prevalence estimation methods that offer protection beyond anonymity. They are suitable for self-administration, for investigating the epidemiology of transgressive behaviour or for socially sensitive behaviours.

Design

In this self-report study, 513 participants (58.7% male) from sports clubs across the UK and Ireland were asked to complete an anonymous survey containing the recently developed Single Sample Count (SSC), along with a comparative method Unrelated Question Model (UQM). This study questioned the respondents on their use of prohibited performance-enhancing drugs (PPD) as sensitive and hormone-boosting herbal supplements (HS) as non-sensitive control questions.

Method

The survey is comprised of sections of SSC, UQM, social projection, and simple network scale-up methods. Respondents were asked to indicate whether they preferred the SSC or UQM for more protection and ease of completion.

Results

A large discrepancy was observed in prevalence estimates for PPD using the UQM (58.4%) and SSC (19.8%), but not for HS (54.9% and 54.0%, respectively). The SSC prevalence estimate for PPD was in keeping with the results from social projection (13.8% in own sport; 26.1% in all sports) and network scale up (19.3% for known and suspected doping combined). A clear preference was logged for SSC.

Conclusion

SSC, but not UQM, showed good concurrent validity with social projection and personal networks for PPD; and good discriminant validity with HS. The observed discrepancy could be explained by strategic responding which can inflate the proportion of ‘yes’ answers in the UQM. Adaptation of the UQM for self-

administration may lead to an unwanted upward response distortion via strategic responding.

Keywords: random response; doping; prevalence; epidemiology; survey; athlete.

2.2. Introduction

The global prevalence of doping abuse in sports is unknown, despite the extensive research effort to characterise it in the last decade (Petroczi & Naughton, 2011). Anabolic androgenic steroids (AAS), the most common form of prohibited performance enhancing drugs (PPD), are well documented for their positive and negative effects on the body (Maravelias, Dona & Stefanidou, 2005; Sjöqvist, Garle & Rane, 2008; Kanayama, Hudson & Pope, 2010); and they are reported to be used among bodybuilders (Goldfield, 2009; Kutscher, Lund & Perry, 2002; Perry, Lund, Deninger, Kutscher & Schneider, 2005) and athletes (Bahrke & Yesalis, 2004). Blood doping is estimated at 14% of world-class track and field athletes or up to 20% among endurance track and field athletes using the biological passport approach (Sottas, Robinson, Fischetto, Dolle, Alonso & Saugy, 2011). Yet, results from prevalence studies present in the literature are hardly comparable or suitable for collation owing to methodological differences. As a consequence, epidemiology of doping is still widely untested, making it difficult to justify investment into such measures to evaluate the effectiveness of anti-doping efforts. Governing bodies and policy makers require evidence-based insight into the prevalence of PPD use in athletes and fitness populations, both to inform resource allocation to this increasing public health concern and to deploy appropriate preventive policies.

Owing to the negative connotations attached to the use of AAS and PPDs in general, among competitive athletes, acquiring credible prevalence data in this area has proved to be problematic (Lentillon-Kaestner & Ohl, 2011; Petróczi & Naughton, 2011; Petroczi & Haugen, 2012). PPD use among body builders and hardcore gym users are not only generally accepted, but viewed as a positive behaviour, and as being part of the bodybuilder identity (Probert, Leberman & Palmer, 2007; Probert & Leberman, 2009). The public expect athletes, in traditional Olympic sports, to break records and perfect their athletic performances while remaining clean of PPDs (Christiansen, 2010; Kreft, 2011; Bloodworth & McNamee, 2010).

The already convoluted situation is further aggravated by the fact that beyond the social stigma and consequences in the sporting context, the use of some PPD's, such as AAS can have legal ramifications. In sporting circles, the use of PPD's can warrant some sort of retribution, up to a lifetime ban, depending on the sport and its governing organisation (McNamee & Tarasti, 2009). Socially, the use of PPDs can be considered as cheating by forcing the body to go past its genetic barriers (Foddy & Savulescu, 2007).

The use of performance enhancing substances is a growing concern in sports and beyond. Despite its importance, epidemiological studies of PPD use are not yet available. Research, conducted in this area, is segmented, and owing to the lack of uniformity in methods and sampling, the results are hardly comparable. In addition, large scale studies are based on self-reports, where, owing to the negative connotations attached to doping, respondents are believed to be subject to a reporting bias, thus skewing results of individual studies as well as the research area as a whole on doping.

On the other hand, a plethora of dietary supplements are available on the market with proven and putative effects on sports performance, some being on a par with prohibited substances

(Maughan, 2005; Maughan, Greenhaff & Hespel, 2011). Herbal hormone supplements (HS) can be bought from most herbal shops. Although they primarily come from natural sources and are legal to purchase, some fall under the WADA List of Prohibited Substances (WADA, 2012). Owing to its putative testosterone boosting effect, one particular HS, *Tribulus Terrestris,* has been widely used by bodybuilders, and is gaining popularity among male athletes and supplement producers alike. A patent has been filed for a food supplement for athletic performance enhancement containing *Tribulus Terrestris* extract (Golini, 2011; Rodriguez, 2009). Supplement use by polypharmacy and/or supraphysiologic doses, is considered to be accepted or often encouraged behaviour among athletes. Thus, self-reports on supplement use are less likely to be influenced by reporting bias.

2.3. Reporting bias effect

Tourangeau and Yan (2007) separated reporting bias into three categories: social desirability, risk of disclosure, and invasion of privacy. Social desirability refers to subjects who answer questions however they feel it is socially acceptable. For instance, if a coach asks one of their athletes if they have smoked or taken any drugs, the athlete is likely to answer 'no' because in the general athletic community such behaviour is outcast. Invasion of privacy is when the subjects feel the questions being asked are intrusive in some way. Risk of disclosure refers to the information provided being passed on to a significant third party, for example, if a researcher feels the information gathered from a participant warrants being reported to the police.

Reporting bias can be significantly reduced if the respondents believe that their identities, as well as the answers they give, are kept confidential. This can be achieved by simply not including names or using other forms, for example, identifying them by the last four digits of their phone number. Alternatively, indirect methods may be used in collecting sensitive information (Krumpal, 2011; Tourangeau & Yan, 2007). These techniques include methods that rely on creating the impression that untruthful answers can be detected (i.e. the one known as 'bogus pipeline'), giving upfront forgiveness for the questionable behaviour by the way the question is phrased, or using a survey design that makes it impossible for the researcher to relate the answers to individuals but affords prevalence estimation at group levels (e.g. the methods using random responses or otherwise mask direct responses). To date, various randomised response models have been developed in order to mask individual responses (Lensvelt-Mulders, Hox, & van der Heijden, 2005a).

2.4. Indirect response models for prevalence estimation

Obtaining reliable prevalence estimates for transgressive or socially sensitive behaviours is obstructed by the respondents' reluctance to truthfully report on their behaviour, indirect methods offering protection over and above anonymity have been developed to reduce evasive responding (Peeters, Lensvelt-Mulders & Lasthuizen, 2010). In the early days, Warner (1965) developed the technique whereby respondents could answer sensitive questions in a way in which their responses remain confidential to them. It works by the use of a randomising device with known probability of the outcome. The randomising device (e.g. a dice, a stack of cards or a spinner) is used to identify which question must be answered. As the only person that can see the randomising device is the respondent. The researcher does not know which question has been answered by which individual, thus providing protection beyond anonymity. The prevalence of the sensitive question is then calculated via the known probabilities for the outcomes of the randomising device and the probabilities of the non-sensitive questions.

In addition to the constant emergence of new models (e.g. Diana & Perri, 2010; Pal & Singh, 2012; Yu, Tian & Tang, 2008), sustained effort has been made to improve the efficiency of exiting methods. A comparison of six statistically equivalent random response models, namely the original Warner's Design, the Forced Response (FR) Technique, Unrelated Question Model, with known and unknown population prevalence for the unrelated question, Moors's Design and Mangat's Improved Model, revealed important aspects in improving efficiency (Lensvelt-Mulders, Hox, van der Heijden & Maas, 2005b). Among these models, UQM, with known population prevalence for the innocuous question, has been found to be one of the most efficient methods for a situation with low population prevalence. It is more psychologically acceptable, owing to using personal but innocuous questions, such as, one's birthday, for the unrelated question.

As alternative to random response techniques (RRTs), estimation models, not reliant on randomization, have also been developed. The key characteristic of these models is that the question about two or more unrelated personal events (including the sensitive target question) is answered with a single response: the total number of the affirmative answers in the Item Count Techniques (ICT) or yes/no answer in the Unrelated Question Method (Greenberg, Abul-Ela, Simmons & Horvitz, 1969) or in the Crosswise or Triangular Models (Yu, et al., 2008). A more detailed discussion of the non-randomized models is presented in Petróczi, Cross, Taft, Shah, Deshmukh, Nepusz & et al. (2011a) and Ming, Tian & Tan (2009).

2.4.1. The Unrelated Question method

The Unrelated Question Model (UQM) consists of only two questions, one of which refers to the sensitive area being researched and the other question is completely unrelated (Greenberg, et al., 1969). Due to this design, Greenberg, et al. (1969) posits that respondents are more likely to be truthful. Respondents who use the randomising device are instructed on which of the two questions they must answer, and just as in Warner's Model (1965), the researcher is blind to the randomizing device, and thus, does not know which question has been answered. This allows the respondent to gain a sense of anonymity when answering the sensitive question. Notably, in the original methods, the randomisation to determine which question in the UQM is to be answered, was done via a device (card, dice or coins) where the outcome was beyond the respondents' control (Lensvelt-Mulders, et al., 2005b). This approach, however, makes the method cumbersome for self-administration.

2.4.2. Randomization methods for self-administration

The instructions for the randomiser can be designed so that it gives an increased sense of anonymity and an increased probability that the survey is completed and the sensitive question is answered truthfully. For instance, respondents are asked to think of someone's (mother, father, partner, best friend, or even their own) birthday which serves as a randomising device. Here, depending on the instructions, respondents are asked to answer the sensitive target question with *p* probability. This approach, for example, has been used in the self-administered FR Model. Respondents were instructed to say 'yes' to the sensitive question, irrespective of the true answers to the sensitive target question, if their mothers' birthday was in the first 4 months

(January – April), and answer the sensitive target question honestly for the remaining 8 months (Pitsch & Emrich, 2011). In this self-administered scenario, the sensitive question is answered with 2/3 probability. Respondents' birthdays have been used as a randomisation device in a multiple question-design with a built-in cheating detection (Moshagen & Musch, 2011). Studies on domestic violence and voting (Moshagen, Musch & Erdfelder, 2012) and attitudes toward disabled people (Ostapczuk & Musch, 2011) have all used this method for self-administered surveys.

An alternative to this is, if the birthday in question is in the first third of the month, respondents must answer the non-sensitive question and if it is in the rest of the month, they must answer the sensitive question, which also gives 2/3 probability for the sensitive question to be answered. The advantage of this approach is that as a randomiser device (card, dice or spinner) is no longer needed. Data can be collected without the need for an interviewer or active randomising, and thus it is suitable for self-administration. Theoretically, this approach can even be taken one step further, where the person whose birthday serves as a randomiser is not specified. Allowing respondents to choose this person, without revealing this information, further enhances protection but also caters for all eventualities in an unknown, diverse and large population (e.g. someone does not have a partner, does not know his/her father's birthday, or is unsure if the parent's birthday should be the biological or foster parent, etc.). However, the effect of this alteration on the outcome is yet to be determined.

2.4.3. Alternative approaches

There are various issues with using the RRT method, primarily, the reluctance of saying 'yes' in the FR variations and the 'false no' bias (a phenomenon that is also known as 'self-protective-no-saying'), where respondents answer 'no' even if it is not the case. This can increase the likelihood of errors. In addition, models relying on unknown population prevalence for the non-sensitive unrelated questions require double sampling in order to establish probability values for the non-sensitive questions. Constant efforts have been made to improve the existing models (Lensvelt-Mulders, et al., 2005b) or develop new approaches (e.g. Diana & Perri, 2010; Pal & Singh, 2012; Tian, Yu, Tang & Geng, 2007; Yan, 2006; Yu, Tian & Tang, 2008). However, RRT models have been developed, not only to protect the respondents, but also to provide protection for the researcher from embarrassment (in personal interviews), or to address the gap between the legal requirements of reporting certain behaviour and the assurance of confidentiality, which is often part of the consenting process. To address some of these concerns associated with the RRT approach, recently, a new method of collecting sensitive data has been developed, called the Single Sample Count (SSC) (Petróczi, et al., 2011a).

2.4.4. The Single Sample Count method

The SSC is a simplified version of the Unmatched List Count (ULC) (Dalton, Wimbusch & Daily, 1994), but unlike the ULC, the SSC only requires an experimental sample as it does not need controls to establish population probability for the non-sensitive questions. The control is built into the questionnaire via four independent questions with known probability. In the SSC method, respondents are given five dichotomous questions, four of which are innocuous, with a known probability (p = 0.5 each) and the fifth question refers to the sensitive area being researched. The respondent must then note how many in total of the questions they answer 'yes' to, without revealing individual answers. This system allows respondents to answer truthfully, without the fear of the researcher knowing exactly which of the questions solicited the 'yes' answers. Owing to the design, the model has four degrees of freedom and the unknown probability of the target sensitive question can be easily calculated from the sum of 'yes' answers and the known probability of the four innocuous questions. The simplicity of this fuzzy response format is attractive for researchers and may reduce errors found in other RRT models owing to a reluctance to forced responses, an easy option for self-protective-no-saying, and a lack of complexity in the instructions.

2.5. Estimation of doping prevalence

The reported rate of doping prevalence varies widely depending on the method used to derive the estimate (Petróczi & Naughton, 2011). Analytical findings range around 2% (WADA, 2010), whilst direct self-reports reach 15% among non-elite athletes (Lentillon-Kaestner & Ohl, 2011). Using an array of indirect estimation methods, RRT has been employed in a variety of PPD based studies, with prevalence results ranging up to 35%

(Pitsch, Emrich & Klein, 2007; Pitsch & Emrich, 2011; Simon, Striegel, Aust, Dietz & Ulrich, 2006; Striegel, Ulrich & Simon, 2010), (Pitsch & Emrich, 2011).

Among these indirect estimation models, those suitable for self-administration are desirable for large scale epidemiology, particularly when involving interviewers is not feasible or economical. This project served as an independent pilot study within a collaborative project investigating doping prevalence among elite athletes and compared the recently developed SSC to a modified UQM (World Anti-Doping Agency Doping Prevalence Expert Group, personal communication). Therefore, the primary aim of this study was to establish concurrent and discriminant validity for the SSC, using PPD as sensitive and HS as non-sensitive, control questions. In addition, a secondary aim was to test whether empowering respondents to select the person for the UQM randomiser question had an effect on the outcome, perceived protection and preference. As the project is a step toward the long-term goal of placing the SSC into the array of epidemiology research tools, an auxiliary aim was to ascertain respondents' views on which of models protects them the most.

This would potentially reduce evasiveness; and determine which one is easiest to understand, thus less likely to produce errors.

2.6. Methods

2.6.1. Protocol

Participants were required to complete one of two, randomly allocated, versions of the questionnaire. Both questionnaires consisted of a demographic section, a social projection/network scale-up section, two questions using the SSC method and two using the UQM and a section on preference. The order of the SSC and UQM were alternated to counterbalance any potential order effect, whereas, the PPD question always preceded the HS question in each SSC and UQM block.

2.6.2. Sample

Following ethical approval, club-level athletes were recruited from various sports clubs across the UK and Ireland via personal contacts. No identifiable information was required from the respondents for this study and demographic information was kept to residence area, age and gender, along with sport and educational levels.

Five-hundred and thirteen athletes (58.7% male) participated. The sample composition showed a good geographical spread with no single segment accounting for more than 16% (*Figure 2A*). The mean age of the respondents was 24.18 ± 3.87 years. The highest educational level of the respondents was predominately undergraduate and A levels or equivalent (*Figure 2B*).

Of the 513 respondents, 203 (39.6%) were from a recreational background, defined as participants who conducted their sport with no monetary gain; 297 (57.9%) were from an amateur background, defined as participants who conducted their sport and received a small amount in terms of monetary gain (e.g. for expenses) and 13 (2.5%) were from a semi-professional background, defined as, participants who receive a regular wage for participating in their sport. Respondents were also from a variety of sports but mainly consisted of track and field events (57.8%, details are presented in *Figure 2C*, followed by football (10.5%), rugby (10.4%), rowing (8.2%), boxing (5.7%), cycling (4.1%) and cricket (3.3%).

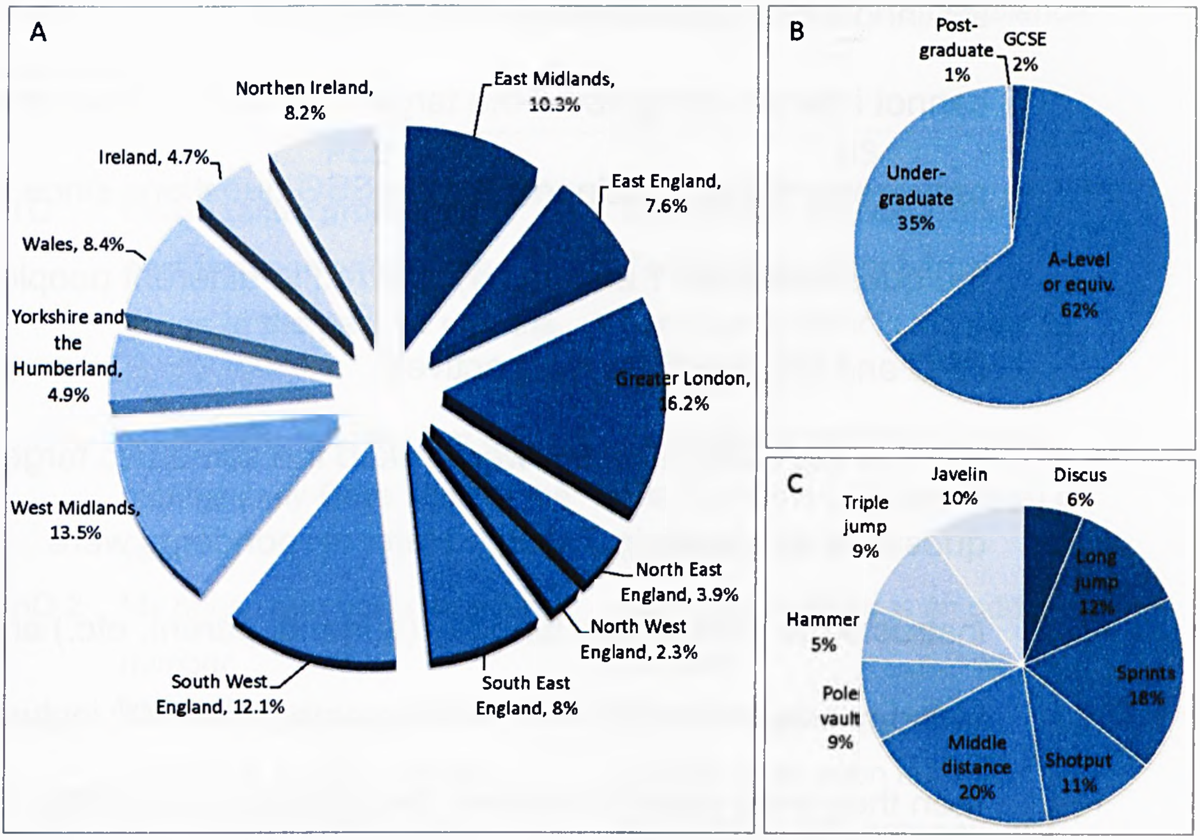


Figure 2. Sample distribution by (A) geographical location of residence (N=513, 100%) and (B) educational level. Panel (C) depicts the representation of disciplines within track and field (N = 296, 100%)

2.6.3. Estimation with SSC and UQM

In the SSC model, participants were asked to complete the SSC for PPD's and HS. Innocuous questions in both SSC sets were with p = 0.5. In order to avoid exposure, the innocuous question sets in which the target PPD and HS questions were embedded were comparable but not identical (*Table 1*). Above statement is unclear. Needs to be tweaked Note that, although, the innocuous questions are direct negations of each other, one cannot infer anything about the target questions by examining the responses of the participants for the SSC questions since two of the questions (InQ 1 and InQ 4) referred to different people in the PPD and HS questions, respectively.

In the UQM, athletes were asked the same two target questions as shown in *Table 1*. Here, respondents were instructed to think of any birthday (a friend, parent, etc.) and if the birthday was in the first third of the month (1^{st} to 10^{th} inclusive) then they were asked to answer the innocuous question, whereas, if the birthday was in the rest of the month, they were asked to answer the target question. The unrelated innocuous question in both UQM was the same, with a probability of 0.5 ('*Is the birthday you are thinking of in the first half of the year?*'). As respondents could freely think of any birthdays unknown to the researcher, having the same innocuous question did not pose a threat of exposure.

Table 1. Questions in the 4+1 SSC model used for PED and HS prevalence estimation.

	PED	HS
TQ	**I have taken prohibited performance enhancing drugs in the past 12 months.**	I have taken tribulus [*Tribulus Terrestris*] or other herbal hormone booster in the past 12 months.
InQ 1	My birthday is in the last 6 months (July-December) of the year.	My mother's birthday is in the first 6 months (January-June) of the year.
InQ 2	My house number is an even number.	My house number is an odd number.
InQ 3	The last digit of my phone number is an odd number.	The last digit of my phone number is an even number.
InQ 4	My mother's birthday falls between January and June.	My birthday falls between July and December.

TQ = Target question, InQ = Inoculons question

2.6.4. Estimation based on others' behaviour

Building on the assumption that people's social networks (the group of people they know) are generally representative of the social surroundings in which they live, we used social projection (Petróczi, Mazanov, Nepusz, Backhouse & Naughton, 2008; Uvacsek, Ránky, Nepusz, Naughton, Mazanov & Petroczi,

2011) and a simplified version of the Network Scale-up Method (Bernard, Hallett, Iovita, Johnsen, Lyerla, McCarthy & et al., 2010) to establish concurrent validity for the SSC and UQM. It has been shown that individuals who partake in a questionable behaviour predict a higher percentage of their social group doing the same and vice versa (Uvacsek, et al., 2011). In addition to a prevalence estimate, it also reveals something about the respondents themselves (Petróczi, Uvacsek, Deshmukh, Shah, Nepusz, & et al., 2011c; Petróczi, Mazanov & Naughton, 2011b). For the social projection question, athletes were asked to estimate the percentage of athletes they believed were taking PPD's in their own sport and sports in general, separately. Zero percentage means nobody whereas 100% means that everybody takes PPD's. As the main focus of this study was on the non-random response models, only a simplified Network Scale-up Method (Bernard, et al., 2010), limited to asking about the size (expressed as number of people) of the athlete's personal network, and the target population (PPD users), was incorporated. Athletes were asked three questions consecutively to indicate; how many athletes they know personally who were using PPD's, how many in their respective sport who were using PPD's and how many athletes they suspect were using PPD's.

The combination of the non-random models, social projection and network scale-up facilitates. Comparing and contrasting information estimated for the athletes' own behaviour, other athletes' PPD taking behaviour, based on subjective normative beliefs, and other athletes' known and suspected behaviour, in the respondent's personal network, respectively. Discriminant validity was shown by duplicating both the SSC and UQM models, with the doping target question replaced by a hormonal supplement (HS) question.

2.6.5. Preference

In the preference section, the respondents were asked which one of the two models they found the easiest to understand and which one they thought protected their anonymity the most. The answer options (showing SSC first or second) were reversed between the two questions.

2.6.6. Data analysis

Prevalence estimate and 95% confidence intervals were calculated for the SSC as described in Petróczi, et al. (2011a), and for the UQM as given in Tourangeau and Yan (2007). Network scale-up estimates for known and suspected PPD use were calculated independently by dividing the sum of the number of athletes known or suspected, by the respondent of using PPD, by the pooled personal network size (number of athletes known by the respondent). Group and gender differences, along with the interaction effect, in prevalence indicators, were detected using ANOVA. Social projections for sport in general and athletes' own sports were compared using repeated measures t-test. Significance was set at $\alpha = 0.05$ for all tests. Statistical analyses were performed in Excel and SPSS 19.0.

2.7. Results

2.7.1. SSC and UQM estimates

The estimation models displayed similar results when estimating prevalence of use of herbal supplementation at all levels, as well as at different sporting involvement and by gender (*Table 2*). In contrast, the SSC estimated the doping prevalence for all levels at 19.88%, whereas, the UQM estimated the prevalence for all levels at 58.41%, approximately 40% over the

SSC estimation. As *Table 2* shows, the UQM estimates for doping and herbal supplementation were very similar for all levels, whereas, the SSC resulted in distinctly different estimates in PPD and HS use across the three sport level groups. Furthermore, the same pattern holds for estimations for male and female athletes separately.

Table 2. Prevalence estimates for doping and herbal hormone supplementation using SSC and UQM, expressed as percentage (95%CIs)

	Prohibited performance-enhancing substance		Herbal supplements with hormonal boosting effect	
	SSC	UQM	SSC	UQM
All	19.88 (10.57, 29.20)	58.42 (52.72, 64.12)	54.00 (44.33, 63.66)	54.87 (49.30, 60.45)
Recreation	31.03 (15.88, 46.19)	61.57 (52.34, 70.80)	41.38 (26.05, 56.71)	48.89 (40.35, 57.41)
Amateur[a]	12.79 (0.80, 24.78)	55.36 (48.00, 62.71)	62.63 (49.99, 75.26)	59.44 (51.90, 66.97)
Male	26.91 (14.55, 39.27)	62.87 (55.20, 70.47)	67.77 (55.30, 80.24)	56.29 (48.95, 63.64)
Female	9.91 (0, 23.95)	52.14 (43.62, 60.67)	36.79 (21.85, 51.74)	52.86 (44.29, 61.42)

[a] includes semi-professional athletes (n = 13)

2.7.2. Estimates from social projection and network scale-up

Indicators of doping prevalence via Social Projection and Network Scale-up are presented in *Table 3*. Projected doping using estimations among fellow athletes were consistently higher for semi-professional and amateur level athletes combined, compared to recreational athletes but without reaching statistical significance ($F(3,509) = 2.900$, $p = 0.089$, $\eta^2 = 0.006$ for social projections for all sports and $F(3,509) = 0.097$, $p = 0.756$, $\eta^2 < 0.001$ for own sport; $F(3,509) = 0.001$, $p = 0.983$, $\eta^2 < 0.001$ for known and $F(3,509) = 0.116$, $p = 0.733$, $\eta^2 < 0.001$for suspected network scale-up estimates.

Table 3. Prevalence estimates for doping using social projection (presented as estimated percentage ± SD) and network scale up method (presented as ratio) by sport levels and gender.

	Social projection	Network scale-up			
	PED in all sports	PED in 'own' sport	PED use known	PED use suspected	Known + suspected
All	26.13 ± 11.28	13.72 ± 15.78	1.30	17.67	18.97
Recreation	24.95 ± 10.76	12.96 ± 12.76	1.56	17.11	18.67
Amateur	26.74 ± 11.46	14.09 ± 17.62	1.02	17.83	18.85
Semi-pro	30.62 ± 14.04	18.85 ± 12.70	3.90	21.43	25.33
Male	26.62 ± 11.95	16.37 ± 18.71	1.97	18.08	20.05
Female	25.43 ± 10.26	10.08 ± 9.09	1.14	12.35	13.49

The social projection showed similar estimations made by male and female athletes when all sports were involved ($F(3,509) = 0.752$, $p = 0.386$, $\eta^2 = 0.001$) but males gave considerably higher estimates for their own sport ($F(3,509) = 16.636$, $p < 0.001$, $\eta^2 = 0.032$). A similar pattern was observed for known ($F(3,509) = 1.182$, $p = 0.277$, $\eta^2 = 0.002$) and suspected PPD use among peers ($F(3,506) = 7.409$, $p = 0.007$, $\eta^2 = 0.014$). Gender and sport level interaction was not observed for any of the four indicators ($F(3,509) = 0.528$, $p = 0.089$, $\eta^2 = 0.006$; $F(3,509) = 2.788$, $p = 0.096$, $\eta^2 = 0.005$; $F(3,509) = 0.026$, $p = 0.872$, $\eta^2 < 0.001$ and $F(3,509) = 2.400$, $p = 0.733$, $\eta^2 < 0.001$, respectively). Notably, social projection within an athletes' own sport was significantly lower than the projected PPD use in sport in general ($t(511) = 17.657$, $p < 0.001$, $d = 0.905$).

2.7.3. Preference

When the respondents were asked which of the two methods they understood the most and which protected them the most, there was a significant difference between which was preferred. Overwhelmingly, 94.70% preferred the SSC, whereas, only 5.30% preferred the UQM. Also, in terms of anonymity, respondents reacted similarly, 87.70% feeling that the SSC protected their answers more than the UQM which came in with , 12.30%. No association was found between gender and protection of privacy or ease of use (Fisher exact test $p = 0.693$ and $p = 0.175$, respectively).

2.8. Discussion

The prevalence of doping is incessantly investigated using various age groups and competitive levels, with estimates varying from 2% to 43% (Petróczi & Naughton, 2011). The large variations can be due to the groups being tested as well as the tools being used to make these estimates. In reference to the tools used for data collection, there seems to be a trade-off between accuracy of the data and the expense in conjunction with time. Although it is automatically assumed that blood, urine and hair testing are objective and accurate, but time consuming and expensive, whereas, questionnaires are cost effective and fast but not accurate. A recent report based on the athletes' haematological profiles indicated that on average 14% of world-class track and field athletes likely used or experimented with blood doping (Sottas, et al., 2011). This figure is well above the approximate 2% adverse analytical findings reported yearly which comprises all types of doping, including the most prevalent steroid doping (WADA, 2010). Analytical methods are further limited by inter-individual genetic and metabolic variations and the practices being used to evade positive doping findings. On the other hand, doping epidemiology research to date is segmented and heavily influenced by sampling and survey methods. This paper, first and foremost, sought to provide evidence for the validity of two models suitable for self-administered surveys, using PPD and HS as testing fields. Two of the outcomes, namely the large difference between the estimates obtained using SSC and UQM for PPD, but not for HS, along with the high prevalence of HS use, were unexpected. In the following section, we discuss possible explanations for these observed phenomena.

2.8.1. Comparisons between substance types

In this survey, respondents were asked about their use of *Tribulus Terrestris* or any herbal hormone stimulants in the last twelve months. Where both the SSC and the UQM estimates were very similar for all the levels combined, as well as the amateur level and the recreational level. The estimates from both models were around 50%, despite that a considerable proportion of the sample being comprised of females. That is, *Tribulus Terrestris* is typically used by males based on the widely held, but unproven belief, about its testosterone altering effect (Borrione, Di Luigi, Maffulli & Pigozzi, 2008; Kreider, Wilborn, Taylor, Campbell, Almada & et al., 2010). One explanation for this is that males have been said to predominantly use supplements to enhance performance whereas females use supplements more for recovery and health (McDowall, 2007). In this study, 58.7% of the respondents were male which would suggest that the respondents who answered yes to the use of herbal supplementation should predominantly be male. Intriguingly, the SSC estimation broken down by gender showed a large difference in HS use, where prevalence among male athletes (67.8%) almost doubled the prevalence reported among their female counterparts (36.8%). Whilst these estimates need to be treated cautiously, owing to the relatively small sample size, it is notable that the UQM did not differentiate significantly between HS use by males and females (56.3% vs. 52.9%, respectively).

There was an increase in both estimated HS and PPD use between recreational and amateur athletes, with higher levels of reported PPD use among recreational athletes being somewhat unexpected. Whilst it is logical to expect some increase in performance enhancing substance use with the increase in level and intensity of training and competition, the recreational level is not generally viewed as having much pressure on performance outcomes. Nor does performance have implications on the livelihood of athletes. The HS use showed the opposite trend. One explanation for this phenomenon could be that as athletes become more focused on training, they seek better ways to accelerate their performance whilst keeping within the rules.

Erdman, Fung and Reimer (2006) suggest that as athletes' competitive levels increase, there is an increase in supplementation, yet they also have increased awareness of doping legislation. Although it could still be considered cheating, the respondents at amateur level are competing at such a low competitive level that repercussions are still very small. There is low risk but high reward, if the respondents move on to the next level.

2.8.2. Normative estimates of PPDs

With regards to social projection, the results showed that the respondents, as a whole, estimated the prevalence of PPD at 26.1%. In the Petróczi, et al. (2008) study, non-users had an average prevalence estimation of 15.3%, whereas users had an average estimation of 35.1%. The social projection in this study is around 10% above the non-user estimation and around 10% lower than the user estimation previously obtained. As social projection works via an increased estimation due to the respondent considering the sensitive behaviour being common, it is fair to assume that the elevated mean estimation suggests that the group tested were likely to consist of individuals who partake in the sensitive behaviour. Notably, social projection, within the athletes' own sport, where athletes are most familiar, and able to make an informed estimation on, but subjectively influenced by the ingroup-outgroup phenomenon (i.e. wanting to maintain the belief that PPD use is more common among others than in peers) was significantly lower than the projected PPD use in sports in general. Taking all these points into consideration, social projection (13.7% - 26.1%) and network scale-up estimation, for combined known and suspected PPD use (19%), were not only reasonably close to each other, but also aligned well with the SSC estimation at 19.9%. Estimation and prevalence indicators broken down by sport involvement levels showed that, as athletes progress through their sporting career, they tend to use PPD's, and to be surrounded by PPD users, to a greater degree.

2.8.3. Comparison of the estimation models

The SSC and UQM prevalence estimates for PPD were very different. In some cases, UQM estimates were nearly double the SSC, with SSC seeming to be much closer to social projection and network scale-up estimations. Intriguingly, explanations of discrepancies in other studies have referred to a 'false no' bias (Coutts & Jann, 2011), as respondents' tended to give a 'no' answer, if they believe that their anonymity is not completely protected, or they are forced to say 'yes' to something that isn't true. Yet 'false no' bias tends to negatively skew the data, thus giving a reduced prevalence estimate, and in this case, the prevalence seems inflated.

Another plausible explanation for discrepancies is that such differences occur when respondents change the results of the randomising device. In this study, it would occur when the respondent is asked to think of a birthday and is then given instructions as to which question to answer. If the respondent does not wish to answer the sensitive question, even though they have been so instructed, to they just need to change the date. This would increase the number of respondents who answer the innocuous question, which could potentially positively skew the data. Both these biases could result from the respondent belief that, in answering the question, they expose personal information about themselves. After all, 87.7% of the respondents felt that the SSC provided them with more protection than the UQM. This supports the premise that the elevated UQM results may be due to a reporting bias.

Figure 3 captures the SSC and UQM estimations for PPD and NS and prevalence indicators for PPD. Whilst SSC estimations were in keeping with the prevalence indicators, and were in the magnitude and direction expected from literature regarding gender and sport involvement differences, UQM estimations did not fit the expected picture. Owing to the scarcity of similar epidemiology studies, there is no straightforward comparison for the estimations obtained via UQM and SSC in this study. One of the two exceptions was a prevalence study in German fitness sports, which estimated doping, particularly AAS prevalence, at 12.5%, using the FR model (Simon, et al., 2006). Given the prevalence of substance use, particularly AAS and stimulants in gyms, and the absence of doping control in this environment, this figure is more in line with the SSC estimation at 19.9%, than the UQM estimation at 58%. A more fitting comparison is reported by Pitsch and Emrich (2011) which obtained very similar prevalence estimates for sub-elite (up to national level) athletes, in a multisport setting, using the FR method. The results showed a comparable level of doping to the SSC estimation in the present study, showing that in 2008, an estimated 15.9% admitted using doping in the current season, with males reporting significantly higher levels (16.5%) than females (1.4%). Notably, the proportion of noncompliance was substantial, constituting some 20-30% of the surveyed population. Pitsch and Emrich (2011) also showed that doping prevalence appears to be higher in sub-elite levels compared to international levels, presumably owing to multiple factors, including the pressure to 'make it to the team/level' and the reduced risk of doping testing. The third study in a similar vein was exclusively conducted among German emerging elite athletes (Striegel, et al., 2010), Hence, owing to the level and age differences, it provides no ready comparison for the present study.

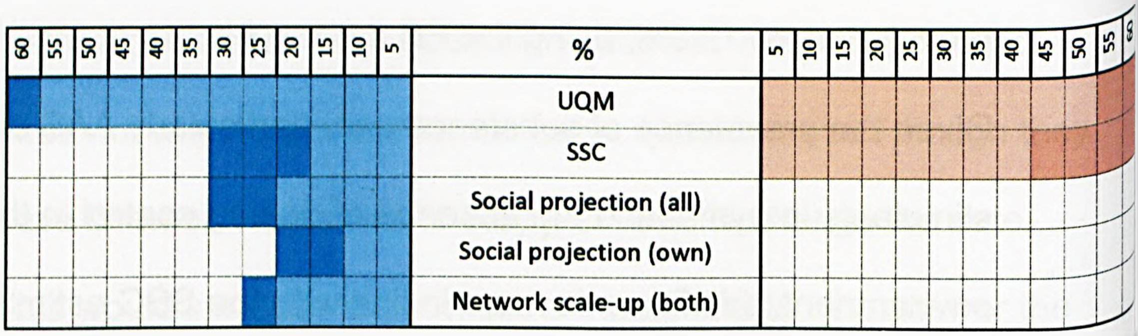


Figure 3. *Comparison of SSC and UQM estimations for PED and NS and prevalence indicators for PED. Shown as percentage, lighter shade denotes recreational, darker shade denotes the addition to the percentage obtained from recreational level athletes for amateur and semi-professional levels combined.*

2.8.4. Noncompliance

Noncompliance has been repeatedly shown in the indirect models affecting a considerable proportion of the responses (e.g. Böckenholt, Barlas & van der Heijden, 2009; Moshagen, et al., 2012; Ostapczuk, Musch & Moshagen, 2011; Pitsch & Emrich, 2011). Therefore, application with cheating detection is highly recommended in situations where response distortion bias is reasonably expected. Paradoxically, if distortion is not anticipated, then there is no reason to trade efficiency of the direct questions for protection by using indirect methods. However, what is considered as 'sensitive' varies greatly from one individual to another and from one culture to another, depending on the prevailing relevant norms in the respondent's social and cultural environment. For example, an athlete maybe more willing to admit illicit drug use if it does not coincide with the list of prohibited performance enhancing substances; or a respondent may be happy to admit illicit drug use under standard anonymity but less willing to report on domestic violence. Therefore, following Chaudhuri and Saha (2005), offering the option to choose between direct reporting and the RRT approach can be extended to a choice between two RRT models – providing they are equally valid, with the same power and similar effectiveness. Undeniably, this approach inevitably increases the time required to complete the survey, thus, it is more suitable for situations in which respondents are not pressured for time and fast completion.

In addition, in order to ensure a high level of compliance, the choice of the randomization device or method is critical. On one hand, respondents must understand and trust the integrity of the randomization process (Landsheer, van der Heijden & van Gils, 1999), but also, it must be feasible, accessible and resistant to manipulation. The UQM Method, with any random person's birthday as randomization, meets some but not all of these criteria, namely, it makes self-administration survey application possible and has a good level of confidence for protection. However, it is open to manipulation even without lying. On the contrary, the SSC contains 4 innocuous but personal questions which afford more flexibility in creating a combination of personal information that is feasible, accessible, and ensures the desired level of confidence in respondents. For example, all four personal questions (birthdays, phone and house numbers) can be about the respondent, or one specific person (e.g. mother, father, partner, best friend); can be one type of personal information (e.g. birthdays) only; or some combination of these. Increase in the number of people used will increase confidence but also the cognitive demand, thus finding the optimal balance depends on the specific context in which the method is employed.

Noncompliance appears to be a major influencing factor for the present project. In the following section, we explore the possibility of strategic responding in the randomizing question and its effect on the observed proportion of 'yes' answers, and thus on the prevalence estimation. Notably, noncompliance is not equivalent to cheating but rather, it refers to events that can be the results of the combination of self-protective' no' saying, random responding arising from 'can't be bothered to think' or 'messing up', strategic responding to avoid of the sensitive question or give false positive answers and lack of understanding. The literature provides ample evidence that, although, random response type models reduce evasiveness, compared to direct self-reports, a significant proportion is still present (Becker, 2010). To estimate and account for cheating, various estimation for random/non-random models has been used and published, ranging from experimental (e.g. Clark & Desharnais, 1998; van den Hout, Böckenholt, van der Heijden, 2010), through survey design (Böckenholt & van der Heijden, 2007), to post-hoc analysis (e.g. Cruyff, van den Hout, van der Heijden, Böckenholt, 2007;

Cruyff, Böckenholt, van den Hout & van der Heijden, 2008; Moshagen, et al., 2012; van den Hout & Klugkist, 2009).

One plausible reason for the reporting bias is that the respondents did not fully understand, from the general format and instructions, how the prevalence estimates were calculated and how it protected their anonymity. Understanding, and the ability to answer a question and follow instructions (Peeters, et al., 2010), are imperative for the accuracy of data being collected. With the estimated prevalence questions used in this study, the understanding of the instructions might be compromised owing to the complexity of the instructions. This can increase the likelihood of error due to honest misunderstanding of the instructions. In this study, in reference to understanding, 94.7% preferred the SSC over UQM. This can be due to the format and instructions for both questions. The SSC requires the respondents to understand the instructions, recall four simple innocuous questions, recall the sensitive question, summate the yes answers, and report. The UQM requires respondents to understand instructions, recall a birthday date, apply the date to an 'if' condition, use that answer to select a question, recall the sensitive question, and report. The UQM is slightly more difficult to follow, possibly suggesting another reason for the elevated UQM estimates, which is, a genuine misunderstanding of the instructions. Due to the SCC's simplicity and comprehension, it is possible that the respondents understand how their answers are masked and their preference is swayed.

2.8.5. The effect of empowerment

Another conceivable explanation is the unwanted effect of empowering respondents to have control over the randomization questions, so the sensitive question can be avoided. Avoiding the situation or question, in which unwelcome information must be revealed has been catalogued as one of the deceiving techniques people employ, if they wish to avoid telling the truth without telling a straightforward lie (von Hippel & Trivers, 2011). Whilst this approach requires more intense cognitive investment from the deceiver, the payoff is low risk to the deceiver (if exposed), coupled with the opportunity of maintaining a favorable self-concept of fully complying with the survey request and being honest, without answering the uncomfortable question on doping.

For practical implications, researchers must keep in mind that the increased security afforded by the technique only addresses one aspect of the question, which is the reduction in evasive responding, but it does not increase the willingness to answer (Peeters, et al., 2010). In the current anti-doping climate, high performing athletes who may use PPD's are not likely motivated to answer, let alone to reveal the truth about their prohibited behavior. Simply, they have nothing to gain but much to lose by being honest. On the other hand, they may prefer to preserve their self-concept of honesty, thus opt for the approach that allows them to serve both desires at once. At a cursory glance, PPD using athletes, striving for honesty, appear to be contradictory. However, research indicates that PPD use may not necessarily be viewed as a moral issue of 'cheating' or 'dishonesty', nor does it aim to gain unfair advantage but is seen as a functional tool to optimize athletic outputs and reach maximum potential (Christiansen, 2010; Lentillon-Kaestner & Carstairs, 2010). Therefore, for many, using chemical assistance in performance enhancement may not be a moral question but merely a functional one (Petróczi, et al., 2011b). A detailed explanation, along with mathematical proof, is provided in the Appendix.

2.8.6. Summary of the advantages and disadvantages of the two models

Random response models with built-in 'noise' generally offer a buffer against social desirability. Some models provide better protection than others. Comparing the two models presented in this study, the protection arising from the UQM model is related to the concealment of the identity of those answering the sensitive question. On the contrary, in the SSC model, respondents are not required to answer the sensitive question directly as it is embedded among four other potentially affirmative answers. However, the price to pay for this added protection is a larger cognitive load on respondents, longer completion time and some loss in precision, with the SSC model having larger confidence intervals than the UQM.

Although the UQM has smaller sampling variance, thus yielding more narrow *CIs* if honest/correct responding can be assumed, the model is seriously limited in dealing with noncompliance, owing to the model being undefined. The UQM model has only 1 *df* for a combination of two or three unknown variables: probability of the sensitive question (to be estimated) and cheating in the question used for randomization (Q1) and/or in the target question (Q2). This limitation of the random response models has been recently confirmed by noting that their multiple issues, cheating detection model is able to estimate the extent of noncompliance, but without knowing anything about the reasons (i.e. lack of understanding vs. deliberate distortion), or status (i.e. proportion of respondents possesses the sensitive attribute), of the non-adherent respondents Moshagen and Musch (2011). This conclusion is similar to those made, for example, by Pitsch and Emrich (2011) and Ostapczuk, et al. (2011). On the other hand, noncompliance can be taken into consideration in the SSC model. This is owing to the fact that, having more questions inevitably means having sufficient *df*s to make adjusted estimates.

2.9. Conclusion

We provided evidence for the validity of the SSC using PPD and HS as testing fields. Prevalence estimates for PPD and HS use are limited by the relatively small sample size and the oversimplified network scale-up method. However, the primary aim of this study was to establish validity for the SSC in comparison to a well-established method and to test the effect of empowering respondents to take control over the lead-up question serves as the randomization device.

The large difference between the estimates obtained via SSC and UQM for PPD, but not for HS, unearthed important issues that researchers must consider when employing UQM in a self-administered format, in unknown and diverse populations. The SSC, which is suitable for self-administration, without modification, produced prevalence estimates closer to the social projection and network scale-up, than the UQM did. The observed discrepancy between UQM and SSC methods could be explained by evasive responding, suggesting that adaptation of the random response models for self-administration may lead to an unwanted response distortion. Offering to think of any person they wish, empowers respondents to avoid the sensitive question, thus respondents do not have to face the dilemma of false telling. We provided theoretical proof that strategic responding can result in a paradox situation, where the proportion of 'yes' answers to the sensitive question in the UQM is inflated.

The results and the overwhelming preference for SSC, on the basis of protection, suggest that the UQM is more likely to result in evasive responding bias and yield inaccurate estimations. Further research, under controlled experimental conditions, is required to ascertain the ways naïve noncompliant respondents answer the SSC/UQM survey questions, in order to determine the likelihood of strategic responding in the randomisation question, versus straightforward dishonesty to the sensitive question. Comparison between UQM models of ‘open’ versus ‘fixed’ person with varying sensitivity of the target questions could provide further evidence, if found, for the potential controlling effect of randomisation by strategic selection of the ‘open’ person. Computerised application would allow measuring and comparing completion times between the different experimental groups. PPD use research would benefit from more investigations comparing two or more methods, including new and improved models for effectiveness, accuracy, statistical power and time efficiency.

Note

The authors are thankful for the useful comments the three anonymous reviewers provided during the review process. One reviewer challenged the UQM method for its weaknesses, pointing out that *the RRT-setup* (UQM) *used in this study leads to the weak RRT results*. More specifically, the reviewer posits that *the comparison between the newly developed SSC and a poorly*

implemented, but established method (UQM) is not unnecessary, nor an extended mathematical proof that a poor method is poor, is required, especially if the authors themselves cared for the method to lead to poor results. The reviewer insists that the *poor performance* of the UQM *should have been predicted as the randomization device meets only two of the three criteria* (i.e. being feasible, accessible, and resistant to manipulation)*, while the randomization devices used in similar studies met all of these criteria*. The present study suggests that the randomisation method used for the UQM may not be resistant to manipulation and that empowering respondents to take control over the randomisation to offer maximum flexibility and trust could yield unwanted consequences. However, the possibility that respondents do not follow the instruction is present in every RRT model simply because the outcome of the randomisation method or device is known only to the respondent. Hence, they can choose to follow or ignore the instruction on how to answer the sensitive question, or whether to answer the sensitive or non-sensitive question (Moshagen, et al., 2012). The difference that makes the UQM variation presented here potentially more susceptible for manipulation is the empowerment of the respondent to take control over the randomisation. Hence, the outcome can be manipulated without explicitly disobeying or cheating.

Although, retrospectively, we generally agree with the comments made by the reviewer, and in fact, results from this project seem to support the reviewer's view. We felt that such conclusion should not be drawn without empirical evidence. Nor should a definite conclusion be drawn based on a single study, with a specific sample, characterised by low level of competition, mainly outside doping control. The question of what type of athletes might engage in strategic responding to Q1, in order to avoid the sensitive Q2, remains open. The scenario we presented in the Appendix assumed that any athletes, regardless of their doping behaviour, could answer Q1 to avoid answering the doping question. The effect of such behaviour is different if only athletes who use doping (hence have something to hide) employ such strategy. At this point, answers to these questions are not readily available from the data presented in this paper, hence, we suggested future studies to deconvolute the situation.

Consequently, we felt that presenting results from both UQM and SSC method and offering a comparison add value to the paper and inevitable owing to the reasons outlined in the aims. Critical views, constructive comments and future research regarding the methods contrasted in this paper make valuable contributions to the field and help to progress the research into indirect estimation models further. We felt that, in order to facilitate this, findings from these cases should be made available to the scientific community, offering the opportunity for critics and supporters alike, to comment on the methods in a constructive, forward-looking way.

2.10. Appendix

In this section, we provide proof that, in cases where prevalence of the sensitive behaviour (with unknown probability *d*) is below 0.5, strategic responding in the first UQM question lead to inflated number of 'yes' answers, thus, resulting in estimations above the true prevalence rate.

2.10.1. Assumption

Figure 4. shows the potential doping related noncompliance (strategic responding in Q1 and dishonest answering in Q2). For simplicity, we assume that noncompliance in Q1 only occurs if an athlete tries to avoid the sensitive (doping) question in Q2.

However, this assumption does not imply that only those would select the person strategically who have something to hide, but rather it posits that any athlete, regardless of the presence or absence of the target behaviour, could have a preference for answering the innocuous question instead of the sensitive one.

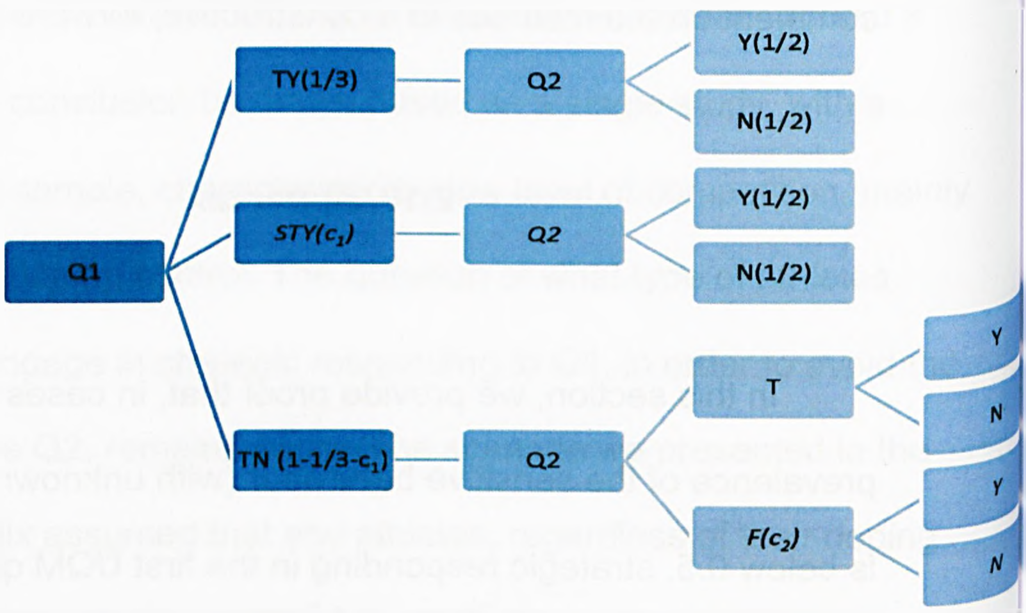


Figure 4. Potential noncompliance in UQM. TY = true yes, STY = strategic yes, TN = true no, T = true, F = false, Y = yes, N = no. Italics denote evasive answer options.

The UQM and its confidence intervals are calculated as:

$$\hat{p} = \frac{O_y - p_2(1-p_1)}{p_1}$$

$$Var = \frac{O_y(1-O_y)}{np_1^{\,2}}$$

$$CI = \sqrt{Var} \times 1.96$$

where O_y is the observed percentage of 'yes' answers, p_1 is the probability that the respondent gets the target question and p_2 is the known probability on the unrelated question.

Bear in mind that the self-administered UQM is based on the expected known probability of a birthday of the respondent's choice. If this question is answered honestly, the expected probability is that the respondent answers an unrelated question with $p_2 = 0.5$ is 1/3 if the birthday falls in the first 10 days of the month. Conversely, the target question is answered by 2/3 of the respondents. However, allowing athletes to think of any person empowers respondent to choose whether they want to answer the sensitive question (and once there, to tell or not to tell the truth) or avoid the sensitive question altogether. This strategic responding can lead to a change in p_1 which is no longer 2/3 but less. Consequently, the proportion of respondents answering the innocuous question with p = 0.5 is higher than the expected 1/3, thus contribute to an inflated O_y.

2.10.2. Proof

Premise: If $p_1*d + (1-p_1)*p_2 < p_2$ then c_1 increases O_y,

$O_y = c_1*p_2 + (1-c_1)*(p_1*d + (1-p_1)*p_2)$

where *Q1* = the question in place for a randomiser device with 1/3 and 2/3 probability; *Q2* = the question respondents required to answer based on the outcome of *Q1,* containing a sensitive doping and a non-sensitive unrelated question, both with binary outcomes; O_y = probability of 'yes' answer (given by the respondents); c_1 = probability of strategic responding in Q1; p_1 = probability of 'yes' in Q1 ; p_2 = probability of 'yes' in non-sensitive Q2 and d = probability of 'yes' in the sensitive target Q2 (e.g. doping).

When an athlete strategically responds to Q1, in order to avoid the sensitive question in Q2 (for whatever reason), then the probability of 'yes' in Q2 is p_2 because he/she chooses the person so the sensitive Q2 can be avoided. However, in the absence of strategic responding, the standard UQM equation stands (1/3 non-sensitive Q2 and 2/3 sensitive Q2). Therefore, the probability of getting the sensitive question in Q2 is p_1, the probability of answering 'yes' is d; the probability of getting the non-sensitive question in Q2 is $1-p_1$, and the probability of answering yes is p_2.

If $c_1 = 1$ then the expected probability is p_2; if $c_1 = 0$, then the expected probability is $p_1{*}d + (1-p_1){*}p_2$. Linear interpolation for $1 > c_1 > 0$ shows that if $p_1{*}d + (1-p_1){*}p_2 < p_2$ then the strategic responding in Q1 (c_1) increases the number of yes answers. It happens if:

$p_1*d + (1-p_1)*p_2 < p_2$

$p_1*d + p_2 - p_1*p_2 < p_2$

$p_1*d - p_1*p_2 < 0$

$d < p_2$ because p_1 is not zero

$p_2 = ½$

$d < ½$

Therefore, c_1 increases the observed proportion of ‘yes’ answers, if $d < 0.5$, which is equivalent to 50% doping prevalence in our example, or 50% prevalence of the sensitive behaviour in question. Conversely, the same strategic responding would, theoretically, reduce the proportion of ‘yes’ answers if the prevalence rate for the sensitive question is higher than 50%. However, it is less likely that respondents feel the need to avoid a question on such common behaviour.

Figure 5 depicts the effect of the interplay between the probability of cheating by strategic responding in Q1 (c_1) and the probability of the sensitive behaviour (d) on the observed proportion of 'yes' answers in Q2 (O_y) for the full range of $0 < c_1 < 1$ and $0 < d < 1$. The graph clearly shows an increasing trend for O_y, as a result of potential strategic responding (c_1) in the context of d. This scenario assumes that anyone can opt for answering the innocuous questions, regardless of their position on the sensitive question. Naturally, if only those switch to the innocuous birthday question who would have said 'yes' to the sensitive question, then such responding would result in a reduction of the number of 'yes' answers. The scenario further assumes that all answers in Q2 are honest. If it is not the case, and cheating occurs in Q2 as well as in Q1, then it is even worse news because we cannot say anything about the combined effect of $c2$, d *and* $p2$, where c_2 = self-protective lying/strategic yes in Q2 and p_2 = probability of 'yes' in the unrelated question.

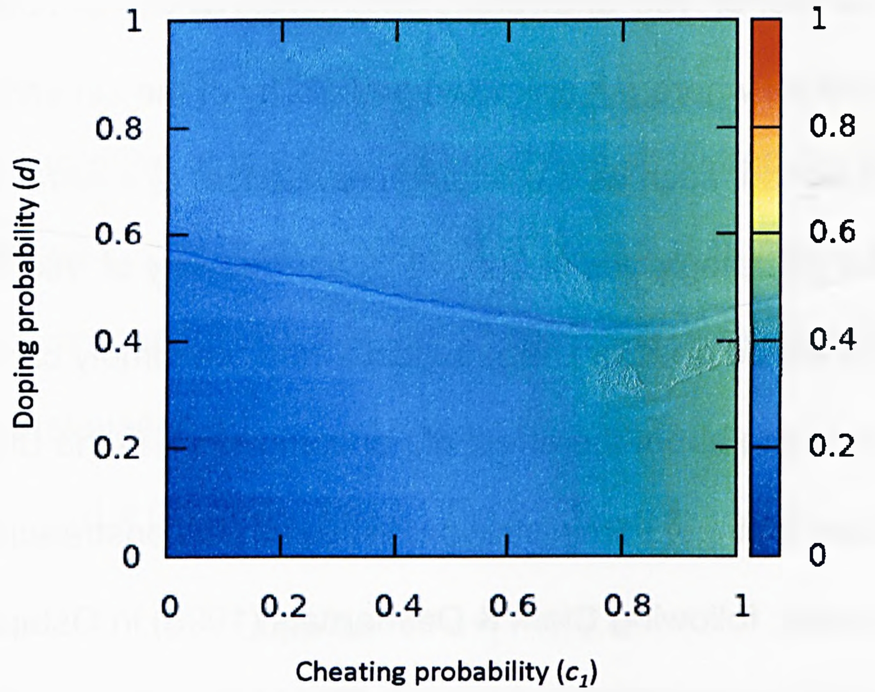


Figure 5. The interplay between the probability of cheating by strategic responding, in Q1 (c_1) and the probability of the sensitive behaviour (d); p_1 = 1/3, p_2 = 1/2, colour (right side of the y-axis) indicates O_y.

2.10.3. Discussion

Depending on how respondents might cheat, the UQM could yield the lower bound of prevalence (self-protective no saying in Q2), but equally, can inflate the estimated prevalence (strategic ‘person selection’ in Q1) if $d < 0.5$. As the relationship between the two (noncompliance in Q1 and in Q2) is unknown, these scenarios hold, if noncompliance either happens in Q1 or Q2. If noncompliance affects both Q1 and Q2, then the expected number of 'yes' answers is determined by the combination of c_2, d and p_2, where d = unknown probability of the sensitive target question, such as the doping prevalence, c_2 = self-protective lying/strategic yes in Q2 and p_2 = probability of 'yes' in the unrelated question. In practical terms, we simply cannot say anything about the effect of noncompliance in the UQM model from a single administration. While as demonstrated for the FR model, following Clark & Desharnais (1998) in Ostapczuk, et al. (2011) and in Pitsch & Emrich (2011), it is possible to detect the proportion of 'noncompliance' in answering the sensitive/unrelated non-sensitive question (referred to Q2 in the proof above) experimentally, by randomly splitting the sample into two, and administering two questionnaires with different probabilities. Such an approach, however, cannot distinguish between different non-compliances or attribute proportion of the noncompliant population, nor can it say anything about whether respondents fail to follow the instructions at the randomization stage (regardless if it is some physical device or instruction based on some personal information, e.g. father's birthday) or fail to respond truthfully to the questions, or address noncompliance in both simultaneously.

2.10.4. Numerical illustration

Denote the probability that an athlete answered the doping question with *r* and keep it constant at 2/3 (as assumed in the UQM if everyone follows the instructions), then we can express doping prevalence as

$$d = (n_{yes}/n_{All} - 1/6) * 1.5 = 1.5 * n_{yes}/n_{All} - 0.25$$

$$n_{yes}/n_{all} = r*d+(1-r)*0.5$$

The value of n_{yes}/n_{all} must be somewhere between *d* and 0.5, as a function of ,*r* ,where *r* is between 0 and 1. If *r* = 1 then, n_{yes}/n_{all} = 0.5 and if *r* = 0.0 then, n_{yes}/n_{all} = *d*. If d < 0.5 and r < 2/3, then n_{yes}/n_{all} will increase and approach 0.5. Conversely, if d > 0.5 and r < 2/3, then n_{yes}/n_{all} will decrease and approach 0.5.

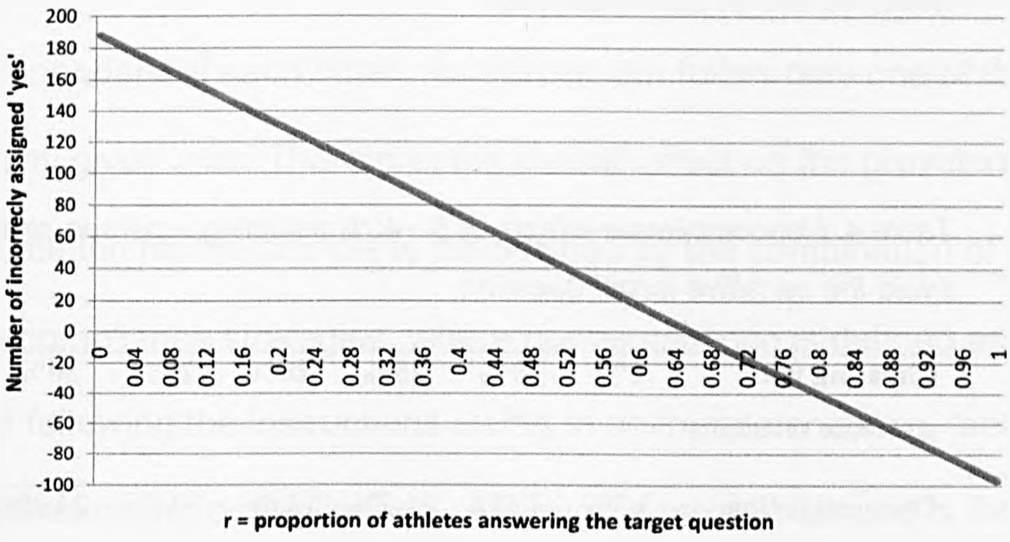


Figure 6. Changes in the number of incorrectly assigned 'yes' answers if noncompliance = answering the birthday question instead of the PED question.

Figure 6a shows the number of incorrectly assigned ‘yes’ answers to the PED question as the function of *r* (proportion of athletes answering the doping question, where *r* is expected to be 2/3, which translates to 342 respondents). Misattributed numbers of ‘yes’ were calculated as the difference between expected number of ‘yes’ from $r = 2/3$, minus the actual number of ‘yes’, if $r \neq 2/3$, but it runs between 0 and 1. Examples to illustrate the inflation effect in the PED use prevalence if $r \neq 2/3$ is presented in *Table 4*. This scenario assumes that any athletes can opt for this type of responding, regardless of whether their answer be to the target question would be discriminatory or not. Overestimation is calculated as the ratio of misattributed number of ‘yes’ and the proportion of the sample instructed to answer the target question, which is 2/3 in our example.

Table 4. Noncompliance effects at 5 - 40% selecting a person strategically to avoid the sensitive target question

Cheating with strategic selection	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**
Over-estimation	3.3%	7.5%	11.7%	13.8%	20.0%	24.2%	28.3%	32.5%

Of course, in real life, the noncompliance scenario is much more complex. For example, it can be assumed that only those who have something to hide, and happen to get the sensitive target question, would switch to the birthday question instead. It can also include a degree of denial among those who would be implicated by a 'yes' answer to the sensitive target question, which has the opposite effect by decreasing in the observed *p*. An expansion of the self-protective 'no' saying could include false negative answers from the innocuous birthday question, if respondents answer 'no,' regardless of the question, in order to prevent any suspicion. Respondent can also answer randomly, but mathematically, it is equivalent of answering the birthday question.

Notably, this list of noncompliance strategies is not exhaustive or independent of each other. An athlete can follow only one of them at any given time. Therefore, the overall effect on the prevalence estimation for the sample is determined by the combination of the noncompliance strategies, where noncompliance is defined as 'not following the instructions owing to deliberate cheating, lack of understanding or negligence'. Although a mixed scenario is the most likely case in any field study, unfortunately the UQM offers very little insight into these hypotheses.

STUDY 2. GOOGLE TRENDS: A POTENTIAL FOR A NATIONAL PREVALENCE VIEW

3.1: Introduction

Anabolic androgenic steroid (AAS) use is increasingly becoming a public health concern, whether at the highest levels of sport, utilised to gain an unfair advantage over competitors (Nikolopoulos, Spiliopoulou, & Theocharis, 2011) or in your everyday training population, to make one's appearance more aesthetically pleasing (Sparkes, Partington, & Brown, 2007). Accurate prevalence data is difficult to obtain, mainly due to response biases (R. A. James, Nepusz, Naughton, & Petróczi, 2013; Petroczi & Nepusz, 2011), therefore, potentially new tools which gather data that supports the view that this is an increasing problem, is paramount to this area of research. Due to the nature of AAS illicit use, credible information regarding access is important for potential users. Credibility of the information can severely influence their decision to partake in said behaviour (R. James, Naughton, & Petróczi, 2010). Information provided from sources that have actually administered AAS is likely to be weighted higher than general information obtained from official sources (R. James et al., 2010). Due to the perceived anonymity provided by the Internet, PPD users are utilising it to gain access (Mcdonald, Marlowe, Patapis, Festinger, & Forman, 2012).

3.2: Facilitation of the Internet

The Internet is increasingly becoming a tool, utilised by potential users, to gain information on areas taboo to the everyday public (Lewis & Arbuthnott, 2012; Mcdonald et al., 2012). This increased use is due to the fact that the Internet is saturated with uncensored opinions, often rooted from personal experiences (Lewis & Arbuthnott, 2012). In the context of this paper, AAS experiences are relayed in the form of forums and general websites, authored by AAS users intending to promote use (Kraska, Bussard, & Brent, 2010). The Internet also provides basic levels of anonymity, allowing potential users and current users to gain and provide information without fear of being identified. Some websites will charge over 50% less than if AAS was purchased from a direct dealer, making it more financially available (Kraska et al., 2010). To the more financially savvy user, this can breed new home grown dealers trying to generate an income (Kraska et al., 2010), thus not only increasing users but distributors as well, potentially creating an evolving branching network from digital to personal.

3.3: Internet research & sensitive populations

The Internet is saturated with a vast amount of information. We, as researchers, should seek to utilise this as a possible source when traditional data collection proves problematic. Researching a sensitive topic can prove especially problematic due to potential response biases. These biases are portrayed in order to manipulate one's perceived image or can be due to certain levels of self-deception (Petróczi et al., 2011). Researchers utilise the Internet to facilitate data collection in two different forms, the first being directly mining data from websites, and the second is to facilitate the distribution of surveys.

3.3.1. Internet facilitated survey distribution

A study by Miller & Sønderlund, (2010) identified forty six research papers from sixteen different databases that used the

Internet for data collection. The majority of the studies used online questionnaires due to their convenience and more importantly, their anonymity. Internet-based questionnaires can produce reduction in accountability, social cues, as well as provide enhanced self-focus (Joinson, 1999). A study which compared computer based questionnaires against traditional pen and paper questionnaires found that social anxiety was lower on the computer in both the anonymous and non-anonymous conditions (Joinson, 1999). Also, this study showed self-esteem was higher on the computer for both conditions and, finally, social desirability was lower on the computer for both conditions. Interestingly enough, differences between anonymous and non-anonymous in the computer condition was not significant. The author suggests that this may be due to the perception that Internet based questionnaires are considered to have some level of anonymity. Yet a meta-analysis has shown that social desirability scores do not differ when research is conducted on, or offline, or using paper questionnaires (Dodou & De Winter, 2014). It is suggested that this may be due to a 'decline effect'. As technology advances, the perception that individuals can utilise the Internet whilst maintaining anonymity is dwindling (Cooper, 2017). The effect on social desirability is dependent on perception of anonymity which the Internet provides, thus, as this perception of anonymity reduces, so will its effect on social desirability.

Although these techniques allow for the respondent to be more forth coming in terms of honest information, it still relies on the respondent telling the truth. Alternatively, data mining is the process by which mass amounts of data are obtained and analysed in order to derive meaning.

3.3.2. Internet data mining

Data mining is the process by which pre-existing mass data is collected, usually by a computer source, in order to create meaning out of the data. One such study mined thirteen community forums, covering one million topics, in order to understand PPD's selection and suppliers. It found that AAS were the most discussed PPD. The study also could identify emerging PPD's (Pineau et al., 2016). It should be noted that data produced by mining can provide limited information. Data collected from a website will only have information that is available, for instance, a message on a forum but nothing else behind it which may better explain the message.

3.4: 'Google', a potential facilitator

The website 'Google' is the biggest search engine used in the world and is now also integrated into most smart phones (Griffiths & Brophy, 2005; Kamvar & Baluja, 2006; S. P. Lewis & Arbuthnott, 2012), thus adapting the way we source information. If you have a question that needs answering, you "Google it". Due to the perceived privacy of the Internet, it could be the first stop for potential AAS users, and search engines like Google, are the gateways to a breadth of information, depending on the search terms used.

Google records and standardises all words and terms searched through its main website and presents them on one of its sister sites named 'Google Trends', allowing for mass data to be mined. Therefore, any terms in reference to steroids will be indexed, thus allowing for geographical trends and potential forecasting. Google trends has been utilised in various behavioural and medical trending and forecasting research (Carneiro & Mylonakis, 2009; Carrière-swallow & Labbé, 2013; Choi & Varian, 2012; Preis, Moat, & Stanley, 2013; Seifter, Schwarzwalder, Geis, & Aucott, 2010; Vosen & Schmidt, 2011). In reference to illicit drug use, Google Trends has been used to map the interest of various drugs over a ten year period in the USA (Woollaston, 2015). The news article reports that the tool was utilised by a detox and rehab website to show trends of various drug popularity. The type of data exhibited include national changes. For instance, it was found that searches for crystal meth peaked in 2007 and 2013. Regional data could also be accessed. For instance, Adderall was the most searched term in New Orleans, cocaine in New York and OxyContin in Seatle. A similar model can be applied to individuals seeking information regarding AAS use. This data could then be used to gain a general insight into national prevalence trends in various aspects of steroid use and further regionalised. Government anti-doping campaigns can utilise this information to target particular cities for campaigns, thus making efficient use of their resources.

As highlighted, Google Trends data could potentially be used to analyse trends in searches regarding AAS, as well as to potentially map, and forecast, past and potential use. Therefore, this study aims to present and analyse data on searches that potential users may input into Google's search engine.

3.5: Methods

3.5.1: Search Terms

Using Google Trends, three terms were analysed, the first was the generic word 'steroids'. This term was chosen because potential users are less likely to use 'anabolic steroids' as a primary search term. It is important to note that other types of steroid searches may be included in the index (i.e. corticosteroids). When 'steroids' was searched, four of the top five results were in regard to anabolic steroids, thus justifying the use of this term.

The second search term used was 'buy steroids', as AAS can be supplied directly from websites which boast that delivery gets through customs every time. This study wanted to highlight any increase in this potential source.

The third and final term was ‘steroid side effects’. This was chosen to ascertain if potential users were directly interested in the potential pitfalls of use.

3.5.2: Google trends query index

It is important to note that the data which is provided by ‘Google Trends’ is in the form of a volume query index, rather than the actual raw query counts. The query index is initiated from the query share. This is the total query volume for each term searched in a geographical region, which is then divided by the total number of queries in that region (Choi & Varian, 2012). These values are then normalised, by attributing the maximum share query in that period as 100 and the query share being examined to be 0 (Choi & Varian, 2012). All data goes back to 1st January 2014, which is well within the five-year period.

3.5.3: Data Analysis

Data from all three terms were analysed over a ten-year period. Significant differences were observed from year to year ($\alpha \leq .05$) to ascertain significant growth or decline in each search term. Mean UK yearly values for each term were correlated against UK yearly border seizures (confiscation of AAS at UK customs by number) and UK street police seizures (confiscation of AAS by UK street police by number). Reported seizures have the ability to provided trends by which Google Trends can be compared against. An increase in online orders should increase cases of seizures, as long as it's detectable. Finally, UK geographical analysis via Google Trends was used to ascertain high risk cities over the ten-year period.

3.6: Results

3.6.1: Term 'Steroids'

Analysis has shown that, over this time period, the term 'Steroids' significantly increased in use over four periods (2007-08, t (102) = -2.76, *P*<0.01; 2008-09, t (102) = -4.88, *P*<0.01; 2011-12, t (102) = -4.16, *P*=0.02 & 2012-13, t (102) = -2.37, *P*=0.02) and significantly decreased over three periods (2010-11, t (102) = 9.02, *P*<0.01; 2013-14, t (102) = 2.76, *P*<0.01 & 2014-15, t (102) = 3.36, *P*<0.01) (

Term	2006 - 2007 Diff	2007 - 2008 Diff	2008 - 2009 Diff	2009 - 2010 Diff	2010 - 2011 Diff	2011 - 2012 Diff	2012 - 2013 Diff	2013 - 2014 Diff	2014 – 2015 Diff
Steroid	*2.37**	*3.44**	*6.04**	*1.52*	*-11.77**	*4.59**	*3.17**	*-4.29**	*-4.90**
Buy Steroid	*0*	*40.33**	*23.42**	*12.14**	*21.17**	*-1.94*	*1.04*	*-8.58**	*-11.50**
Steroid side effects	*0*	*14.44**	*1.27*	*2.17*	*52.77**	*-1.67*	*3.67*	*-1.21*	*-1.74*

Table 5). The largest increase was observed in the 2008-09 period (6.038) and the largest decrease was observed in 2010-11 (-11.769). No significant correlations were observed and, therefore, not reported.

3.6.2: Term 'Buy Steroids'

Similar to the term 'Steroids', the term *'Buy Steroids'* analysis showed three periods where the term increased in use, 2007-08, t (102) = -7.55, *P*<0.01; 2008-09, t (102) = -4.12, *P*<0.01; 2010-11, t (102) = -7.78, *P*<0.01) (

Term	2006 - 2007 *Diff*	2007 - 2008 *Diff*	2008 - 2009 *Diff*	2009 - 2010 *Diff*	2010 - 2011 *Diff*	2011 - 2012 *Diff*	2012 - 2013 *Diff*	2013 - 2014 *Diff*	2014 – 2015 *Diff*
Steroid	*2.37**	*3.44**	*6.04**	*1.52*	*-11.77**	*4.59**	*3.17**	*-4.29**	*-4.90**
Buy Steroid	*0*	*40.33**	*23.42**	*12.14**	*21.17**	*-1.94*	*1.04*	*-8.58**	*-11.50**
Steroid side effects	*0*	*14.44**	*1.27*	*2.17*	*52.77**	*-1.67*	*3.67*	*-1.21*	*-1.74*

Table 5). The largest increase was observed in the 2007-08 period (40.327).It should be noted that the previous period exhibited 0 searches for this term, therefore, further statistical analysis wasn't conducted. The term exhibited three periods in which the score significantly decreased, 2009-10, t (102) = 3.96, *P*<0.01; 2013-14, t (102) = 3.79, *P*<0.01; 2014-15, t (102) = 5.41, *P*<0.01. The largest decrease was 2014-15 (11.500).

Positive relationships were observed between the search term and the combination of Border force seizures with street police seizures (*r* = .768, n=9, *P* = .016). Seizures were divided into their individual properties to observe their individual relationship strength with the search term. Police seizures had the strongest positive significant relationship (*r* = .914, n=9, P = .001), whereas, border force did not show a significant relationship (*r* = .596, n=9, *P* = .090). Finally, a positive relationship was observed between this search term and the search term, ‘Steroid side effects’ (*r* = .786, n=9, *P* = .007).

3.6.3: Term ‘Steroid side effects’

This term exhibited the least change. There were no significant decreases over this time period and only two significant increases (

Term	2006 - 2007 *Diff*	2007 - 2008 *Diff*	2008 - 2009 *Diff*	2009 - 2010 *Diff*	2010 - 2011 *Diff*	2011 - 2012 *Diff*	2012 - 2013 *Diff*	2013 - 2014 *Diff*	2014 – 2015 *Diff*
Steroid	*2.37**	*3.44**	*6.04**	*1.52*	*-11.77**	*4.59**	*3.17**	*-4.29**	*-4.90**
Buy Steroid	*0*	*40.33**	*23.42**	*12.14**	*21.17**	*-1.94*	*1.04*	*-8.58**	*-11.50**
Steroid side effects	*0*	*14.44**	*1.27*	*2.17*	*52.77**	*-1.67*	*3.67*	*-1.21*	*-1.74*

Table 5). The first being 2007-08, $t(102) = -3.89$, $P<0.01$. Again, it should be noted, that the previous period exhibited 0 searches for this term. The second significant increase was 2010-11, $t(102) = -11.02$, $P<0.01$) and was the largest change for all terms. As previously stated, a positive relationship was observed between this term and “buy steroids”.

Table 5. Changes in search index for the term 'steroids', buy steroids and steroid side effects between 2006 – 2015.

Term	2006 - 2007 *Diff*	2007 - 2008 *Diff*	2008 - 2009 *Diff*	2009 - 2010 *Diff*	2010 - 2011 *Diff*	2011 - 2012 *Diff*	2012 - 2013 *Diff*	2013 - 2014 *Diff*	2014 – 2015 *Diff*
Steroid	*2.37**	*3.44**	*6.04**	*1.52*	*-11.77**	*4.59**	*3.17**	*-4.29**	*-4.90**
Buy Steroid	*0*	*40.33**	*23.42**	*12.14**	*21.17**	*-1.94*	*1.04*	*-8.58**	*-11.50**
Steroid side effects	*0*	*14.44**	*1.27*	*2.17*	*52.77**	*-1.67*	*3.67*	*-1.21*	*-1.74*

*Diff – The change in search index between years specified. * - Significant change <0.01*

Table 6. Actual search index for the term 'steroids', buy steroids and steroid side effects between 2006 – 2015.

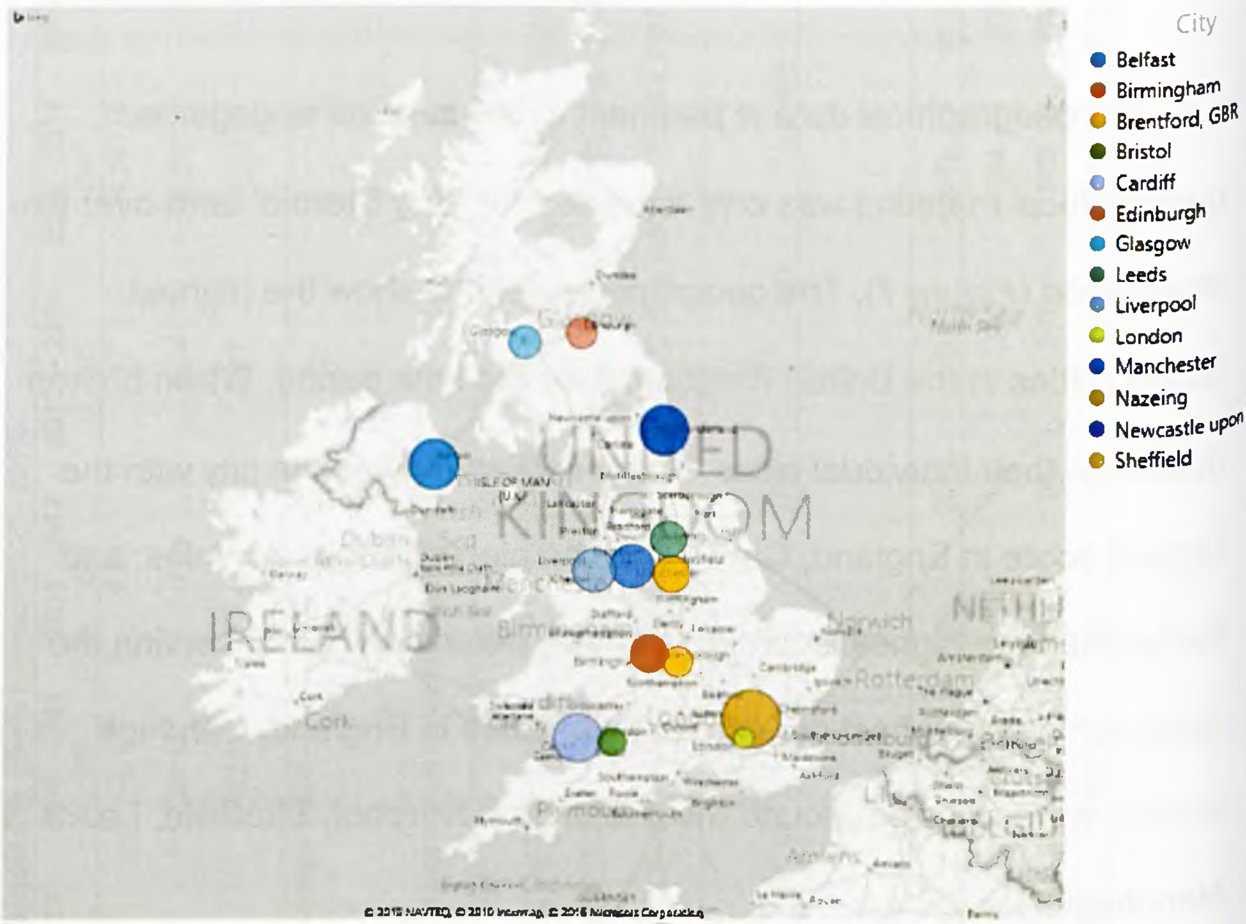
Term	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Steroid	64.02 ±8.43	66.38 ± 6.90	69.83 ± 5.77	75.87 ± 6.81	77.38 ± 8.18	65.62 ±4.61	70.21 ± 6.48	73.38 ± 7.24	69.10 ± 8.57	64.19 ± 6.09
Buy Steroid	0	0	40.33 ± 38.54	63.75 ± 13.92	51.62 ± 17.05	72.79 ± 9.69	70.85 ± 12.12	71.88 ± 10.27	63.31 ± 12.68	51.81 ± 8.6
Steroid side effects	0	0	14.44 ± 26.81	15.71 ± 29.44	17.88 ± 33.51	70.65 ± 8.36	68.98 ± 9.40	72.65 ± 9.80	71.44 ± 7.87	67.52 ± 9.787
BF Seizures (No)	89	126	259	341	113	133	284	507	466	Data to be released

Table 7. Steroid seizures between 2006 – 2014.

Relative Authority	2006	2007	2008	2009	2010	2011	2012	2013	2014
Boarder Force Seizures	89	126	259	341	113	133	284	507	466
Seized by police force	433	371	546	530	562	576	560	636	591
Police and Boarder force seizures	522	497	805	871	675	709	844	1143	1057

3.6.4. Geographical data

As geographical data is pertinent to behavioural engagement, geographical mapping was only exhibited for ‘Buy Steroid’ term over this time period (*Figure 7*). The geographical results show the highest scoring cities in the United Kingdom over the time period. When broken down into their individual cities, Nazeing (Essex) was the city with the highest score in England; Cardiff had the highest score in Wales; and Belfast had the highest score in Northern Ireland. When observing the geography, the highest concentration of cities in England, with high scores, were situated around the midlands (Liverpool, Sheffield, Leeds & Manchester).



City	Score
Nazeing (Essex)	100
Cardiff	82
Belfast	81
Newcastle upon Tyne	80
Manchester	73
Liverpool	72
Sheffield	63
Birmingham	62
Leeds	62
Glasgow	57
Edinburgh	55
Brentford, GBR	55
Bristol	52
London	46

Figure 7. Geographical representation of indices of the search term 'Buy Steroids' between 2006-2015

3.7. Discussion

General online retail sale growth within the UK has shown a 15.8% growth in online spending in 2014 and 16.2% growth in 2015, suggesting more and more are using the Internet to purchase their goods. This ever increasing dependence on the Internet to provide information, as well as access to various prohibited products, or otherwise, is potentially being exploited by steroid users and distributors (Kraska et al., 2010). The likelihood of potential users partaking in the behaviour can be dependent on their social network (Maycock & Howat, 2007), hence, why social orientated prevention programs have been the focus of previous researchers (Yesalis & Bahrke, 2000). The Internet doesn't only offer access but is also a source of information. Prior to the emergence of steroid networks on the Internet, potential users would have to gain access via direct contact to networks (in person) (Maycock & Howat, 2007), thus removing anonymity. Anonymity is especially important to athletic potential users as relevant authorities will impose sanctions on those exposed (O'Connor, Mostrous, Devlin, & Connor, 2011; Smith, 2011). The privacy and ease of the Internet makes its utilisation an increasingly attractive option for potential users. This is supported by the significant increase in the search terms over this time period (

Term	2006 - 2007 *Diff*	2007 - 2008 *Diff*	2008 - 2009 *Diff*	2009 - 2010 *Diff*	2010 - 2011 *Diff*	2011 - 2012 *Diff*	2012 - 2013 *Diff*	2013 - 2014 *Diff*	2014 - 2015 *Diff*
Steroid	*2.37**	*3.44**	*6.04**	*1.52*	*-11.77**	*4.59**	*3.17**	*-4.29**	*-4.90**
Buy Steroid	*0*	*40.33**	*23.42**	*12.14**	*21.17**	*-1.94*	*1.04*	*-8.58**	*-11.50**
Steroid side effects	*0*	*14.44**	*1.27*	*2.17*	*52.77**	*-1.67*	*3.67*	*-1.21*	*-1.74*

Table 5). The use of search term, ‘Buy Steroids’, exhibited significant growth year to year over a four-year period. More concerning is the fact that the search term, ‘steroid side effects’, wasn’t used until 2008, and didn’t reach the levels of ‘steroids’ and ‘buy steroids’ until 2011 (*Table 6*).

3.7.1: Digital drug dealing

AAS sales websites are becoming more diverse in the products that they sell as well as their marketing approach (Cordaro, Lombardo, & Cosentino, 2011). Various sites are bilingual, allowing for people from multiple backgrounds to gain access. More importantly, they offer a wide range of products. The extended products tend to revolve around alleviating side effects i.e. estragon manipulation and/or erectile dysfunction, thus promoting polypharmacy behaviour seen by other researchers (Dodge & Hoagland, 2011).

One major concern with attaining AAS directly from an online source is that there is always a chance it may not be what is advertised (Graham et al., 2009). Access directly through dealers have the same pitfalls, yet they would have feedback from their customer base as to what products are reputable. First time users who buy AAS from the Internet lack the individual experience and knowledge to avoid counterfeit products. Counterfeit AAS not only put the consumer at a financial risk, but potential physical ones as well (Graham et al., 2009).

3.7.2: Breaking borders

AAS still is classed as a C drug in the UK, making it difficult for potential users to access easily. After opening the borders to Eastern Europe, there has been a surge of illegal AAS, mainly coming from countries with less ridged laws regarding AAS (Pellegrini, Rotolo, Giovannadrea, Pacifici, & Pichini, 2012). AAS are being smuggled into the country by individuals in bulk, or more specifically to this paper, ordered from online sources which are then delivered through customs (Kraska et al., 2010). *Table 7* shows an overall increase of seizures by the border and police force. Strong significant correlations were observed between total seizures and the term ‘buy steroids’ (r = .768, P

= .016), yet when separated, the significance was rooted in the police force (r = .914, P = .001) and not the border force, suggesting that a lot of AAS are making it through UK border patrol. This could be explained by the ever-evolving techniques, used by criminal websites, to disguise the contents. Some websites even guarantee 100% success with customs in the EU (Kraska et al., 2010). Packages arrive with no identifying markers and sometimes with the AAS inside another product, e.g. a video tape (Kraska et al., 2010). Websites even go as far as to provide information as to how to evade prosecution from authorities once packages have been received (Kraska et al., 2010). One of the main concerns is the quality of the online purchases, as the ingredients may not be what it on the container, which could be dangerous or not effective at all (Pellegrini et al., 2012).

3.7.3: Google Geographical prevalence

Due to response bias, it is difficult for researchers to gain accurate prevalence data on AAS use and near impossible for potential users. Therefore, this is why Google Trend's ability to map geographically searches could be an important tool in the fight against doping. Yet it is important to ascertain the validity of its results. Drug culture can facilitate the use of AAS. The combination of AAS and illicit drug use has been observed in multiple populations, primarily as part of an illicit drug/body building culture, as well as less obvious motives (Petersson, Bengtsson, Voltaire-carlsson, & Thiblin, 2010). The results from this study suggested that Nazeing (Essex) was the city with the highest score in England. Geographical studies regarding AAS online purchasing are scarce. A news article written in The Sun News Paper in 2015, highlights elevated risks in this area. The article suggests that individuals seeking treatment for AAS abuse have increased to more than double the national average over the past five years. The article even suggests that needle exchange programs, originally set up for heroin addicts, is now being overshadowed by AAS users by nearly two thirds. More interestingly, they interviewed users who were quoted saying:

> "*It's open in most of the gyms and easy to buy over the Internet, so why not?*" (Joe) (The Sun, 2015).

This suggest that access, via the Internet, is considered easy. It also highlights the drug's progressive behaviour as well as the influence of perceived societal AAS use.

> "*Before long I was taking every steroid under the sun. I was spending £400 a month. It was like a club — if you weren't taking*

> *steroids you weren't in with the cool gang.*" (Gary Whittaker) (The Sun, 2015).

Cardiff had the highest concentration in Wales, these results were not surprising as the national sport culture and personal success in sport can be a major motivator when considering AAS use (Takta et al., 2013). Success in national sports can yield fame and fortune during and beyond. Participation, starting with increased wages, admiration, worship of the nation, remuneration from endorsements, once their athletic career is over, elevated costs for inspirational talks, seminars and even personal coaching. Wales is renowned for its rugby culture and rugby is a sport that would greatly benefit from AAS use. Size, strength and explosive power are all augmented by AAS use and are primary physical attributes required to compete at high levels (Olds, 2001). Testing in rugby isn't as common as what you would find in other high level sports (Trump, Ungoed-Thomas, & Trump, 1998) and is ignored or accepted as part of the sport:

> *"It's their choice, doesn't really bother me from a moral point of view. it's part of the sport"* (Paul, Rugby) (Erickson et al., 2014, p. 3).

The added anonymity previously described would allow for players to gain access without fear of being caught or judged. These two cities highlight two of the major motivations of AAS use, athletics verses ascetics.

3.8: Conclusion

Some consider the Internet as being instrumental in modern day AAS criminality, with it being central to access, manufacturing, distribution, as well as being a limitless information source (Kraska et al., 2010). With this in mind, it is potentially easier to analyse AAS user activity. The results shown in this study suggest that Google Trends can be used to primarily identify 'at risk' cities for potential users. Future research could use previous data to formulate trends and forecast future markets. Anti-doping programmes could also focus on educating those 'hot spots' so that funds can be allocated more intelligently.

CHAPTER 3. PROFILING POTENTIAL PPD USERS

Preamble

Various studies have identified ‘at risk’ populations in regards to doping (Baron, Martin, & Abol Magd, 2007; Buckman, Yusko, White, & Pandina, 2009; Hanley et al., 2016; Hoff, 2012; Kanayama, Pope, Cohane, & Hudson, 2003; Molinero & Marquez, 2009). They tend to encompass specific areas of doping influence, yet fail to assess them at key stages, i.e. when they are considering PPD use. One large data set was created, of which two studies could be created. *Study 3*; this study sets to analyse individuals who are considering using PPD’s in the near future, in order to map key aspects of doping influence, and then compare them against current/past users and individuals who had never considered doping. Studies have also eluded to specific legal sports supplementation as being a gateway to PPD use. These studies even suggest the total number of supplements prior to doping, but fail to identify a clear potential path and key areas in said path. *Study 4* utilises supplement data, collected from the current/past PPD users, in order to identify a path of supplementation towards PPDs, and identify key stages in their motivations to use said supplement.

STUDY 3. PROFILING AT RISK DOPING POPULATION

4.1. Introduction

Supplementation is defined in the oxford dictionary as 'a thing added to something else in order to complete or enhance it'. It is further defined in a human context as 'a substance taken to remedy the deficiencies in a person's diet' (Dictionary.com, 2016). The western world is becoming more and more reliant on supplementation to alleviate their perceived deficiencies (Gahche et al., 2011; McDowall, 2007). If perceived deficiencies are not met with legal supplementation, there is a risk that individuals may seek out prohibited performance drugs and methods (PPD). This paper looks to profile these 'at risk' populations. Profiling has been used to identify 'at risk' population for various public health concerns (Evans, 1997; Freeman & Winstock, 2015) with varying results. PPD ‘at risk’ populations have not had the same level of exposure as other public health concerns. Profile studies have lacked the depth required to develop a credible deterrence program, and more importantly, suffer from methodological biases (R. a. R. A. James et al., 2013). Previous studies utilised self-reporting measures which can be manipulated, thus skewing results due to the sensitivity of the research area (R. a. R. A. James et al., 2013). This study intends to utilise implicit in conjunction with explicit methods, in order to alleviate some of these biases, as well as follow up with any potential users, so that strong predictors may be identified.

4.2. The body systems and their limitations

Research, regarding motivation to use PPD’s, has yet to identify the perception of one’s internal functions which support physical activity. Supplementation, in the context of physical activity, primarily revolve around the three of the body systems, which are subsequently targeted by supplement companies. The body systems that are targeted by supplement manufacturers are; the energy system, primarily involved producing or resynthesizing adenosine triphosphate, the bodies simplest form of energy (Heckman, Sherry, & de Mejia, 2010); the central nervous system, involved in stimulation and arousal (Juhn, 2003); and the endocrine system involved in producing and regulating hormonal activity (Rogerson et al., 2007).

4.2.1. The Energy system

The energy system is broken down into three interchanging process, the ATP-PC system (involved in short duration & high power), the glycolytic system (involved in moderate duration & moderate power) and oxidative system (involved in high duration & low power), all of which are designed to produce adenosine triphosphate (ATP) (Baker, McCormick, & Robergs, 2010). ATP is the body's simplest form of energy (Gastin, 2001). Energy is released inside of cells during the ATP cycle. When ATP is broken down into its simplest form from carbohydrate compounds, a phosphate is removed via hydrolysis creating cellular energy and converting ATP to adenosine diphosphate (ADP). These systems can be supplemented at different phases with varying effects. For example, ATP can be supplemented by directly increasing carbohydrate intake via glucose based supplements (Campbell et al., 2013), or indirectly with Creatine phosphate (Feldman, 1999; Rawson et al., 2008). Creatine phosphate, also produced in the liver, attaches to ADP in order to resynthesizes ATP, enabling the user to reduce recovery time (Feldman, 1999).

As the ATP-PC and glycolytic systems only provide ATP for short durations, the oxidative system is the most influential in endurance based sports. In endurance sports, VO_{2max} is paramount to success (Tucker & Collins, 2012). VO_{2max} is the ability to achieve maximal oxygen uptake. It relates to the ability to deliver oxygen and nutrients to working muscles which is mediated by cardiac output and the oxygen/nutrient capacity of blood (Maughan, 2005). Research has shown large genetic variability in VO_{2max}., for instance, 10 to 30% VO_{2max} (Bouchard et al., 1999). Researchers have identified 21 single nucleotide polymorphisms (SNP) which influence VO_{2max}.The greater the number of these SNP's one possesses, the greater the VO_{2max} and VO_{2max} trainability. High haemoglobin concentration is advantageous to endurance athletes as the higher the concentration, the higher the capacity to carry oxygen and nutrients to working muscles (Maughan, 2005). Recombinant human erythropoietin (rhEPO) is utilized by some to synthetically increase the hemoglobin number, thus increasing the ability of the body to deliver oxygen and nutrients to the working muscles (Lundby et al., 2012; Robinson et al., 2006).

4.2.2. The Nervous system

The nervous system can be crudely broken down into the central nervous system (CNS) and the peripheral nervous system (PNS). The nervous system's major influences on exercise stem from the cerebellum, involved in muscle coordination. As well as the diencephalon, involved in sensory feedback (Mitchell, Kaufman, & Iwamoto, 1983; Rauch, Schönbächler, & Noakes, 2013). The nervous system is limited by its ability to communicate effectively with muscles and other sensors. Prolonged exercise can lead to a form of nervous system fatigue which can negatively influence physical and mental performance (Davis, Alderson, & Welsh, 2000).

This system can be stimulated by supplementation. For instance, caffeine blocks the adenosine receptors in the brain (Higgins, Tuttle, & Higgins, 2010). Adenosine is a neurotransmitter which reduces nerve activity in the brain. This makes the brain hyperactive, which in turn, causes the pituitary gland to secret adrenaline, thus enabling the user to react to stimuli's faster (Laurent et al., 2000) as well as alter substrate utilisation (Hackman et al., 2006). Stronger illegal stimulants like amphetamines have even been shown to improve endurance (Zaretsky, Brown, Zaretskaia, Durant, & Rusyniak, 2014).

4.2.3. The Endocrine system

The endocrine system's main anabolic hormone in the body is testosterone. In adult populations, the body utilises it mainly for libido, sexual potency and protein anabolic activities, i.e. muscle growth (Hiller-Sturmhofel & Bartke, 1998). Primarily, testosterone is produced naturally in the gonads (the ovaries or testes), but also in small amounts from adrenal glands. Supplement manufacturers utilise compounds, in the form of plant hormone derivatives or chemical hormone precursors, in order to manipulate the natural production of certain hormones (Borrione et al., 2012). Plant based PPD's often contain plant based hormones, otherwise they contain modulating properties. For instance, Tribulus Terrestris is said stimulate the luteinising hormone, which in turn stimulates testosterone production (Richard B Kreider et al., 2004). Recreational users, as well as athletic users, utilises this genre of supplements to manipulate their endocrine system to promote muscle mass.

Muscle strength and power are paramount to success in explosive sports. Muscle strength and power is determined by muscle mass. Individuals with large proportions of type 2 muscle fibres generate larger torque in dynamic situations (Maughan, 2005). Muscle mass can be influenced by training stimulus (Roig et al., 2009), diet (including supplementation) (R B Kreider, 1999; Maughan et al., 2007), and genetics (Guth & Roth, 2014; Wolfarth B Hagberg JM, Pèrusse L, Rauramaa R, Rivera MA, Roth SM, Rankinen T, Bouchard C., 2005). Training and diet can be controlled and manipulated by athletes and recreational gym users, but genetic limitations are a constant. Genetic limitations in the endocrine system can influence the secretion of hormones, which in turn, can affect muscle regulation (Velloso, 2008) and further affect success in sport (Ahmetov, Egorova, Gabdrakhmanova, & Fedotovskaya, 2016; Lippi, Longo, & Maffulli, 2010; Lopez-Leon, Tuvblad, & Forero, 2016; Mattsson, Wheeler, Waggott, Caleshu, & Ashley, 2016; Wolfarth B Hagberg JM, Pèrusse L, Rauramaa R, Rivera MA, Roth SM, Rankinen T, Bouchard C., 2005).

It has been shown that PPD users identify their genetic limits and what was required to surpass them. A PPD user said:

> *"I basically came to the conclusion that there was no way I was ever going to get to where I wanted to be with the small amount of drugs I could buy regardless of whatever genetics I had. It's just that simple. The farther along I wanted to go in bodybuilding, the larger my body had to be and the more drugs I had to take to get there"*
>
> (Kraska et al., 2010, p. 167)

All three of these systems are marred by natural limitations which can be stretched, using training techniques, legal supplements and diet. The perceptions of their limitations are evident by supplement user's justification for use. Justification ranges from maintaining strength, endurance enhancements, extended training periods (Petróczi, Naughton, et al., 2008), energy boosting properties (O'Dea, 2003), performance improvements, improving strength, boosting immunity (Dascombe, Karunaratna, Cartoon, Fergie, & Goodman, 2010), improving circulation, soft tissue repair and reducing inflammation (Molinero & Marquez, 2009).

Supplement users can gain a sense of these limitations by comparing previous performances and/ or comparing against peers.

4.3. Comparing self with self or with others

4.3.1. Self

Self-efficacy is a cognitive self-evaluation by which individuals assess their ability to achieve specific behaviours (Bandura, 1977). In the context of this study, it is the belief of achieving personal and professional performance goals with their current resources. Self-efficacy has been identified as an integral component when predicting behavioural intention in health-related behaviour. For instance, a study found that individuals with low self-esteem were more likely to engage in regular multivitamin use (Gacek, 2016). It should be noted that multivitamins showed a significant relationship with self-efficacy, yet other supplement genres showed no significant relationships. It could be argued that multivitamins play an important role in the everyday efficiency of the body's systems, as well as how well other supplements work (Gacek, 2016), hence, the efficacy of use is higher than other supplements. An early initiation into supplementation self-efficacy influences supplementation in order to achieve and even push the boundaries of athletic capacity (Birzniece, 2015; Jagim et al., 2016). Whereas, in higher levels of physical competition goals, and the belief of achieving these goals, are influenced by direct competitors (Petróczi, Mazanov, et al., 2008).

4.3.2. Others

In competition, one's ultimate success is dependent on the ability to be better than competitors. Knowledge of competitor's achievements can provide one with external goals. If the perception that one's natural ability isn't enough to achieve this goal, training and all approved supplements can be used to reduce the shortfall. If using all approved means of improving performance fails, then there is a risk that individuals may turn to PPD's. Using semi-structured interviews, a study found that competitive cyclists potential to indulge in doping behaviour was higher when it was felt that attaining their goals without doping wasn't perceived as possible (Lentillon-Kaestner & Carstairs, 2010). Further on, if the perception that competitors are achieving their goals by using PPD's, it can further influence PPD behaviour (Dunn, Thomas, Swift, & Burns, 2012; Petróczi, Mazanov, et al., 2008).

4.4. Association with PPD

There are various situations where respondents are less likely to give an honest answer. This could be intentional or unintentional. The intention is mainly driven by social desirability (Gucciardi et al., 2010). If the respondent considers his or her behaviour as undesirable towards the asker of the question, or their social group, there is an increased likelihood they will be dishonest. Historically, data regarding sensitive areas has been collected by explicit questionnaires, allowing for potential response biases. More recently, various implicit methods have been utilised. This is due to the fact that it forces the users to respond to timed events, thus not giving respondents the time to be dishonest. Implicit cognition is thought to be automatic, with a reduced conscious awareness (Rooke, Hine, & Thorsteinsson, 2008). Implicit association testing (IAT) measures the strength of an automatic association (Sriram & Greenwald, 2009). Implicit measures, utilise reaction times, attentional bias, arousal and memory associations. It works by sorting grouped words into pre-identified categories. For example, sorting the word 'steroids' or 'EPO' into categories of 'Me' or 'Not Me'. The test instructs the respondent to sort the words into a specific category. The response time latency for each category is collated and interpreted and the category with the shortest time latency is considered as the association.

If the respondents perceive a conflict between the word and the category, they are expected to take slightly longer to respond, causing an overall delay when comparing two polar opposites. The benefit of implicit association is that it may have the ability to assess cognitive processes that ordinarily wouldn't be available. A reduced sensitivity to social desirability may explain when explicit measures don't match behaviour and help further explain explicit measures in a dual process cognition model (Rooke et al., 2008). Implicit association testing must be approached cautiously as method specific variations can skew results (Mierke & Klauer, 2003; Teige-Mocigemba et al., 2016).

4.5. Social influence

It is important to acknowledge the influence one's social environment has on the potential of PPD use (Maycock & Howat, 2007). For instance, body building gym social culture is said to involve regular conversations regarding PPD's, as well as provide potential access (Grogan, Shepherd, Evans, Wright, & Hunter, 2006). If a current PPD user is in a potential user's social group, it increases the likelihood of gaining access and overall initiation. Maycock & Howat, (2007) highlighted that the presence of social capital may enhance initiation of

PPD's. Social capital refers to the benefits gained from belonging to a particular social group. Social trust can be associated with social capital and can be utilised when making decisions. In this context a potential user is more likely to be influenced by someone in their social group regarding PPD's than by someone they don't know. Influence can also be in the form of peer pressure, which can stem from a need to 'belong', or even from parents who wish their children to succeed (Karazsia et al., 2013). How much the peer pressure is felt is mediated by psychological processes such as internalization of societal ideals, engagement in social body comparison, and body dissatisfaction (Karazsia et al., 2013). Social body comparison revolves around comparison of one's self against peers which is then utilised as ideals. Partaking in doping behaviour can be a result of body dissatisfaction stemming from not matching up to these ideals (Karazsia et al., 2013). A study has also shown that weak confidence to resist social pressure was a strong indicator in PPD use (Zelli, Mallia, & Lucidi, 2010). In a sporting context team, sports exhibited varying peer pressure, depending on the level of sport. For instance, a non-professional cyclist may receive social pressure to abstain from doping, whereas, for professional cyclists, it is the opposite. They felt an increase in pressure from team mates and even managers (Lentillon-Kaestner & Carstairs, 2010).

Overall, it is important to acknowledge that without access, the chances of potential users obtaining PPD's can be reduced drastically. A study by Maycock & Howat (2005) exhibited an increase in initiation of PPD's when there was prior association with a PPD user. These eleven subjects initiated use of PPD's within one year of starting weight training, whereas, the average was three years. Current users, as well as dealers, can also provide potential users with invaluable first-hand experience and information regarding use, overcoming barriers, etc. Maycock & Howat (2005) also demonstrated that PPD dealers can help overcome barriers by providing information on individual PPD's, administration, side effects, legitimacy of PPD's and how to deal with stigma. Vast amounts of information regarding PPD use are available from various sources, but is it all correct or even credible? Potential users are likely to gather as much information perceived as credible before partaking in the behaviour (R. James et al., 2010). The problem is, what is considered credible? It is thought that perceived authorities, in general, are the most likely to provide the most credible information. Although information provided by authorities have, in the past, provided an imbalanced view, skewing more towards the negatives, questioning its credibility (Goldberg, Bents, Bosworth, Trevisan, & Elliot, 1991). Potential PPD user's weigh information, provided by actual users far higher than perceived authorities. This is with the view that the information provided is from first-hand experience rather than grouped studies.

4.6. PPD user profiling

Profiling is the process by which psychological and behavioural characteristics of a group are mapped in order to use the profiles to make identifications. In the context of PPD use, profiles have been created using drug pattern data (Evans, 1997), personality factors (Galligani, Renck, & Hansen, 1996), motivation (V. Barkoukis, Lazuras, Tsorbatzoudis, & Rodafinos, 2013; Cohen et al., 2007), and at-risk profiling (Buckman et al., 2009). Although profiling can provide researchers with a mass amount of information, the information provided in profiles should consist of characteristics of PPD users, so that these profiles can be used to identify at-risk populations (Cohen et al., 2007). A study in the late 1990's provided a profile of one hundred steroid user (thirty three % competitive body builders and sixty seven % recreational users) (Evans, 1997). The study highlighted side effects, length of use, weekly dosage, PPD combinations, cycle length, type of PPD used and additional drug use. Although, demographic data like low income (Angoorani & Halabchi, 2015) can be used as an identifiable characteristic, it lacks the potential to implement an intervention. Also, this type of information gives an idea as to the patterns of use, yet it lacks information that anti-doping programs can utilise in their efforts. Cohen et al., (2007) also profiled users for PPD use patterns, purchasing behaviour, side effects, other drug use and mental history, but also looked at the actual user, their motivations, history and methods of practice. The study found that appearance and performance attributes were the most stated motivations. These motivations were mediated by age, as age increased various motivations reduced. Age of initiation of PPD's was also reported with a mean age of 25.81 Yrs. The study also displayed forms of negative reinforcement, namely a loss of the gains provided by PPD use caused users to continue to use. Motivations and age of initiation help anti-doping programs by demonstrating at-risk ages as well as situations where PPD use may be elevated. Anti-doping benefits the most from profiles which help identify at risk populations. A study of 234 male students found that PPD users demonstrated past excessive usage behaviour, i.e. heavy alcohol drinking and illicit drug use (Buckman et al., 2009). The study also found that PPD users demonstrated high sensation seeking and more coping enhancement reasons for recreational drug use. The majority of these profiles collect data from respondents who are already partaking in PPD behaviour. Anti-doping programs would benefit the most from profiling individuals at-risk of PPD use by profiling groups who are thinking about using

PPDs. This can allow anti-doping programs to identify what made individuals cross the line.

4.6. Aim of this study

The aim of this study is to profile individuals who are considering using PPD, against individuals who have never considered using, and against current/past users. Areas profiled were; perception of bodies deficiencies, self-efficacy without PPD's, implicit association of PPD's, barriers to doping, and social group. Respondents who were considering using were followed up to ascertain contributing factors to any PPD use.

4.7 Methods

4.7.1. Participants

Volunteers were recruited among body builders, athletes and recreational gym users. Participants were required to self-report from a predetermined list on the stage of PPD use they were in. Each participant was then categorised into three subcategories; Current and past user (CU), thinking about using (TU), never considered (NC). Recruitment was focused on participants who were thinking about using PPD, but other subcategories were collated for comparison. Specific inclusion criteria were that subjects were UK born males (to avoid inter-group differences by culture and gender), and had some knowledge of and/or experience with supplementation. Both implicit and explicit measures were distributed via email so to reduce response bias (Joinson, 1999). All respondents provided a contact email separate to when they completed their questionnaires, and all respondents were contacted after twelve months. Data on whether respondents from the TU group had started using PPD's and their identification number was collected via an on online form. Prediction calculations on aspects of self-efficacy, body system belief, BIAT scores, and social group were then conducted.

4.7.2. Anonymity

In order to track and match participants, they were asked to disclose the last four digits of their phone number as it was not enough information to identify them but was memorable enough for the participants to repeat. This number was used on the follow up online form.

4.7.3. Implicit Measures

As previously mentioned, implicit association is the process of quickly sorting categorised words into pre-identified categories. It has been utilised in similar past studies which have focused on food selection (Richetin, Perugini, Prestwich, & O'Gorman, 2007) and even various aspects of doping research (Brand, Melzer, & Hagemann, 2011; Brand et al., 2014; R. James et al., 2010; Petróczi et al., 2011; Schirlin et al., 2009). The study by Petróczi et al., (2011) highlighted the significance of using implicit association by using a modified version called the Brief Implicit Association Test (BIAT) (Sriram & Greenwald, 2009). The study demonstrated this tools' ability to identify users which use PPD's, but are dishonest on the explicit measures, therefore, this study utilised the BIAT approach. Two BIAT were used, both requiring the respondents to sort PPD related words into categories. The first BIAT required respondents to sort "PPD" and "supplement" category words into "me", "not me" categories (Supplements were non-focal), The second BIAT required respondents to sort "PPD" and "supplement" category words into "advantage", "disadvantage" categories (Supplements were non-focal) (

Table 8). These were used to ascertain whether the respondents associated PPD's with themselves and as an advantage. The BIAT is scored using D scores, ranging from 1+ to -1, the closer to 1 in either direction signifies the strength of the association (Sriram & Greenwald, 2009).

Table 8. BIAT Category's and corresponding words (*APPENDIX 4. Inquisit scripts*)

Category	Words
PPD	Steroids, drugs, Stimulant, Hormone
Supplement (Non-focal)	Vitamin, mineral, protein, superfood
ME	I, myself, mine, my
Not Me	They, their, them, others
Advantage	Faster, bigger, stronger, muscular
Disadvantage	Damage, rage, imbalance, sterility

4.7.4. Explicit measures

A Questionnaire was formulated in order to gather information pertaining to this study. Each section focused on; demographics, social aspects, perceived barriers, information sources, self-efficacy, and effectiveness of PPD's:

Demographics - This section was to ascertain various personal data regarding the respondents in order to group them. It consisted of traditional demographic info, i.e. age, gender, postcode etc.

Social – This section contained five questions to ascertain various aspects of the respondent's social group. Four questions were to ascertain the number of friends the respondents had that were users and how close they were to their training group. An additional question was utilised to ascertain whether respondents had been offered PPD from users.

Barriers - This section contained two areas; perceived body systems as potential barriers and barriers to PPD's. Both were rated on a five-point Likert scale. Body system barriers looked at three body systems (energy, endocrine, nervous). Scoring ranged from 'not restricting' to 'extremely restricting' and barriers to PPD looked at eight areas. Scoring ranged from 'not inhibiting' to 'extremely inhibiting'.

Self-efficacy – This section was to ascertain whether respondents could achieve certain goals without PPD's. The section looked at seven areas that could be affected by PPD's, all of which were scored on ten-point Likert scale, ranging from 'strongly agree' to 'strongly disagree'.

Additional questions –The respondents were required to put in order the categories of supplementation they have used (Protein, legal hormone, creatine, vitamins, BCAA, fat burners, illegal hormones and stimulants). This data was used in study 4. The final questions referred to the perceived effectiveness of PPD's. They had to rate how effective they perceived PPD's were on a five-point Likert Scale, ranging from 'extremely effective' to 'extremely ineffective'.

4.7.5. Data Analysis

The means, standard deviations, and frequencies were all calculated and displayed in tables. One-way analysis of variance (ANOVA) with Tukey's Honestly Significant Different post hoc to ascertain differences between the three groups. Correlations were also used to ascertain relationships between the implicit and explicit measures. Multiple regression analysis was used to test if aspects of their self-efficacy, body system belief, BIAT scores, and social group significantly predicted whether or not, a respondent who was thinking about using PPD's, actually started using. Statistical significance was set at 0.05. The statistical software used was SPSS 23.0.

4.8. Results

4.8.1. Participants

Participants were recruited from seven major cities in the UK (Kingston 22, Nottingham 19, London 18, Birmingham 14, Leicester 14, Twickenham 6, Liverpool 4 and Newcastle 2). The study consisted of 99 subjects (49 recreational gym users, 25 body builders and 25 athletes). 28 had never considered using PPD's, 37 were current or past users and 34 were thinking about using. Of the respondents thinking about using, 15 were recreational gym users, 6 were body builders and 13 were athletes. Participants were aged between 18 and 36 (Mean 26.33 ± 2.32 years).

4.8.2: Perceived limits of the body systems

Of the body's systems, the respondents rated how restricting they thought each were. This was done on a five-point Likert Scale. Low scores indicated the respondent believed the system to be not restricting and high scores indicated extremely restricting. Significant differences were observed for two of the bodies systems (*Table 9*); analysis for the *endocrine system* exhibited significant difference (P<.05) in perception between the groups [F(2,96) = 25.96, *P*<0.01]. Post hoc analysis revelled both TU (M= 3.50, SD= 0.51) and CU (M= 3.68, SD= 0.48) significantly rated higher than NC (M= 2.29, SD= 1.33) (*P*<0.01). Analysis on perceptions of the *energy system* exhibited no significant difference in perception between the groups [F(2,96) = 0.44, p=0.63]. Finally, analysis for the *nervous system* exhibited significant differences (P<.05) in perception between the groups [F(2,96) = 34.61, *P*<0.01]. Post Hoc analysis showed NC (M= 1.86, SD= 1.11) rated the nervous system significantly higher than both TU (M= 0.56, SD= 0.50) and CU (M= 0.46, SD= 0.51). No significant differences were observed between groups TU and CU.

Table 9. Perceptions of body system deficiencies (uses five-point Likert scale)

Body System	**Thinking of using (TU)**	**Never Considered (NC)**	**Current/Past User (CU)**
Endocrine system	3.50 ± 0.50*	2.29 ± 1.33	3.68 ± 0.46*
Energy system	1.74 ± 1.16	1.89 ± 1.32	2.00 ± 1.11
Nervous system	0.56 ± 0.50	1.86 ± 1.11*	0.46 ± 0.51

*Indicates significant difference between groups P<0.01

All results were standardised, using SPSS internal function, SPSS produces standardised Z scores that allow for data, which varies in range, to be plotted on the same scale. The results were plotted onto a radar chart (*Figure 8*). TU exhibiting similar body system barrier profile to CU, with them both scoring the endocrine system as the most restricting, whereas, the NC group rated the endocrine the least restricting, and the nervous system the highest.

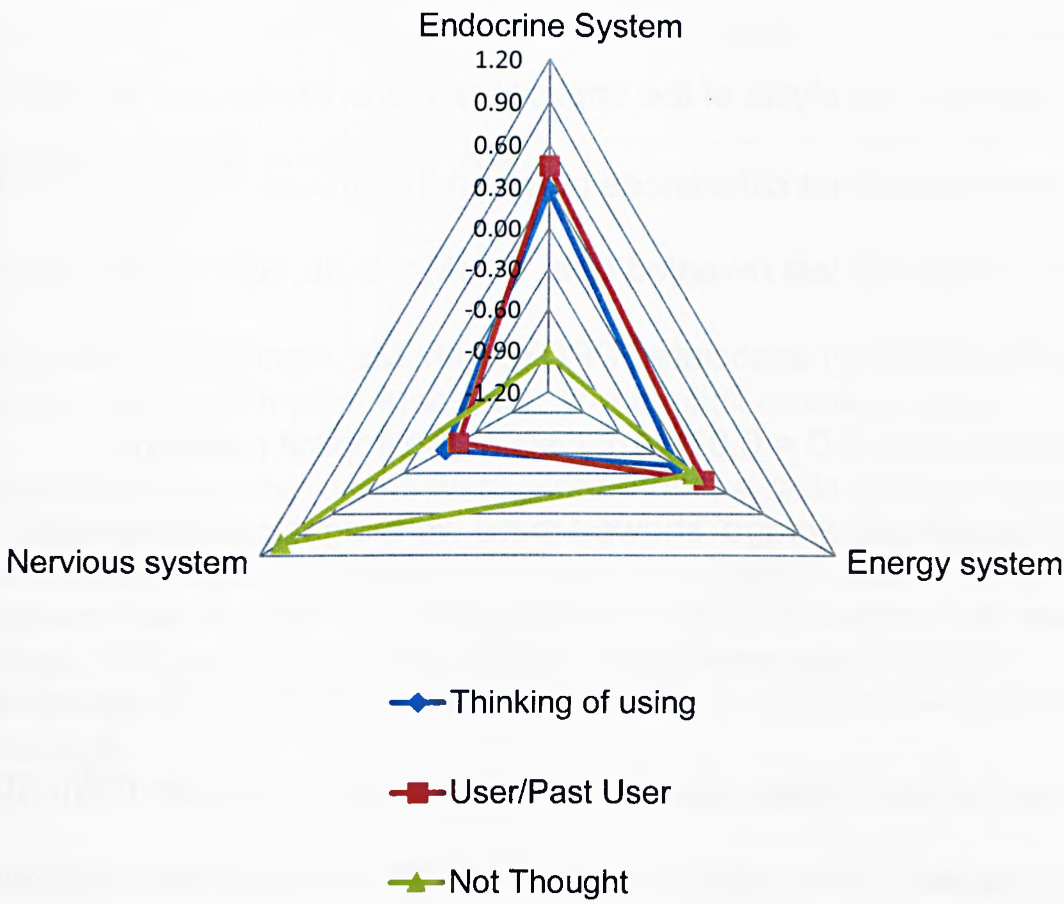


Figure 8. Perceived body system which could act as a barrier to training, large numbers suggests a large barrier.

4.8.3. PPD Association

Respondents were required to provided implicit (Me vs Not me & Advantage vs Disadvantage) and explicit perceived effectiveness about PPD via a Brief Implicit Association Test and Likert Scale questions on

PPD's effectiveness. Significant differences were observed for all of the measures between NC and both TU and CU (*P<.05*) (

Table 10). Analysis of the implicit measure '*Me/not me*' showed there were significant differences between the groups [F(2,96) = 81.00, *p*<0.01]. Post Hoc test revealed both TU (M= -0.38, SD = 0.25) and CU (M= -0.40, SD 0.29) associated PPD's, with 'Me' significantly more than NC did (M= 0.26, SD = 0.07). Analysis of the implicit measure, '*Advantage/Disadvantage*' showed there were significant differences between the groups [F(2,96) = 120.86, *p*<0.01]. Post Hoc test revealed both TU (M= -0.22, SD = 0.22) and CU (M= -0.39, SD 0.17) associated PPD's as an 'advantage' significantly more than NC did (M= 0.26, SD = 0.09). Analysis of the explicit measure of '*PPD effectiveness*' showed there were significant differences between the groups [F(2,96) = 75.27, *p*<0.01]. Post Hoc test revealed both TU (M= 4.09, SD = 0.83) and CU (M= 4.11, SD 0.81) scored the effectiveness PPD's significantly more than NC did (M= 1.82, SD = 0.86).

Table 10.PPD implicit association scores (-1 to 1) and effectiveness of PPD's (five-point Likert scale)

Category of BIAT	Thinking of using (TU)	Never Considered (NC)	Current/Past User (CU)

BIAT- Me - not Me	-0.38 ± 0.25*	0.26 ± 0.07	-0.40 ± 0.29*
BIAT Adv - Disadv	-0.22 ± 0.22*	0.26 ± 0.09*	-0.39 ± 0.17*
Explicit PPD effectiveness	4.09 ± 0.83*	4.11 ± 0.81*	1.82 ± 0.86*

*Indicates significant difference between groups

Results from both implicit measures and explicit measure were standardised and the results were plotted onto a radar chart (*Figure 9*). The PPD association profiles for TU and CU, again, were similar, whereas, NC did not associate PPD's with themselves, or as an advantage.

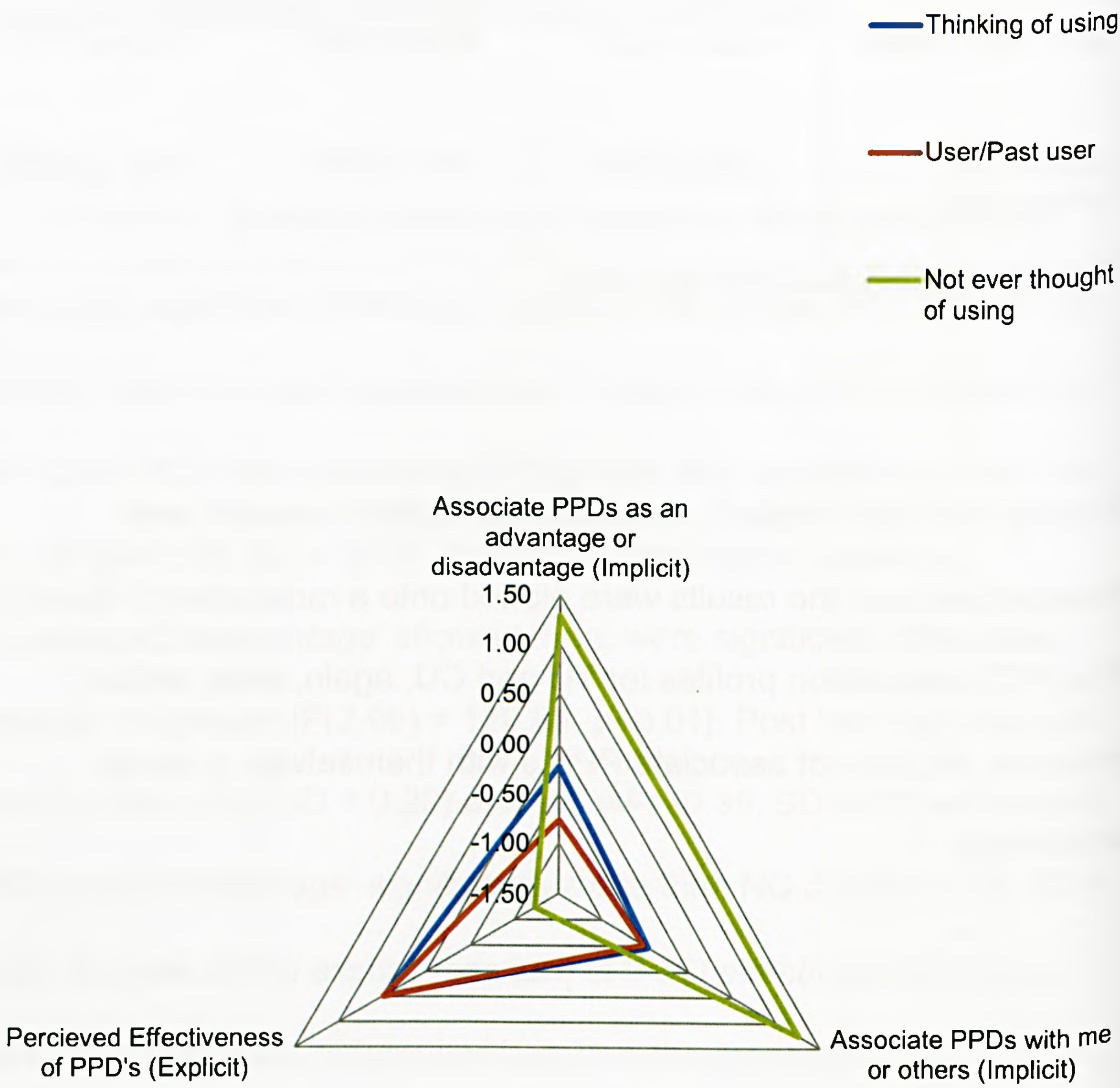


Figure 9. Standardised profile for implicit measures and perceived effectiveness of PPD's. Large values in the implicit measures denote an association with 'not me' and 'disadvantage' and small values denote a 'me' and 'advantages' association with PPD's. Positive values for effectiveness equated to a perceived high level of effectiveness of PPD's.

4.8.4. Self-efficacy without PPD's

In line with self-efficacy assessments, each respondent had to assess whether or not they could achieve certain goals without PPD. Low scores indicated that they could achieve the goal without PPD and high scores indicated they couldn't achieve the goal without PPD. Significant differences ($P<.05$) were observed in four of the seven measures (*Table 11*): Significant differences were observed for self-efficacy '*Attraction*' measures [$F(2,96) = 3.205$, $p = 0.05$] between the groups. Post Hoc analysis revealed CU (M= 5.27, SD 2.35) believed they wouldn't be as attractive without PPD's, significantly more than NC did (M= 3.86, SD = 2.21). Significant differences were also observed for self-efficacy '*Performance*' measures [$F(2,96) = 16.46$, $p<0.01$]. Post Hoc analysis revealed both TU (M= 6.79, SD = 2.12) and CU (M= 6.51, SD 2.04) believed they wouldn't be able to achieve their performance goals without PPDs significantly more than NC did (M= 4.04, SD = 1.99). Significant differences were also observed for self-efficacy '*social interaction*' measures [$F(2,96) = 2.93$, $p = 0.05$]. Post Hoc analysis revealed CU (M= 2.59, SD 1.30) believed they wouldn't be able to achieve their performance goals without PPDs significantly more than

NC did (M= 1.00, SD = 0.00). Finally, significant differences were also observed for self-efficacy '*training potential*' measures [$F(2,96) = 31.01$, $p<0.01$] between the groups. Post Hoc analysis revealed both TU (M= 7.24, SD = 2.31) and CU (M= 6.46, SD 1.88) believed they wouldn't be able to achieve their performance goals without PPDs significantly more than NC did (M= 3.39, SD = 1.73).

Table 11 Perceived ability to achieve tasks without PPD's (Self Efficacy measures)

Task	Thinking of using (TU)	Never Considered (NC)	Current/Past User (CU)
Aesthetic goals	5.62 ± 3.34	4.86 ± 2.53	5.32 ± 3.30
Attraction	4.85 ± 2.19	3.86 ± 2.21	5.27 ± 2.35*
Everyday tasks	1.12 ± 0.41	1.00 ± 0.00	1.03 ± 0.16
Training intensity	4.62 ± 2.39	4.68 ± 2.23	5.08 ± 2.56
Performance goals	6.79 ± 2.12*	4.04 ± 1.99	6.51 ± 2.04*
Social Interaction	1.38 ± 0.99	1.00 ± 0.00	1.59 ± 1.30*
Training potential	7.24 ± 2.31*	3.39 ± 1.73	6.46 ± 1.88*

*Indicates significant difference between groups

All results were standardised, and the results were plotted onto a radar chart (*Figure 10*). The self-efficacy profiles for TU and CU again are similar, both rating training potential and performance goals the highest, whereas NC scored training potential the lowest.

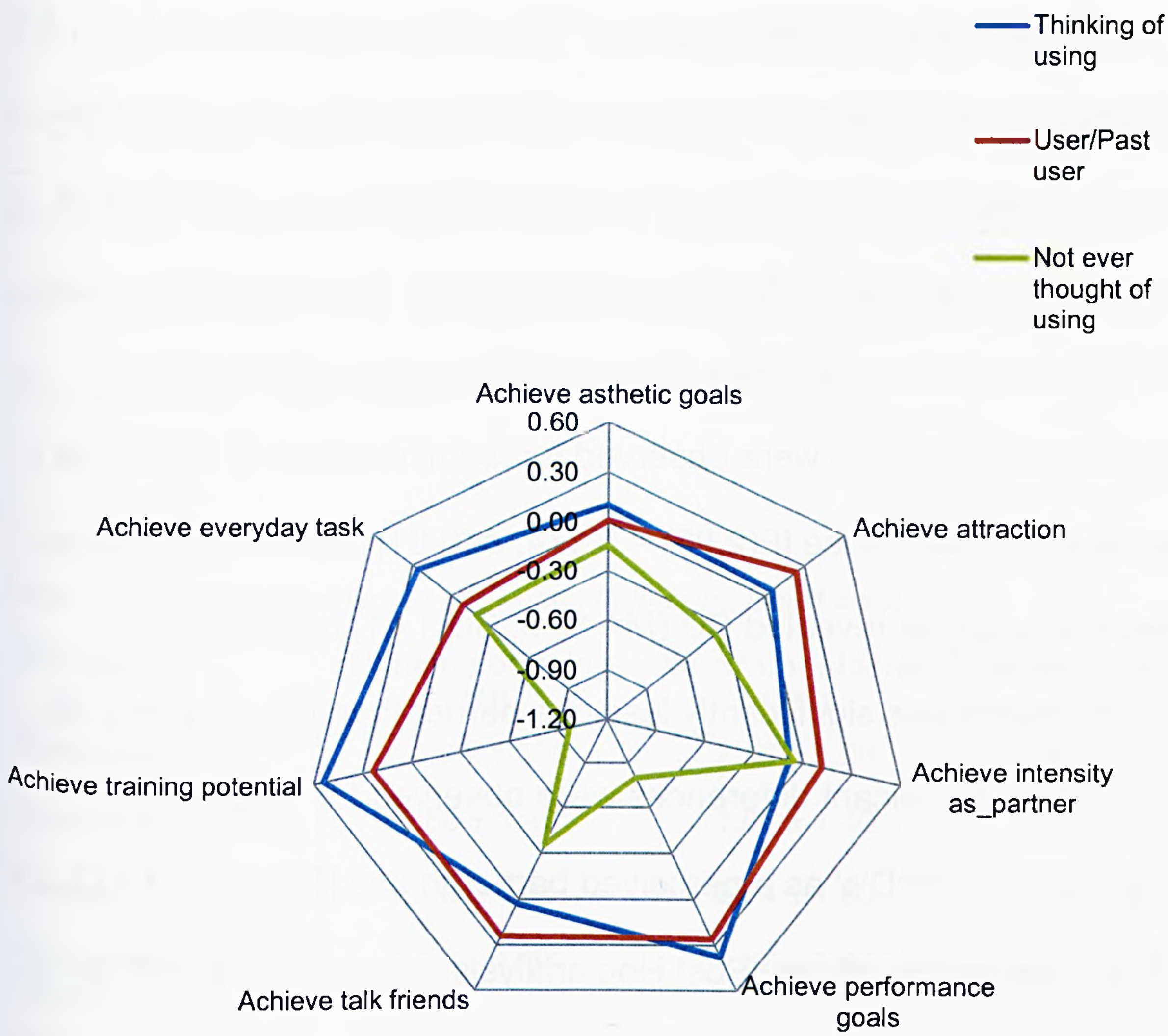


Figure 10. Standardised self-efficacy measures: High values indicate a perceived inability to achieve named aspect without PPD's

4.8.5. Barriers to PPD's

Perceptions of what may block PPD use is important, as it may be utilised as part of deterrence programs. Eight aspects were observed using a five-point Likert Scale, low scores indicating it is perceived as not inhibiting, ranging up to extremely inhibiting. Significant differences ($P<.05$) were observed in five of the eight measures (*Table 12*): Significant differences were observed for 'administration of PPD's' as a perceived barrier to use [$F(2,96) = 6.174$, $p<0.01$] between the groups. Post Hoc analysis revealed CU (M= 1.46, SD 1.41) believed administration was significantly less of a barrier than NC did (M= 2.46, SD = 1.20). Significant differences were observed for 'credible' information on PPD's' as a perceived barrier to use [$F(2,96) = 4.823$, $p = 0.01$] between the groups. Post Hoc analysis revealed CU (M= 0.95, SD 1.15) believed credible informational was less of a barrier than NC did (M= 1.96, SD = 1.40). Significant differences were observed for 'Psychological side effects' as a perceived barrier to use [$F(2,96) = 3.058$, $p = 0.05$] between the groups. Post Hoc analysis revealed both TU (M= 1.59, SD = 0.89) believed psychological side effects were less of a barrier than NC did (M= 2.32, SD = 1.47). Significant differences were observed for 'Physiological side effects' as a perceived barrier to use [$F(2,96) = 10.921$, $p<0.01$] between the groups. Post Hoc analysis revealed both TU (M= 1.94, SD = 1.04) and CU (M= 2.19, SD 1.37) believed psychological side effects was less of a barrier than NC did (M= 3.21, SD = 0.79). Significant differences were observed for 'interest in PPD's' as a perceived barrier to use [F(2,96) = 76.793, *p*<0.01] between the groups. Post Hoc analysis revealed both TU (M= 0.00, SD = 0.00) and CU (M= 0.00, SD 0.00) believed psychological side effects were less of a barrier than NC did (M= 2.07, SD = 1.41).

Table 12. Perceived barriers to PPD uses (five-point Likert scale)

Barriers	Thinking of using (TU)	Never Considered (NC)	Current/Past User (CU)
Administration	1.29 ± 1.53*	2.46 ± 1.20	1.46 ± 1.41*
Credible information	1.56 ± 1.46	1.96 ± 1.40	0.95 ± 1.15*
Finance	1.59 ± 1.28	2.14 ± 1.30	1.68 ± 1.29
Psychological side effects	1.59 ± 0.89*	2.32 ± 1.47	2.08 ± 1.23
Stigma	2.21 ± 1.32	2.14 ± 1.30	1.81 ± 1.54
Access	2.38 ± 1.69	2.50 ± 1.20	2.22 ± 1.69
Interest	0.00 ± 0.00*	2.07 ± 1.41	0.00 ± 0.00*
Physiological side effects	1.94 ± 1.04*	3.21 ± 0.79	2.19 ± 1.37*

*Indicates significant difference between groups

All results were standardised using SPSS internal function and the results were plotted onto a radar chart (*Figure 11*). TU exhibited similar perceived barrier profile to CU, whereas, the NC group, on average, scored higher on everything apart from *stigma*. *Interest* was the largest perceived barrier for the NC group according to *Figure 11,* but this is due to the standardising results. NC largest barrier was *physiological side effects* and TU largest barrier was *access*.

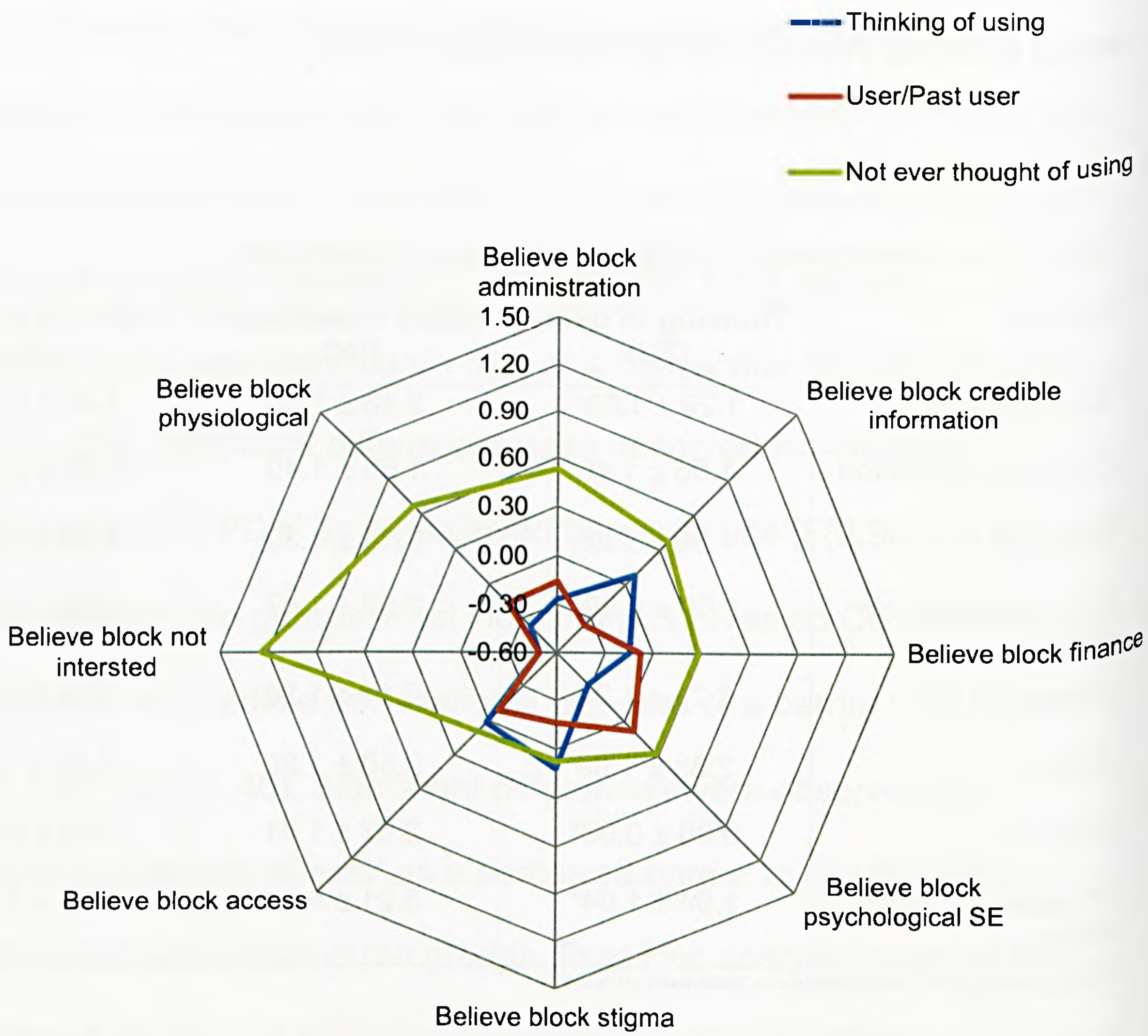


Figure 11. Perceived barriers to PPD use

4.8.6. Explicit, implicit relationship

Relationships were observed between the implicit measures and explicit measures. Both BIAT's correlated with each other (r = 0.74, p<0.01). The 'Me' 'Not me' BIAT correlated with effectiveness of PPD (r = -0.62, p<0.01), restriction of the endocrine system (r = 0.49, p<0.01), and the number of people in the respondents' gym social group who use PPD (r = 0.20, p = 0.05). The 'advantage'/disadvantage' BIAT also correlated with effectiveness of PPD (r = -0.67, p<0.01), restriction of the endocrine system (r = 0.43, p<0.01), the number of people in the respondents' gym social group who use PPD (r = 0.29, p = 0.04), and the number of people in the respondents' social group who use PPD with whom the respondents actually socialise (r = -0.29, p = 0.04). Relationships were also observed between perceived restriction of the endocrine system and the order of when they started using legal testosterone boosters.

4.8.7. Twelve Month follow up

Twelve months after the baseline data was collected, respondents who reported they were thinking about PPD use were contacted and asked if they had started using. 79.4% of the 34 responded. Multiple regression analysis was used to test if aspects of their self-efficacy, body system belief, BIAT scores and social group significantly predicted whether or not a respondent who was thinking about using PPD's actually started using. The results of the regression indicated that two predictors explained 68.3% of the variance (R^2=.83, $F(2,24)$=25.84, $p<.01$). It was found that the number of gym PPD users with whom the respondent socialised significantly predicted PPD use (β = .72, $p<.01$), as did the belief the respondent wouldn't be able to achieve their performance goals (β = .28, $p<.05$).

These new users had 4.25 ± 2.09 gym friends who used PPD's and a performance goal achievement score of 7.83 ± 1.47 (high scores indicated they couldn't achieve the goal without PPD).

4.9. Discussion

The aim of this study was to ascertain similarities and differences exhibited by individuals thinking about taking PPD's, in comparison to individuals who had never considered PPD, and current/past users. The primary focus of this study was on the group thinking of using PPD's as this group could be considered at risk. It should be noted that the respondents were grouped from their own self-reporting. This may skew the results if a social desirability bias is present.

4.9.1. Motivated by the body

The body's systems have varying effects on performance. Some may be deemed more important than others, depending on the goals of the individual. It is important to acknowledge that the TU group was made up of 17.6% body builders, 38.2% athletes and 44.2% recreational users. Recreational users and body builders are more likely to be motivated by aesthetics (Sagoe et al., 2015, 2014), whereas, athletes are more likely to be motivated by performance (Birzniece, 2015). This was reflected in the TU group which considered training potential, performance and aesthetics as leading areas they felt would be lacking without the use of PPD's. In terms of the perceived system deficiency, the TU group considered the endocrine system the most in need of supplementation. This group of respondents already highlighted that they were interested in PPD's but hadn't partaken, which suggests a certain level of understanding in terms of PPD's effect on the body. Attempts to alleviate the endocrine deficiency were also observed. Positive relationships were observed between legal hormone boosters (order of purchase) and the perceived restrictiveness of the endocrine systems. 58.8% of the group had taken legal hormones and, for the majority, it was the third supplement they had purchased (20%) but it ranged from the second to the sixth supplement purchased. It could be argued that the use of legal hormone boosters is the first step towards PPD use as it allows the user to gain experience in supplementing the endocrine system, thus highlighting its deficiencies, as well as providing a potential entry point to more illegal supplementation.

4.9.2. Perceived barriers

The strength of perceived barriers can reduce the likelihood of partaking in behaviour (Judge et al., 2012), yet overcoming barriers has the potential to reduce social controls which restrict use of PPD's

(Maycock & Howat, 2005). In this study, the TU group highlighted access and social stigma of PPD's as leading barriers. Maycock and Howat, (2005) also identified stigma and access, along with credible information and administration, as barriers to PPD. Stigma was identified by 90% of Maycock's participants, stemming from family, non-using friends and health professionals. The study also highlights how individuals who initiate PPD use are advised by current users on how to deal with stigma, which, in turn, caused a shift in attitude towards PPD and a reduction in related social controls. In terms of access it was believed that potential users had to make contact with dealers and establish a relationship, yet with the emergence of the Internet's involvement in the distribution of illicit substances, this may no longer be the case.

4.9.3. Social influence

Social norms are the behavioural rules by which social members must adhere to or risk alienation from the group. In the context of this paper, whether it is socially acceptable to use PPD's. As previously stated, negative connotation can be attached to users from family members, health professionals and more importantly, non-using friends.

Therefore, the ratio of using and non-using friends in a TU social group may influence behaviour. The self BIAT (me-not me), which associated PPD's with themselves, significantly correlated with the number of members in the respondents social group who use PPD's (r = -0.29, p<0.01) and the number of members who take PPD's with whom the respondent socialises outside of a gym setting (r = -0.29, p<0.01). This suggests that there is an increased likelihood that individuals who are considering using PPD's may being influenced by the number of other users in their social group.

The individuals from the TU group who had started using, exhibited further evidence that social influence may be a major factor in PPD use. It could be argued that PPD use may be an attempt to fit in with a group of potential users, or to conform to norms of a dominant group (Carron, Bray, & Eys, 2002; Oostveen et al., 1996).

4.10. Conclusion

It has been pointed out that education will be unable to have an impact if someone has decided to dope.

> "*If somebody's deliberately breaking the rules, all that education has no impact at all, it's irrelevant.*" (Participant 2) (Winand, 2015, p. 28)

Profiles for CU's and TU's show that they both score very similarly to each other and both very different from NC *(Figure 8, Figure 9, Figure 10, Figure 11)*. These results point to a similar mindset for both users and those that may be transitioning to use. Is the mindset a consequence of joining the group or was it there prior to joining? Regardless of its origin, implementing any successful anti-doping program will be dependent on the social environment of offenders.

STUDY 4. PROGRESSIVE POLYMORPHIC BEHAVIOUR: TEACHING CHILDREN TO DOPE

5.2. Introduction

In sports, doping is a term given to socially unacceptable, and sometimes illegal, forms of performance enhancement. If the social and legal attachments are removed, prohibited performance enhancing drugs (PPD's) would be considered as just another form of performance enhancement, rather than a morally charged substances (Petróczi, 2013). It is important to note that the function of PPD's are to enhance performance, and regardless of the motivation, (i.e. unfair advantage) making it a viable option for individuals with a functionalistic view rather than a moral one. The incremental model of doping behaviour (IMDB) approaches PPD's with a functionalistic view rather than a moralistic one. The model posits that doping stems from progressive learned behaviour from a functional perspective (*Figure 12*) (Petróczi, 2013).

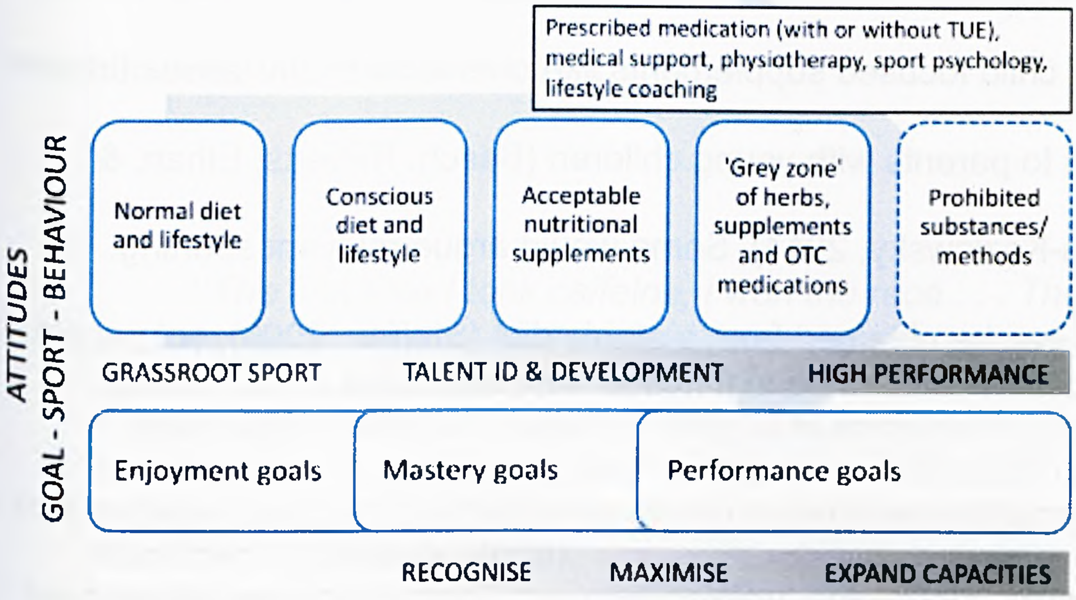


Figure 12. Incremental model of doping behaviour (Petróczi, 2013, p157)

A big part of how children learn to behave is derived from their social environment, and whether this behaviour continues, largely depends on whether the behaviour elicits a positive or a negative experience. Drug use has been suggested to induce forms of reinforcement learning via positive and negative reinforcement (Robbins & Clark, 2015). This is progressive in nature, in that, positive experiences drive users to seek out stronger drugs (Robbins & Clark, 2015).

Its human nature to continually improve oneself (Harris & Quigley, 2008). From a very young age our children are taught to supplement deficiencies in their body (Ells et al., 2008; Low, Farrell, Biggs, & Pasricha, 2013; Nelson, Naismith, Burley, Gatenby, & Geddes, 1990), usually using multivitamins as a starting point. For instance, there are a variety of child focused supplements like chewable multivitamins that are marketed to parents with young children (Basch, Roberts, Ethan, & Samayoa-Kozlowsky, 2014). Some would argue relevant sporting nutrients can be obtained from a stable diet (Steffen, 2006), yet people prefer the convenience of supplementation. As children get older, supplementation becomes a progressive part of their lives, whether it be multivitamins, sleep aids, training aids etc. Even aged populations have been reported to administer herbal supplements in conjunction with prescribed medication in order to promote the action of said medication, although these can, potentially, cause negative interactions (Nisly, Gryzlak, Zimmerman, & Wallace, 2010). It is this general supplementing learned behaviour that could potentially translate into progressive fitness supplementation, and eventually lead to the use of PPD's.

5.3. Positive reinforcement

Positive experiences which occur from specific behaviour, reinforces that behaviour, and thus, increases the likelihood the behaviour will occur again. For instance, in a study on young cyclists, it was demonstrated that if a supplement provided perceived success, it was then used over and over again.

> "*The first time I took caffeine, I won the race . . . The next week, I took it again and won again. It is perhaps a coincidence, but after that, I took it every race*" (Benjamin, U23) p338 (Lentillon-Kaestner & Carstairs, 2010).

Positive reinforcement also feeds into progressive learned behaviour in the form of operant conditioning (Wood, 2002, 2004). Operant conditioning is a form of learning by which behaviour is strengthened or weakened depending on the consequences of the original behaviour. In the context of PPD use, positive experiences of legal supplements drive behaviour towards more illicit PPD's. This further supports the gateway hypothesis, yet to the knowledge of this thesis, research is yet to demonstrate how supplement use progresses or identify at risk supplements which may act as a direct gateway to PPD use. Identifying these supplements will allow anti-doping programs to direct their efforts towards educating on the risk of use.

5.3. Fitness industry: building on a healthy foundation

The fitness industry is saturated with supplements that claim to aid users in alleviating their perceived deficiencies. At this point it is important to acknowledge that supplementation can be categorised in to two mediums. Direct supplementation, is the process by which the compound lacking in the bodies system is directly replaced. For instance, testosterone being injected directly into the body or drinking orange juice to increase vitamin C levels. The second medium is by a precursor which indirectly increases the body's secretion of a specific compound by altering major pathways. For instance, Tribulus Terrestris indirectly increases the body's secretion of testosterone (Kreider et al., 2004). Precursors can be considered more invasive in nature, as it serves to manipulate the homeostasis of the system that it is targeting.

In a physical exercise context, supplementation is utilised to remedy perceived deficiencies in in body composition or exercise performance. Supplementations utilised are typically from legal sources, for instance, protein shakes, Creatine, fat burners etc. Yet if these sources do not appease the user's perceived deficiencies, then there is a potential for them to continually progress to a more elaborate supplement, up to and including the point of illegal supplementation.

5.4. Visual and performance drivers: The road to tolerance

Fitness supplementation revolves around visual and performance attributes, which are more likely to produce positive reinforcement in the form of visual or performance goal attention. For instance, fat burners are frequently used to reduce fat levels in the body, making the user appear leaner and potentially rewarding them by being visually more attractive to the opposite sex (Weeden & Sabini, 2005). Some supplements cater to both performance and visual goals. Creatine is one of the most widely utilised supplements (Cooper, Naclerio, Allgrove, & Jimenez, 2012). It is utilised to resynthesize adenosine triphosphate, the body's simplest form of energy. Creatine supplementation can increase strength, lean muscle mass and muscle morphology (Cooper et al., 2012). Continual use of certain supplements can lead the user to develop a level of tolerance, thus shifting their perception of deficiency and potentially leading them to source stronger supplements until legal sources no longer fulfil their requirements. One of the main issues that relevant governing bodies have with illegal supplementation is that they lack the regulation which is mandatory for legal vendors and, thus, pose potential health risks (Evans, 1997; Graham et al., 2009).

In order to aid relevant anti-doping programmes, the aim of this study is to ascertain whether there is progressive behaviour, in terms of supplementation, prior to PPD use. Also, this study would like to ascertain if there is a specific genre of supplements which may act as a gateway to PPD use.

5.5. Methods

5.5.1. Participants

Volunteers were recruited among body builders, athletes and recreational gym users from around the UK. Specific inclusion criteria were that they were UK born citizens and that they were currently or had previous taken a PPD. All 37 participants were males, aged 25.92 ± 5.11.

5.5.2. Procedure

Participants were required to report from a predetermined list of supplement genres, the order of the supplements used as well as the total number. The predetermined list included: Vitamins and minerals, protein, creatine, branch chain amino acid, stimulant (pre-workout), fat burners and legal hormone boosters. For each of the supplements used, the respondents noted the reason they took the supplement, as well as how effective it was in alleviating that problem. Effectiveness was scored on a ten-point Likert Scale, ranging from 'not at all effective' to 'extremely effective'. Reasons for using said supplement was abbreviated into terms e.g. strength, burn fat etc.

5.5.3. Data Analysis

Frequency tables were created in order to ascertain which supplements were predominantly used, in which order they were used, and the reasons for using said supplement.

5.6. Results

5.6.1. What do I need and why

The information provided by the respondents allowed for this study to map potential trends in supplementation use prior to PPD use. *Figure*

13 shows the supplement percentage by order of use. It shows that PPD users used the supplements in the following order, prior to PPDS: protein, creatine, BCAA, Stimulant, legal hormones and illegal hormones. In these cases, initiation of PPD started as early as the fourth supplement and on average, 5.73 ±0.87. The leading motivations for supplementation were, firstly, muscle growth, then strength, and then the process by which either are achieved, i.e. training harder (*Table 13*).

Table 13. Motivations for supplementation use

Reason for supplementation	*%*
Muscle growth	35.45
Increase strength	22.73
Train harder	11.36
Support training	10.00
Reduce body fat	8.64
Parent influence	5.45
Support immune system	1.82
Increase focus	1.82
Increase power	0.91
Increase endurance	0.45
Get ripped	0.45
Recover from injury	0.45
Suggested by friend	0.45

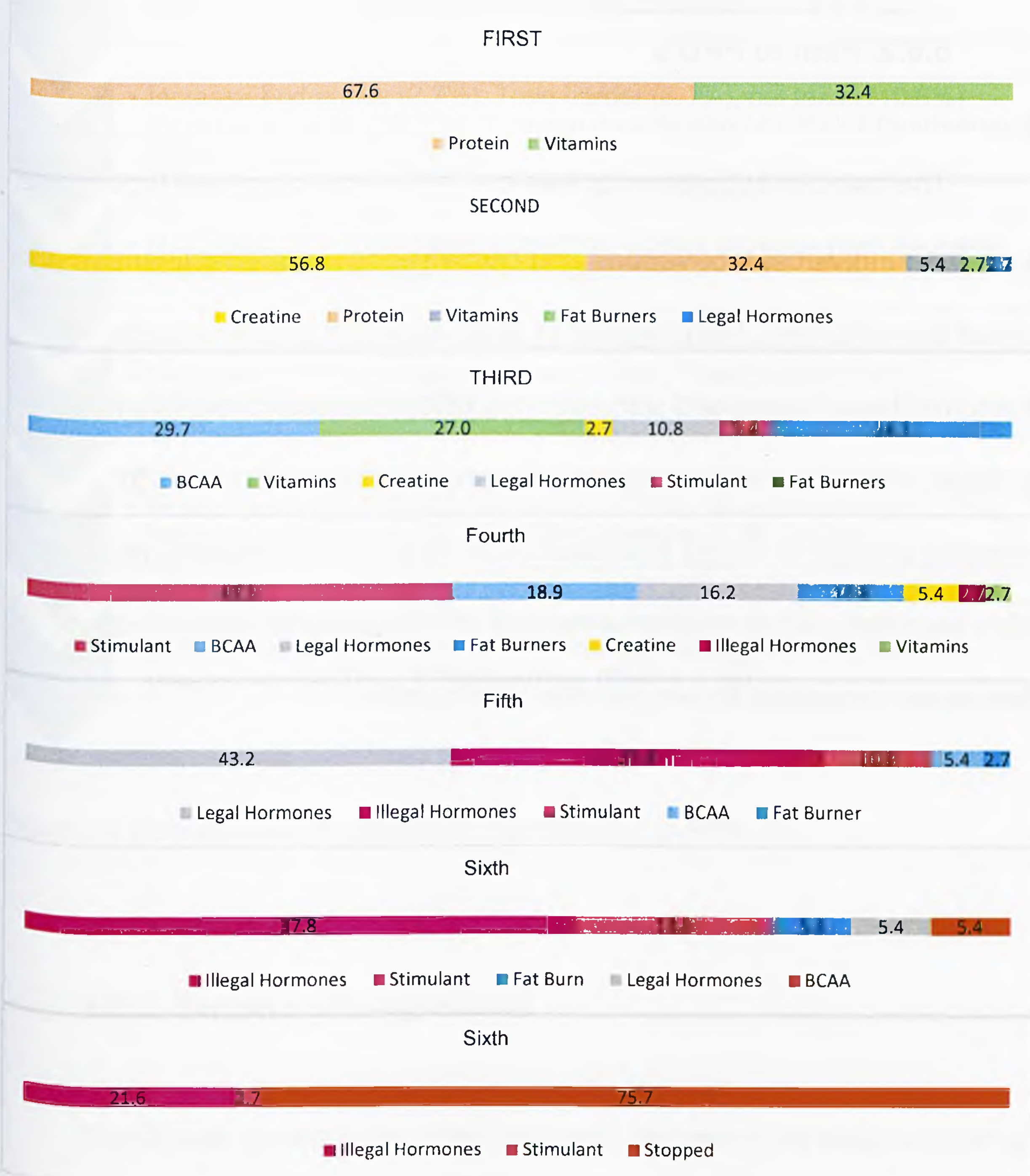


Figure 13 Supplement percentage by order of use prior to PPD's. Red indicates cessation of supplementation.

5.6.2. Path to PPD's

The trend of supplements was put into a flow diagram (*Figure 14*) with their individual motivations and perceived level of effectiveness. Apart from BCAA's, the progress of supplementation seems to be matched by an increased perception of effectiveness. Starting with protein, which has an average effectiveness rating of 5.13 ± 1.57, ranging through to illegal hormones at 8.43 ± 1.14. Increasing muscle size was the leading motivator for four of the supplements. The other two were to support training and to train harder.

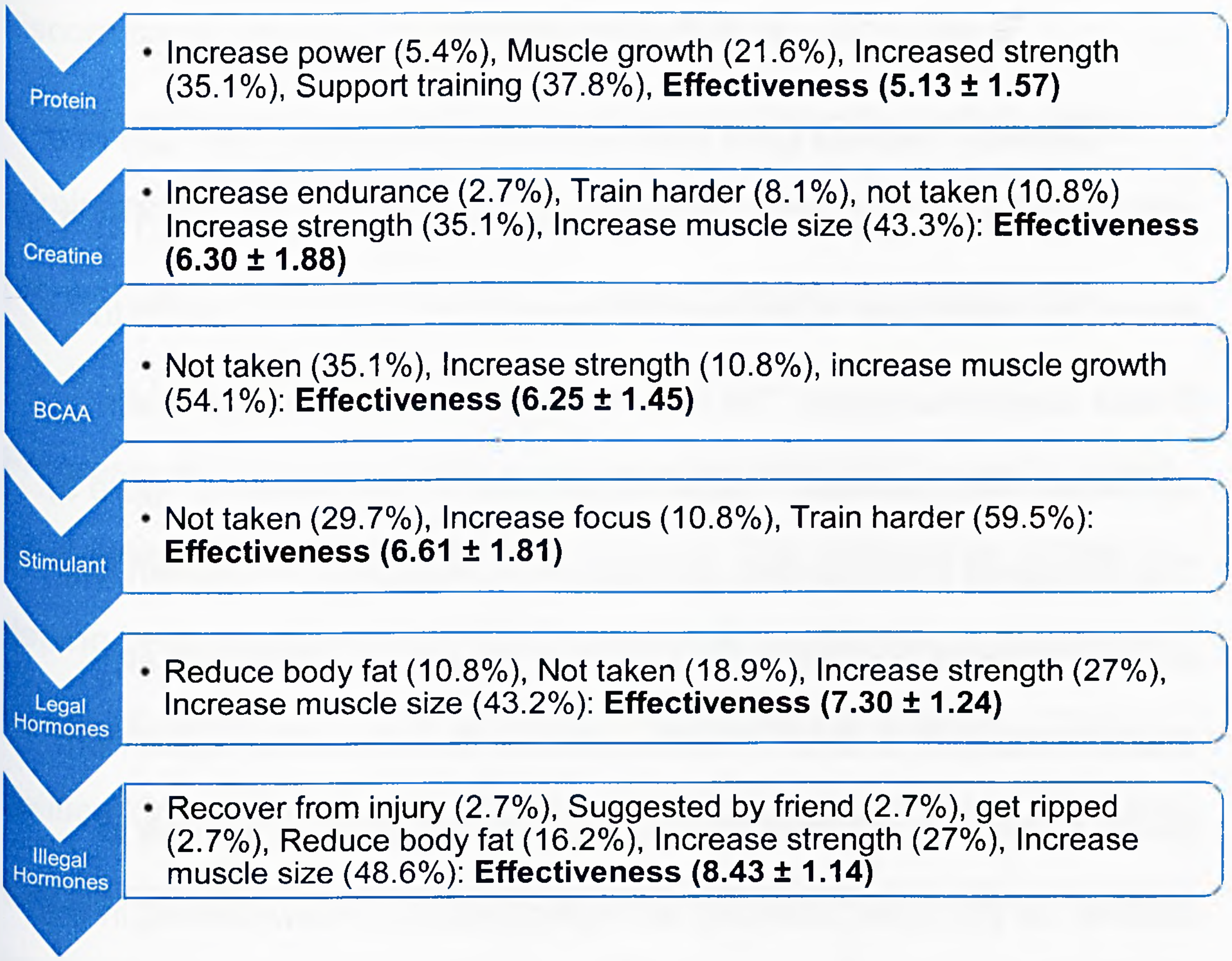


Figure 14. Flow diagram of supplement trend leading to PPD use

5.6.3. Dangers of progression

Significant correlations were observed between the total number of supplements with both legal hormone boosters (r =.43, p<.01) and PPD's (r = .73, p<.01). Order of legal hormone boosters and order of PPD's significantly correlated (r =.57, p<.01) as did perceived effectiveness of legal hormone boosters and effectiveness of PPD's (r = .76, p<.01).

5.7. Discussion

Gateway theories posit that illegal PPD use stems from use of a prior supplement (Backhouse et al., 2013; Hildebrandt et al., 2012). The aim of this study was to ascertain if there is a progressive nature to fitness supplementation. The results suggest that, in terms of their perceived effectiveness, it could be considered progressive (Figure 3). The perceived effectiveness was shown to progress from protein, with an effectiveness score of 5.13 ± 1.57, to the use of PPD's with an effective rating of 8.43 ±1.14. All supplements in-between, apart from BCAA's, showed progression in terms of effectiveness from one to another. At this point, it should be highlighted that multivitamins, in the majority of cases, were not the first supplement. This suggest that this progressive, learned behaviour may be initiated in conjunction with the initiation of physical training, rather than prior to this. As the effect multivitamins have on performance and body composition are minimal, it is conceivable that it lacks the positive reinforcement to drive progressive behaviour. It also should be highlighted that there may be a degree of cross over, once a supplement has been initiated, which can produce potential problems. A polypharmacy approach to supplementation runs the risk of adverse drug events and even negative interactions which can lead to adverse effects, ranging from general discomfort to life threating situations (Lazic et al., 2011). New supplements may be synergistic to other supplements already being administered, thus improving their perceived effectiveness, for example, pre-workout supplements (Smith, Fukuda, Kendall, & Stout, 2010).

Progression from one supplement to another requires the user to make an evaluation of multiple influencing factors. The incremental model of doping behaviour (Petróczi, 2013) posits that progression is moderated by social (Ohl et al., 2015), economic (Humphreys & Ruseski, 2011), political (Ventura & Segura, 2010), and cultural environmental factors (Schneider, 2006). Previous supplement experience was also assessed. Positive experiences, i.e. perceived effectiveness of a supplement, when rated high, are more likely to encourage continual or progressive use. This progression starts from the first instance of reinforcement and compounds incrementally for cases afterwards(Wise & Koob, 2014). Development of drug abuse does not only come from positive reinforcement. Fear of withdrawal systems can also serve as a motivator (Wise & Koob, 2014). Usually, withdrawal symptoms refer to physical symptoms like thermoregulatory problems, yet a reduction in performance or body composition, which occurs with cessation of a particular supplement, could be considered a withdrawal. Compulsive behaviour is said to occur when use is driven by this fear. In this study, the leading reason for supplementation was to increase muscle size (35.35%), suggesting body composition was a primary motivator. Progressing from one supplement to another, in terms of effectiveness, eventually reduces the legal options available which can lead users to seek illegal options to satisfy their needs. The higher the numbers of supplements, prior to PPD use, suggest learned behaviour. Respondents from this study, initiated PPD use after an average of 5.73 ± 0.87 supplements. This was in conjunction with a study conducted on 2650 students, which highlighted a relationship between previous nutritional supplementation and prevalence of PPD use. The study found that individuals were over four times likely (1.3% to 5.4%) to dope, if they had previously used nutritional supplementation (Papadopoulos et al., 2006), yet the study fails to highlight potential key stages. This study sought to highlight key stages in the said progressive behaviour. From the results, key supplements were identified, and stages attributed to them, depending on when they were administered, in relation to physical exercise initiation and PPD initiation. The stages are as follows; initiation stage, conscious manipulation stage, increase in intensity, and mimicking.

5.7.1. Phase 1: Initiation

The initiation stage is when an individual first initiates physical exercise for a specific personal reason. For instance, joining the gym to build muscles or jogging to increase cardio. In this study, during the initiation stage, the majority of cases used protein as their first supplement. Protein was primarily utilised to support training, whether it be for muscle size or strength. It is important to acknowledge that any anabolic substances are mediated by the presence of protein (Evans, 1997). Protein's primary function is to repair damage caused by rigorous physical activity by a process called protein synthesis. Therefore, it could be argued that, protein is the most important supplement, as without it, muscles won't repair and get stronger (Atherton & Smith, 2012). A study showed, from a sample of 273, that initiation of protein use can start as early as 16 years old (M_{AGE} = 16.64, SD 1.93), suggesting that initiation of protein supplementation starts midway through adolescence (Karazsia et al., 2013). Protein use has been linked to adolescent dissatisfaction with their muscularity, scoring significantly higher on the male body attitude scale (MBAS) (Yager & O'Dea, 2014). The study identified that 'Drive for Muscularity' and 'Muscle appearance satisfaction' were strong predictors in current protein use. Another study has shown that protein is the first instance of exercise supplementation, and that it can progress into other substance, mainly creatine (Karazsia et al., 2013). They found that previous protein use could go as far as to predict future creatine use.

5.7.2. Phase 2: Conscious manipulation

The conscious manipulation stage is the first instance when the administer consciously manipulates the body's system for a specific performance goal. During this phase, creatine was identified as the first instance when one of the body's systems was consciously manipulated. Creatine is one of the most utilised supplements on the market (D'Anci, Allen, & Kanarek, 2011). Unlike protein, where the overriding reason for supplementation was to support training, reasons for creatine use were more specific, i.e. increase muscle size and strength. This conscious stage is mirrored in the incremental model of doping which shows a progression from a conscious diet and life style to acceptable nutritional supplements. Karazsia et al., (2013), has also shown a progression in age, from protein supplementation, to creatine supplementation. The study showed that the mean age from protein initial use, to creatine initial use, was a mere 0.55 years. Research has shown that as individuals age, their ability to regenerate high energy phosphates increases (Cooper et al., 2012). This suggests that at younger ages, creatine supplementation is more effective, and as they age, becomes less so. As the majority of natural creatine is derived from meat, vegetarian athletes as well as adolescents experience greater effects of creatine (Rae, Digney, McEwan, & Bates, 2003). As creatine's effectiveness reduces as individuals age, the perceived benefits of the supplement may also reduce, causing the user to seek more effective supplements.

Creatine can be found in the brain as well as muscle tissue. A large amount of research is conducted on the effects of creatine on athletic performance (Branch, 2003), but a few studies have also highlighted its importance in brain functionality. Creatine supplementation has been shown to reduce mental fatigue (Watanabe, Kato, & Kato, 2002), working memory, and intelligence (Rae et al., 2003). The brain can contribute up to 20% of the body's energy consumption, therefore, any supplement which can manipulate energy production could, indirectly, improve the brain's efficiency by improving energy availability at a cellular level (Andres, Ducray, Schlattner, Wallimann, & Widmer, 2008). These findings have encouraged creatine to be considered as a cognitive enhancer (Bostrom & Sandberg, 2009; Joshi, Pranav, 2013). The physical and the psychological benefits obtained from creatine supplementation has the potential to provide enough positive feedback for them to continue or even progress their supplement behaviour. It has been suggested that addiction (in this case PPD use) stems from, and develops from, first reinforced responses, and strengthens incrementally thereafter (Wise & Koob, 2014).

5.7.3. Phase 3: Increase intensity

During this stage, supplementation is less about the development of muscularity and more about the performance on a given day, which, in the long run, contributes to the development of muscularity. Hence, the reason for high utilisation of BCAA and stimulants during this phase. Stimulants utilised to increase performance are classified as psychomotor stimulants, sympathomimetics and central nervous system stimulants (Avois et al., 2006). Caffeine is the most utilised stimulant on the market. It's generally not seen as a drug, mainly because it is utilised in everyday life, in the form of tea, coffee, soft drinks, diuretics, cold remedies and many more (Graham, 2001). Yet it is important to acknowledge that it is the compound caffeine, and not caffeine drinks like coffee, that illicit performance gains (Graham, 2001). Caffeine actions are similar to amphetamines in that it primarily stimulates the central nervous system. For the physically active, this can reduce fatigue and increase activity specific focus (Avois et al., 2006). Adenosine receptors are found in nearly every tissue type in the body, specifically the brain, heart and skeletal muscle. Caffeine has a similar molecular structure to adenosine, hence, its action on the receptor. Blocking adenosine receptors in the brain causes the body to bypass blood glucose as an energy source and utilise fat stores. In strength activity, caffeine has been said to work on the direct action of the muscle, via enhancement of the myoneural function and contractibility (Graham, 2001).

When combined with other compounds, caffeine can enhance the primary action of said compound (Graham, 2001) and it is this synergistic action that encourages manufacturers of pre-workout supplements to include it in their products. Pre-workout workout supplements contain key ingredients which are designed to maximize training intensity, as well as promote recovery (William Kedia et al., 2013). Pre-workout ingredient combinations can be vast but generally contain stimulants like caffeine, energy deriving BCAA's, and other performance promoting ingredients like creatine (William Kedia et al., 2013).

Pre-workout supplements have been shown to increase perceptions of perceived energy, alertness and focus (Spradley et al., 2012) and have even been shown to produce a significant increase in hormonal response to training (Kraemer et al., 2007). Pre, mid and post values for growth hormone, plasma IGF-1, serum free, and total testosterone, all significantly increased when using a pre-workout supplement containing caffeine, creatine, L-arginine (a BCAA), as well as other vitamins and minerals (Kraemer et al., 2007). Strength performance after using a pre-workout supplement has also been investigated. It was shown to increase the number of repetitions in the final set of a strength program for upper extremities but not lower extremities (Jagim et al., 2016). Whereas, in a six week, double blind protocol, it found that pre-workout supplementation increased subjective workout experience in the form of visual analogue scale scores for energy, focus and concentration, yet it didn't show any significant increases in performance (William Kedia et al., 2013). Research has shown that individuals who are motivated to exercise at a high intensity may be predisposed to androgen reward reinforcement (Wood, 2004).

5.7.4. Phase 4: Mimicking

In this phase, supplementation mimics the offensive prohibited substance. For instance, prohormones mimic the actions of anabolic androgenic steroids. Prohormones is the term given to a group of supplements which act as androgenic precursors (King et al., 2012). Essentially, prohormones are compounds, which, when ingested, can be converted into a specific hormone, in many cases testosterone. For instance, pregnenolone is a precursor to all hormones produced in the body, yet in males, has a propensity to be converted into testosterone or aldosterone via dehydroepiandrosterone pathways. Manufactures of prohormones manipulate loopholes in the law that suggest a compound can be sold as a supplement as long as the ingredients could be considered natural to the body (Frans T. Delbeke, Van Eenoo, Van Thuyne, & Desmet, 2002; Rahnema, Crosnoe, & Kim, 2015). When pro-hormones are classified as dietary supplements, they can be sold over the counter and are marketed as a legal alternatives to anabolic androgenic steroids, with fewer side effects, and with the ability to yield strength and size gains (King et al., 2012). They have even been suggested to help reverse age related testosterone decline (Ziegenfuss, Berardi, & Lowery, 2002). More experienced supplement users are aware of developments in the supplement market but less savvy users may unwittingly expose themselves to unclassified steroid compounds and precursors. (Kimergård, Walker, & Cowan, 2015).

Individuals using prohormones may already have crossed the line to PPD use without even realising it. A study, conducted using gas-chromatography / mass spectrometry analysis on 634 non-hormonal supplements, from thirteen different countries found that 14.8% of the products contained between 0.01µg/g to 190 µg/g of anabolic androgenic steroids not described in the ingredients (Geyer, Parr, & Mareck, 2004). The study also highlighted the UK as one of the countries with the highest number of cases with 18.8% of the positive cases (Geyer et al., 2004). Other countries, like USA, Sweden, Norway, Germany, Belgium and Israel have been said to have a comparable number of cases (Ayotte et al., 2001). Smaller supplement companies often share their manufacturing equipment with other companies, some which many manufacture anabolic steroids, thus, running the risk of cross contamination (Rahnema et al., 2015). Supplement analysis has also found cases where the ingredients are correct but have found discrepancies in the dosage found on the labels, with some significantly overdosing and some under dosing(Ayotte et al., 2001). The implications of cross contamination and overdosing is that, the user could potentially have a skewed experience, and this could possibly influence future behaviour. For instance, if a company produces a new product and, on its release, has higher levels than the ingredients displayed, when the user experiences the same supplement at its intended levels, there is the potential for the user to get a sense of tolerance has been built as the perceived same dosage is producing reduced results.

It has been suggested that androgens have the ability to be moderately reinforcing (Wood, 2004). This reinforcement is mediated in the brain similarly to caffeine and acts through the mesolimbic dopamine system (Wood, 2004). Research, using rats, showed that androgens can induce a conditioned place preference, with the rats preferring injections into the nucleus accumbens (Wood, 2004), which is involved in natural reinforcement and plays a role in drug addiction (Carelli, 2002). The mesolimbic dopamine pathway starts at the ventral tegmental area (VTA) of the brain. When something rewarding is experienced, dopamine neurons in the VTA are activated, which then projects to the nucleus accumbens, causing dopamine levels in the nucleus accumbens to increase (Wood, 2004). High testosterone levels don't just produce size and performance gains. In today's society, dominant males or 'Alpha males' have higher testosterone levels, win more confrontational situations, and have sexual encounters with more partners (Wood, 2004). This suggests that supplementation of prohormones has the potential to develop psychological as well as physical aspects. Anecdotal research has suggested a progressive nature, beyond legal supplementation, with data pointing towards an increase in anabolic androgenic steroid use, after each successive cycle (Wood, 2004).Yet in this context, research is limited in regards to the psychological effects. An increase in the frequency of sexual encounters and positive confrontational situations, caused by an increase in testosterone via prohormone supplementation, has the potential to positively reinforce its use.

5.8. Conclusion

The aim of this study was to ascertain whether fitness supplements have the ability to reinforce and progress to more intense supplementation, prior to PPD use. Firstly, it was identified that the progressive behaviour starts from initiation into exercise, and not from prior supplement use, i.e. multivitamins. This may be due to the fact that physical activity provides the framework to progress supplementation in the form of physical progression, i.e. as the body increases in strength/size etc., it requires an increase in said supplement or a more effective one. This study highlighted the notion of progression in the form of an increase of perceived effectiveness, as users went from one supplement to the next, until the use of PPD. Between five and six different genres of supplements were used prior to PPD use. The genre of supplement used depends on the user's stage of training, yet this study believed that Creatine and Pro-hormones have the potential for the largest influence. Creatine, as it is the first instance of a user manipulating the homeostasis of the body's systems, potentially has the ability to improve various psychological aspects, as well as physical ones and its effectiveness reduces with age. Prohormones, as they are the closest to mimicking a prohibited substance, in this case anabolic androgenic steroids, can be reinforcing through the mesolimbic dopamine reward system and can enhance social standings. Other supplements (Protein, BCAA, Stimulants) lack the psychological influence of the other two supplements and can be deemed as supportive in their action rather than progressive. Anti-doping supplement educational programmes should highlight the dangers of high numbers of supplements and legal hormone boosters, as well as help develop decision making when selecting supplements. Athletes who use supplements to functionally improve their performance (Petróczi, 2013), should be provided with alternatives that are not prohibited, to allow them options in their endeavour (R. James et al., 2010).

6. CHAPTER 4. TEAM SPORTING INFLUENCE ON PPD USE

Preamble

Sports, like football, consistently report low PPD use numbers (Dvorak et al., 2006), even though some playing positions would benefit from PPD use. Study 1 looks to ascertain if there are differences in PPD attitudes between player positions in a sport which is considered relatively PPD free. American football, on the other hand, exhibits large cases of PPD use. American football teams have large squads due to the sports high injury rate, allowing for potential social hubs to form. Study 2 looks to ascertain if these hubs differ in attitudes to doping.

STUDY 5. SPORTING POSITIONAL AND SOCIAL INFLUENCES ON PPD USE

6.1. Introduction

In the UK football (FB), otherwise known as soccer, is one of the highest participated sports (Farrell & Shields, 2002), yet relative doping cases are very low or non-existent (Dvorak et al., 2006; Jiri Dvorak, Junge, Grimm, & Kirkendall, 2007). American football, on the other hand, is a relatively new sport in the UK, which is becoming increasingly participated in by individuals from England and the rest of Europe (Karpakka, 1993; Maguire, 1990). Conversely, American football is known to have various doping issues, ranging from adolescent doping (Stilger & Yesalis, 1999) to major doping scandals (Holt, Erotokritou-mulligan, & Sönksen, 2009). These two contrasting sports could produce interesting insights as to how they influence doping behaviour.

6.1.1. PPD Football fit

As a primary motivator, athletes utilise PPD's to increase performance (Engelberg, Moston, & Skinner, 2015) and the method of PPD used is dependent on the physical requirements of the sport. The physical requirements of football is considered uniquely variable and unpredictable (Jonathan Bloomfield, Polman, & O'Donoghue, 2007), making it difficult to attribute an overriding physical necessity to the sport. Bloomfield, Polman, Butterly, & O'Donoghue, (2005) identified significant differences in BMI [$F(3,2069) = 15.4$, $P<0.001$], statue [$F(3,2069) = 161.3$, $P<0.001$], and body mass [$F(3,2069) = 171.7$, $P<0.001$], between goalkeepers, defenders, midfielders and forwards, player position has also been shown to have a significant influence, activity frequency, as well as intensity (Bloomfield et al., 2007). Strikers have been suggested to perform significantly more high intensity movements, like sprinting or jumping. This suggests a more explosive element and a potential benefit from PPD's, like anabolic androgenic steroids. Midfielders, on the other hand, have been shown to cover greater distances than other positions (Rienzi, Drust, Reilly, Carter, & Martin, 2000), suggesting that they would benefit from a more endurance based PPD, like EPO, as well as AAS. The variety in positional requirements suggests that there isn't a one size fits all PPD. Yet research has suggested that athletes can not only be influenced by performance, but also by return from injury (Mazanov, Huybers, & Connor, 2011; Smith et al., 2010), which can affect all player positions.

6.1.2. Doping in football

To date, there is very limited data regarding PPD use in UK football (Malcolm & Waddington, 2008). In 1963, the British government found that football, cycling and athletics had the largest cases of drug use (Malcolm & Waddington, 2008). More recently, cycling (Bell et al., 2016) and athletics (Hoff, 2012) have shown cases of individual and even systematic doping, whereas, football has exhibited very few cases. Positive cases between 1994 and 2005 were as low as 0.12% and of these cases, PPD use was extremely low, with the majority of cases being recreational drugs like cannabis and cocaine (J Dvorak et al., 2006).

During Sepp Blatter term as president of the Federation Internationale de Football (FIFA), he argued that football is relatively free of doping (Malcolm & Waddington, 2008), yet more recently, Sepp Blatter has been accused of corruption within the organisation (Bean, 2016; Boudreaux, Karahan, & Coats, 2016), which suggests that everything he has stated may have been manipulated in order to suit an agenda.

It has been acknowledged that the true extent of doping in FB is unknown (Dvorak et al., 2006) yet the assumption, adopted by many in FIFA, is that football is relatively drug free. This assumption is based on that: 1. their drug testing program is robust and is implemented throughout the football season. 2. Football players are believed to think that PPD's will not improve footballing performance or skill. 3. Anti-doping education campaigns not only are provided for players, but also for support staff (doctors, administrators and officials), thus helping to develop a drug free culture (Dvorak et al., 2006; Malcolm & Waddington, 2008). In 1999, FIFA's and UEFA's medical committee met with the focus of identifying doping risks and developing educational programs to combat this phenomenon. Other sports have incorporated educational programs (Aubel & Ohl, 2014; Vassilis Barkoukis, Kartali, Lazuras, & Tsorbatzoudis, 2016; Sagoe et al., 2016) with varied success. So, what is it about FB and its organisation, which dissuades use?

6.1.3. PPD American Football Fit

AMF is becoming a rapidly growing sport across Europe and other continents, but concerns are being raised regarding the high physical demands (speed, strength and power), not to mention large injury rates (Wang et al., 1993; Pincivero & Bompa, 1997; Nalçakan & Özkol, 2009). Fry and Kraemer (1991) evaluated AMF players from the National Collegiate Athletic Association (NCAA), Division 1, where the positional skills were assessed through; one repetition maximum back squats, one repetition maximum power cleans, vertical jumps, and 40-yard sprint times. These being powerful and explosive movements' clearly demonstrating the speed, strength and power requirements for the sport.

Due to these specifically high physical demands, athletes of this, and other power sports, could potentially be at risk to use prohibited performance drugs (PPD. The National Finnish Olympic Committee conducted research into their elite athletes and their attitude towards doping, and found that athletes approached most frequently to use prohibited substances were those competing in speed and power sports (Alaranta et al., 2006).

Potential PPD use could be considered higher in AMF than other sports for a variety of reasons. Firstly, the game of AMF is extremely competitive as well as physically demanding. There are fifty two players on the official roster for a team, yet during game time, there are only eleven players on the pitch at one time, highlighting the very high levels of competition between team mates, as well as other teams. Only the best players will play, i.e. players who meet their positional requirements and exceed in ability, athleticism, and knowledge. Having an advantage over team mates in the same position, as well as opponents can be an attractive option, as it will mean potential game time as well as good stats and game wins. Secondly, remaining competitive takes its toll on the athlete's body, thus increasing the likelihood of injuries, further increasing the likelihood of PPD use for recovery. Smith et al. (2010) found athletes to have a positive attitude towards substances that aided in speedy recovery. A study on NFL injuries over 1024 games (two seasons) exhibited 4283 non-concussion injuries and that these injuries occurred over 97.7% of team games (Lawrence, Hutchison, & Comper, 2015). These injuries predominantly occurred to wide receivers, tight ends and defensive backs. Due to the internal competitive nature of AMF, it is important to return as quickly as possible. As PPD's may decrease the recovery time, injured players may be more likely to partake in the behaviour (Horn, Gregory, & Guskiewicz, 2009).

Thirdly, there is the evolution of what is physically required for the sport. Wang et al. (1993) studied the changes in high school AMF players between1963-1989, and found that there was a significant change in body mass index (BMI) between years 1972-1989, creating an interest whether these increases were due to nutritional intake and training strategies and what proportion was due to the use of PPDs (Wang et al., 1993). The bigger and more powerful players play offensive line (OL) and defensive line (DL), whilst the remaining positions are not as power orientated. Speed, strength and power are still fundamental to all positions i.e. running backs (RB), wide receivers (WR), defensive backs (DB), line backers (LB) and tight ends (TE) (Pincivero & Bompa, 1997). The offensive line, quarterbacks, tight ends, line backers and defensive lines all have large body masses with low body fat (Kraemer et al., 2005), suggesting that these positions may benefit the most with PPD's that promote size.

6.1.4 Doping in American football

PPD use in amateur AMF has been shown, Yesalis and Bharke (2000) and Bloodworth and McNamee (2010) found that 3-12% of adolescent males admit using PPD's at some point during their life time. The more concerning figure, was that 38% of users have stated that they received their PPD's, either from within the team, or from outside physicians (Green et al., 2001).

Research regarding the prevalence of PPD's, in AMF, is lacking and anecdotal at best. For example, it's speculated that in the 1980's, PPD use occurred between 50% and 75% in the offensive and defensive line (Hoffman et al., 2009).

The highest profile cases of AMF doping were part of the largest network of doping in history (Athey & Bouchard, 2013). Bay Area Laboratory Cooperative (BALCO), raided on the 3rd September 2003, initiated by an anonymous tip. The company was involved in manufacturing and distributing an undetectable PPD called Tetrahydrogestrinone (THG) (Athey & Bouchard, 2013). THG was distributed to various athletes across multiple sports, one of which was William Romanowski, an NFL player. William was instrumental in recruiting other AMF players, as well as individuals from other sports to use this designer PPD.

6.1.5 PPD Social Networks

A social network refers to the people with whom an individual interacts. Social networks can be instrumental in influencing illicit behaviour amongst individuals in a social network (Valente, Gallaher, & Mouttapa, 2004). Dark Networks is a name given to social networks which operate outside the boundaries of the law (Bell et al., 2016). There is a certain level of social interaction in regards to PPD use, ranging from gaining information (Dimeo et al., 2014), and, or access (Maycock & Howat, 2007b), to a complex social network of doping (Bell et al., 2016). Sports teams provide the ideal framework and environment for PPD use to thrive. It is important to note that a sports team is not only your traditional team where everyone is competing for the same goal (e.g. rugby) but also individuals who compete in different sports but train in the same area (e.g. athletic, gymnastics etc). The reason why these should also be considered as a team in a PPD use context, is that they are likely to train together, sharing experiences, thus potentially promoting PPD use into other sports. The spread of PPD use between different sports by social networking has been demonstrated between football, athletics, baseball and boxing (Athey & Bouchard, 2013). In social networks, 'bridges' or 'liaisons' have weak links to multiple networks and can act as a liaison between groups and even can even introduce groups that otherwise wouldn't be accessible. In the BALCO scandal, William Romanowski introduced Victor Conte (BALCO founder) to athletics coach, Remi Korchemny, who in turn, connected Conte to multiple Olympic sprinters (Athey & Bouchard, 2013). Centrality refers to the degree to which a person is central to a network and is often utilised in drug prevention programs. Peers who are central to a social group exemplify the norm of the group, and, in a group who partake in illicit behaviour, tend to be the earliest initiators (Athey & Bouchard, 2013). Identifying how social aspects of sports teams influence the initiation and spread of PPD use can help antidoping authorities design interventions based around these social aspects (Cuijpers, 2002).

6.1.6. Team Cohesion on PPD behaviour

Carron (1982) defined cohesion as the tendency to remain united. As groups are social in nature; cohesion signifies the solidity of social bonds. If the bonds are not solid, then dedication and direction of the task is lost. For example, the national championships could be the team's goal. Ideally then, all team members share that common goal. If not, then the team's potential of achieving the goal is reduced. The social concept is similar, whereby, if an individual does not feel a sense of belonging to a group, then they are less likely to support or follow a group's decisions or desires. Doping is associated with cohesion, in that doping may be part of the culture and norms of the team (Bilard et al., 2011). This can be seen in team sports with high doping occurrences (Lentillon-Kaestner, 2013).

6.1.6.1 Team Norms

Norms are a set of standards, unwritten rules for the group. Carron *et al.* (2005) stated norms have a significant influence upon behaviour. As part of the theory of planned behaviour, norms are considered perceived social pressures which influence or dissuade individuals from partaking or avoiding, in this case, PPD behaviour (Oostveen, Knibbe, & De Vries, 1996; Rivis & Sheeran, 2003). An individual's conformity to these norms leads to a change in behaviour or belief, despite the pressure being imagined or real (Carron *et al.,* 2005). The number of members within a group also plays an essential role, because, if the majority of members support an action or specific behaviour, this increases the pressure and has a greater influence upon the individual to embrace the norm (Carron *et al.*, 2005). Shields *et al.* (1995) conducted research on baseball and softball players, in regard to performance norms, in relation to cheating and violating rules. It was found that male college athletes were more accepting of the concept to cheat or violate the rules, if the orientation was winning (Shields *et al.*, 1995). Petróczi (2007) also found that a winning orientation could effectively influence an individual's doping attitude, when the sole focus was performance and winning competitions. AMF, being a highly competitive sport, inside and out, had an increased risk of using PPD's if the teams primary focus was winning.

Individuals leading behavioural norms tend to have a major focus on performance and winning. They also tend to be of status, or possess characteristics of credibility, they are better liked powerful, have greater powers of persuasion, and ultimately, influence group members to alter their mind sets and behaviours (Carron *et al.,* 2005). More essentially, leaders can have an influential role in regard to future potential use of PPD's. For instance, an athlete, training in a gym that is perceived to be predominantly using PPD's, has the potential to remove the social stigma attached, and could even influence initiation, as the behaviour is not deemed alien in that environment. Positive PPD norms can even extend to an entire sport, in that, due to either the specific attributes of the sport and/or number of doping cases which may lead to the perception that use is widespread. For instance, rugby players are required to develop large amounts of muscle mass in order to perform. Sporting culture has been highlighted as an important influencing factor and can intensify as the level of sport participation increases (Smith et al., 2010). This can be seen in sports like cycling (Lentillon-Kaestner, 2013). A study conducted on eight professional cyclist found that one of the cyclist believed that a lot of cyclists, at amateur level, abuse the therapeutic use exemption to use corticoids and that, because they used the exemption, they considered the use legal (Lentillon-Kaestner & Carstairs, 2010). The study went on to describe multiple situations where training partners would use substances and believed it was widespread. A failure to conform to social norms can lead to a disruption of goal achievement (Carron, Bray, & Eys, 2002; Oostveen et al., 1996).

6.1.6.2 Pressure to conform

If the norm of a team is to use PPD's, the environment can cause the perception of, or actual, social pressure within a team at high levels of competition (Lentillon-Kaestner & Carstairs, 2010). Although 'whistle blowing' is less likely in team sports, encouraging others to dope enforces a 'we are in it together' attitude, whereby, if someone does report a case, it becomes a mutually assured destructive situation (Whitaker, Backhouse, & Long, 2013). This can be seen in the recent case when Vitaly Stepanova and Yuliya Stepanova exposed their nation in a state wide doping scandal, potential risking them competing in future competitions. The IOC allowed them to compete (IAN, 2016), but athletes are still less likely to report a PPD use, choosing instead to confront the PPD user personally (Erickson, Backhouse, & Carless, 2017). Some PPD users have used the perception of others doping as a justification for their behaviour, with an attitude that the others pressured them to conform (Petróczi, Mazanov, et al., 2008). The phenomenon has been described as a false consensus effect (Ross, 1977). It has been defined as 'an egoistic bias to overestimate the degree to which others are like us' (Dawes, 1989, p1). This technique has been used to measure prevalence in various undesirable health behaviours (Suls, Wan, & Sanders, 1988). A study conducted on 974 professional Australian athletes from rugby leagues, rugby unions, athletics, hockey, softball, netball, diving and triathlon, found that athletes with prior drug use overestimated the others use of illicit drugs, (although not specific) in their particular sport, and sports in general (Dunn et al., 2012). More specifically to doping, a study also found that athletes who had engaged in doping behaviour estimated others doping significantly higher than respondents who had not (Petróczi, Mazanov, et al., 2008). It is important to make a distinction between actual or perceived pressure to conform and the use of perceived pressure as a justification.

6.1.6.3. Whistleblowing

The notion of a team is that of a group of individuals working towards a common goal. Conflict can occur when two or more individuals have incompatible goals and/or the belief that that the behaviour of others in the team is contrary to attaining goals (Laios & Tzetzis, 2005). PPD use could be considered a source of conflict, depending on the norm of the team. A team who predominantly uses PPD may encounter conflict from someone who is completely against PPD use. The crude options for an individual in this situation are to follow suit, ignore the situation, or expose the guilty parties (Whistleblowing). Whistleblowing can incur repercussions from team in the form of isolation, or in situations where the whistle-blower is also involved in use, self-incrimination. A study on nine national level athletes highlighted that depending on the sport, individuals would either keep quiet about someone in their social training circle (teammates or training mates) doping or ‘whistle blow’ (Whitaker, Backhouse, & Long, 2014). This highlights the differences between teams with common goals and teams who just train together. Sports where reporting a doper had no personal repercussions to the ‘whistle blower’, i.e. track and field, were more likely to inform the relevant authorities, if they encountered someone who was doping (Whitaker et al., 2014). Team sports i.e. rugby, football etc, on the other hand, were more likely keep quiet if a team mate was doping, stating loyalty to teammates and the sport (not wanting to give the sport a bad name), repercussions from the social group (isolation etc), and feeling helpless to stop use, as main reasons. One would also argue that an individual teammate doping carries all the risk but the team benefits in that they aid the team in achieving their overall goal. It has been suggested that anti-doping prevention programs should examine broader group and community norms around doping so that interventions can be developed which focus on speaking out against social norms and increase awareness of reporting lines (Whitaker et al., 2013).

6.1.7 Sporting level influences

The level at which an individual competes can influence PPD behaviour. The transition from amateur to professional competition can also influence PPD behaviour (Petróczi & Aidman, 2008). For instance, elite cyclists, illicit performance-enhancing substances like caffeine, analgesics and nutritional supplements are a way-of-life, and an accepted part of the culture of competitive cycling at various levels (Smith *et al.*, 2010) Lentillon-Kaestner and Carstairs (2010) interviewed young cyclists who were attempting to make it professionally, or had just made a start to their professional carriers. They found that young cyclists had a positive attitude towards doping, if it led to a continued carrier (Lentillon-Kaestner & Carstairs, 2010; Lentillon-Kaestner *et al.*, 2012). It was even found that the experienced cyclists would pass down information and teach the younger cyclists of their team the methods and substances to use (Lentillon-Kaestner & Carstairs, 2010). The perception of athletes partaking in doping behaviour at the same level and even higher level may influence athletes to partake in PPD behaviour, in order to compete on a level playing field.

6.2. Methods

Elements from study 1 were used to inform and strengthen study 2.

6.2.1 FB Participants Study 1

This sample consisted of fourteen Football players from a team in the Isthmian league. The Isthmian league consists of semi-professional football clubs from London, east and south-east England. The team had a mean age of 27 ± 3.4 Yrs. The sample consisted of five forward players, four defenders, four midfield players and one goal keeper. Four team members did not wish to take part.

6.2.2. AMF Participants Study 2

The sample consisted of thirty one university level American football players based in the United Kingdom. The team had a mean age of 21 ± 1.8Yrs. Out of the thirty one players, two were running backs (RB), five offensive linemen (OL), four tight ends (TE), four wide receivers (WR), five defensive line (DL), two line backers (LB), four corner backs (CB) and five safety (S). Twenty four of the players competed at university level, five at a regional level, and two for the UK National Team. The whole team had training time of 9 ± 2.63 hours.

6.2.3. Anonymity Procedure

All participants were randomly assigned a number in order to maintain anonymity when providing responses. Numbers were used to link data together and was used during the social network analysis.

6.2.4. Social network

The technique used was a modified version of the McCallister & Fisher (1978) tool, used in Kiuru *et al.* (2010). This modified procedure required the team to individually identify their top three friends from the whole team, using the numbers from the anonymity procedure. This information was used to observe sub groups within the team. Group analysis was conducted by a third party, using a fuzzy method as individuals are known to belong to multiple groups simultaneously (G. B. Davis & Carley, 2008). Network analysis wasn't conducted on FB group, as the sample was too small. Results were observed from a team level and a positional level (goal keeper, defender, midfielder & forwards). The results from the AMF social network analysis was used to create social hubs for further analysis. Results were observed at team level and at each hub.

6.2.5. Questionnaire

Both FB and AMF were provided with a self-administered paper based questionnaire. Respondents were instructed to put their anonymity number on the top of their sheet. The questionnaire was broken down into various sections: Cohesion measures, Doping measures, Doping Prevalence and Pressure.

6.2.5.1. Cohesion measure

As a team's success is largely dependent on how well the group as a whole fits together (Carron et al., 2002), the first section consisted of a common tool used to assess cohesion, the Group Environment Questionnaire (GEQ) (Brawley *et al.*, 1987; Whitton & Fletcher, 2014). The GEQ produces results on a four-factor model, derived from the four subscales; group integration-task (GIT), individual attraction to group-task (ATGT), group integration-social (GIS), individual attraction to group-social (AGTS) (Carron *et al.*, 1985; Whitton & Fletcher, 2014). These four subscales focus upon two main concepts of cohesion task and social. Task refers to the team's goals, whilst social refers to the inter-member relations. In team sports there is the group (team) and the individual, the GEQ assesses the degree to which the group and individuals share the tasks and social outlines. Items for each of the subscales are scored on a one to nine agreement Likert Scale with one equating to 'strongly disagree' and nine equating to 'strongly agree'. Items which correspond to each subscale are collated and a mean determined. The larger the score, the more the respondent agrees with the subscale. ATGT & GIS are scored between 4 to 36 and GIT & AGTS are scored between 5 and 45.

6.2.5.2. Direct and Indirect Attitude Measures

In order to separate the moralistic attachment to PPD use, attitude measures were devised with a moralistic approach towards PPD use and a functional approach to PPD use. Attitudes to each approach were measured using direct and indirect methods.

Direct attitude measures

Direct attitude measures were created following guidelines mentioned in Francis et al., (2004). For the '*moralistic approach*', respondents were asked to rate achievement through rule breaking in general (RBG), various positive to negative continuums. The continuums were good/bad, right/wrong, worthwhile/worthless, beneficial/detrimental, wise/foolish and safe/risky, all scored on a ten-point scale. In the AMF study, three items (wise/foolish, safe/risky and worthwhile/worthless) were combined to create a scale (α=0.65). In the FB study five items were selected (right/wrong, worthwhile/worthless, beneficial/detrimental, wise/foolish and safe/risky) and combined to create a scale (α=0.73).

When measuring PPD use with a '*functional approach to use'* (FPU), a similar approach was used. Respondents were asked to rate PPD use to achieve objectives on various positive to negative continuums. The continuums were good/bad, right/wrong, worthwhile/worthless, beneficial/detrimental, wise/foolish and safe/risky all scored on a ten-point scale. In the AMF study, four items were selected (right/wrong, good/bad, worthwhile/worthless, wise/foolish) for a scale (α=0.77). In the FB study, five items (Good/bad, Right/wrong, Beneficial/Detrimental, Wise/Foolish, Safe/Risky) were selected to create the scale (α=0.78).

Indirect attitude measures

Indirect attitude measures were created following guidelines mentioned in Francis et al., (2004). The formation of the indirect attitude scale involved a combination of behavioural beliefs and outcome evaluations. Each behavioural belief had a linking outcome evaluation (*Table 14, Table 15,*

Study	**Behaviour: Increased performance**	**Evaluation of the expected outcome**
AMF	I will be a better athlete if I enhance my performance.	Being a better athlete for me is..
AMF/FB	If I improve my performance, I will compete in higher level.	Competing at the higher level for me is...

AMF/FB	If I increase my performance, my income will be higher	Higher income for me is..
FB	I need to increase my performance to reach my personal performance goal.	Reaching my personal performance goals for me is.
AMF/FB	Performing to the best of my ability is an important personal goal to me.	Achieving the goals I set to myself is...

Table 16). Items were categorised into three subgroups for scale development, functional focus, doping attitude (FDA) (*Table 15*), morally framed doping attitude (MDA) (*Table 14*) and performance enhancement goal attitude (PEGA) (

Table 16).

Study	**Behaviour: Increased performance**	**Evaluation of the expected outcome**
AMF	I will be a better athlete if I enhance my performance.	Being a better athlete for me is..
AMF/FB	If I improve my performance, I will compete in higher level.	Competing at the higher level for me is...
AMF/FB	If I increase my performance, my income will be higher	Higher income for me is..
FB	I need to increase my performance to reach my personal performance goal.	Reaching my personal performance goals for me is.
AMF/FB	Performing to the best of my ability is an important personal goal to me.	Achieving the goals I set to myself is...

Table 14: Morally framed doping attitude items (MDA). AMF - 3 ITEMS (α=0.75). FB - 3 ITEMS (α=0.62).

Study	**Behaviour: Breaking the rule/cheating**	**Evaluation of the expected outcome**
	Using doping is morally wrong	Doing what morally right for me is...
AMF/FB	Using doping gives unfair advantage	Gaining unfair advantage for me is...
FB	If I use doping, I will feel I cheat	Cheating for me is...
	If I use doping, I will not harm others	Harming others for me is...

	Using doping is not against the spirit of sport	Keeping the sport clean of drugs for me is...
AMF	Using doping is against fair play	Fair play for me is...
AMF/FB	If I use doping, I will violate the anti-doping rules	Adhering to the anti-doping rules for me is...

When constructing the MDA scale for AMF 3 items were selected;

- *'Using doping gives unfair advantage',*
- *'Using doping is against fair play'*
- *'If I use doping, 'I will violate the anti-doping rules'*

The scale Cronbach Alpha was well above threshold (α=0.75) so it was used in the study. Yet the highest Cronbach Alpha for the FB study was (α=0.62). This was just under the threshold and so would not be used.

Table 15. Functional focus doping attitude items (FDA). FB – 9 ITEMS (α=0.91). AMF – 4 ITEMS (α=0.59). R signifies scores were reversed

Study	**Behaviour: Achieving an athletic goal**	**Evaluation of the expected outcome**
FB	Using doping can make my results better.	Making my results better is...
FB	If I use doping, I will remain competitive.	Remaining competitive for me is...
FB	If I use doping, I will not know what I am capable of without drugs.	Knowing what I am capable of for me is...
	Using doping can help to improve my athletic performance.	Improving my athletic performance is
FB/AMF	If I don't use doping, I will not benefit from my hard work and training as much as I want to.	Getting return on my hard work and training for me is...
FB/AMF	Using doping will not help me training hard.(R)	Training hard for me is...
FB	Using doping after injury will not aid my recovery. (R)	Recovering fully and quickly after injury for me is ..

FB	If I refrain from using performance enhancing drugs, I can see the results of my natural ability. (R)	Seeing how far my natural talent can take me is.
FB/AMF	If I use doping, I will be a more competitive athlete.	Being a competitive athlete for me is..
FB/AMF	If I increase my performance with doping, my income will be higher.	Increasing my income for me is...

When constructing the FDA scale for FB study, nine items were selected (Table 15);

- Using doping can make my results better.
- If I use doping, I will remain competitive.
- If I use doping, I will not know what I am capable of without drugs.
- If I don't use doping, I will not benefit from my hard work and training as much as I want to.
- Using doping will not help me training hard.(Reverse scoring)
- Using doping after injury will not aid my recovery. (Reverse scoring)
- If I refrain from using performance enhancing drugs, I can see the results of my natural ability. (Reverse scoring)
- If I use doping, I will be a more competitive athlete.
- If I increase my performance with doping, my income will be higher.

The scales Cronbach Alpha was well above threshold (α=0.91) so they were used in the study. Yet the highest Cronbach Alpha, with four items for the AMF study was (α=0.59). This was under the threshold and would not be used.

Table 16. Performance enhancement goal attitude items (PEGA). AMF – 4 ITEMS (α=0.67), FB PEGA – 4 ITEMS (α=0.81).

Study	**Behaviour: Increased performance**	**Evaluation of the expected outcome**
AMF	I will be a better athlete if I enhance my performance.	Being a better athlete for me is..
AMF/FB	If I improve my performance, I will compete in higher level.	Competing at the higher level for me is...
AMF/FB	If I increase my performance, my income will be higher	Higher income for me is..
FB	I need to increase my performance to reach my personal performance goal.	Reaching my personal performance goals for me is.
AMF/FB	Performing to the best of my ability is an important personal goal to me.	Achieving the goals I set to myself is

When constructing the PEGA scale for FB study four items were selected:

- If I improve my performance, I will compete in higher level.
- If I increase my performance, my income will be higher
- I need to increase my performance to reach my personal performance goal.
- Performing to the best of my ability is an important personal goal to me.

The Scales Cronbach Alpha was well above threshold (α=0.81) so it was used in the study. When constructing the PEGA scale for AMF study, four items were also selected:

- I will be a better athlete if I enhance my performance.
- If I improve my performance, I will compete in higher level.
- If I increase my performance, my income will be higher
- Performing to the best of my ability is an important personal goal to me.

The Scales Cronbach Alpha was just above threshold (α=0.67) so they were used in the study.

When scoring the PEGA, MDA and FDA scales, each behaviour item (scored on a 1 to 6 agreement scale) was multiplied by its corresponding expected outcome (scored on a -3 to +3 desirability scale). All items in the scale were added together. Positive scores indicate a preference towards the behaviour and negative scores indicate an aversion.

6.2.5.3. Doping Prevalence and pressure

The false consensus effect is when individuals assume that others share attitudes and partake in similar behaviours to a larger extent than what the reality is (Dunn et al., 2012). Respondents in both the AMF study and FB study were required to estimate the percentage of PPD users in their current team, in their league, and in the league above. Respondents were required to report what their reaction would be to a team mate doping. Respondents were also required to give a percentage of pressure felt to use PPD's.

6.2.5.4 Team Norms

Various aspects of team's norms were assessed using a Likert Scale. These included: abiding by team social norms, team situational expectations, agreement on appropriate and inappropriate behaviour, sense of behavioural freedom, behavioural disapproval, complying with norms, achievement comparison, experience exchange, and learning from the experience from others. Responses were scored on a six-point Likert Agreement Scale, ranging from strongly disagree to strongly agree, all scores were profiled onto a radar graph.

6.2.5.5. Demographics

The final section was used to identify demographical information i.e. age, playing position, level of competition and play time.

6.2.6. Implicit association

Two BIAT were used, both requiring the respondents to sort PPD related words into categories. The first BIAT required respondents to sort “PPD” and “supplement” category words into “me”, “not me” categories (Supplements were non-focal) the second BIAT required respondents to sort “PPD” and “supplement” category words into “moral”, “immoral” categories (Supplements were non-focal) (*Table 17*). These were used to ascertain whether the respondents associated PPD’s with themselves and an advantage. The BIAT is scored using D scores ranging from 1+ to -1, the closer to 1 in either direction signifies the strength of the association (Sriram & Greenwald, 2009).

Table 17. BIAT categories and corresponding words (APPENDIX 4. Inquisit scripts)

Category	Words
PPD	Steroids, drugs, Stimulant, Hormone
Supplement (Non-focal)	Vitamin, mineral, protein, superfood
ME	I, myself, mine, my
Not Me	They, their, them, others
Moral	Fair, honourable, honest, right
Immoral	Unfair, deshonorable, dishonest, wrong

6.2.7. Data Analysis

The FB study broke up respondents into playing positions and descriptive data was recorded. Social networking analysis was conducted in the AMF study hubs (groups) were created. Hubs were visually represented using a network diagram created on Cytoscape 3.4. All results were then reported as a team mean and standard deviation, and then further reported for each hub mean and standard deviation. Comparisons were then conducted by removing each tested hub from the team mean and comparing it against the remaining team mean, using a one sample *t*-test in SPSS 23. Correlations were also conducted in order to ascertain relationships.

6.3. Study 1 FB Results

6.3.1. Past, present, future doping

100% of the team stated they currently weren't using any PPD's. When asked if they had used anything in the past, 85.7% answered they had not and 14.3% answered they would rather not say. When asked if they would take anything in the future, 85.7% answered no and 14.3% answered, they weren't sure. When broken down into player position, it was one player from the forwards and one player from the midfielders who had preferred not to say if they had used before and also stated they weren't sure if they would use again. The results highlight that there may be individuals in the team who may have previously used PPD's and would be willing to use them in the future.

6.3.2. Estimation of doping in FB

Each team member was asked to estimate how many individuals were doping in their team, in their league, and the league above. As a team, it was estimated that 7.29% ± 8.01% doped within the team, 13.92% ± 16.85% in their league and 13.42% ± 10.76% in the league above. When broken down into individual positions, forwards had the largest perception of doping in the team with 10.40% ± 9.52% and doping in the league with 19.40% ± 23.70%,whereas, midfielders had the largest perception of doping in the league above 21.50% ± 17.10% (*Figure 15*). The results suggest that footballers have the perception that PPD use does not increase as the level of competition does. It also highlights positions with higher work rates estimate higher use throughout.

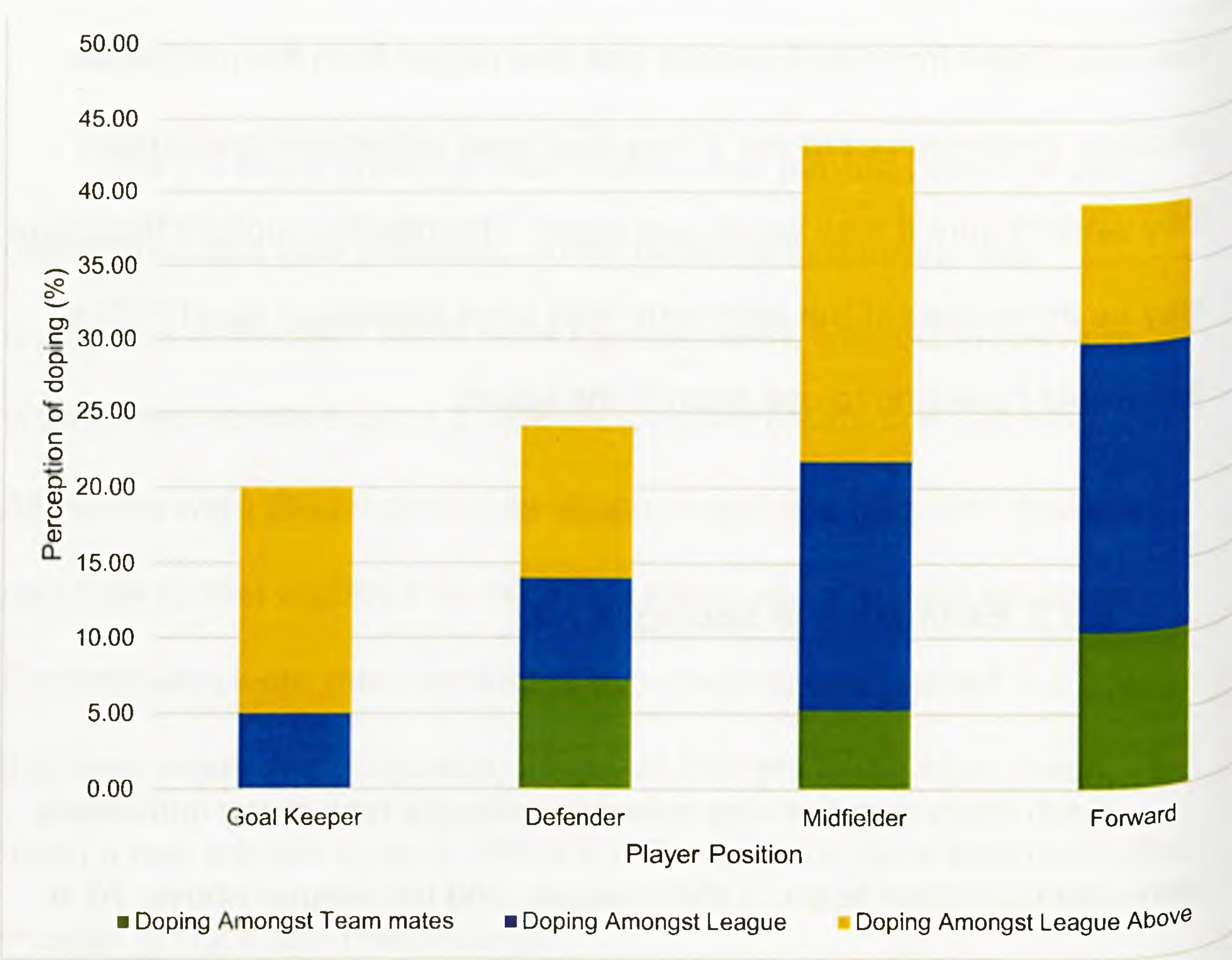


Figure 15: Perception by position of PPD use in the team, the league & league above.

6.3.3. Pressure to dope

Pressure to dope in the team was very minimal, with team members, on average, feeling 2.50% ± 4.27 pressure to dope. Although low, forwards exhibited the highest perceived pressure 4.00% ± 5.48, followed by defenders 2.50% ± 5.00, then midfielders 1.25% ± 2.50% and finally, the goalkeeper 0.00%. The results suggest that although low, there is a sense of pressure within team football, with the forwards (arguably most explosive) who felt the most pressure.

6.3.4. Reaction to team doping

The reaction to an individual being caught doping by this team would be either, to ignore it (50%), or to understand it, without making any judgement (50%). Forwards were more likely to understand (80%), midfielders were more likely to ignore it (75%), defenders were equally split between the two and the goal keeper would completely ignore it (*Figure 16*). These results are in accordance with other studies which witness team members ignoring PPD use (Erickson et al., 2017).

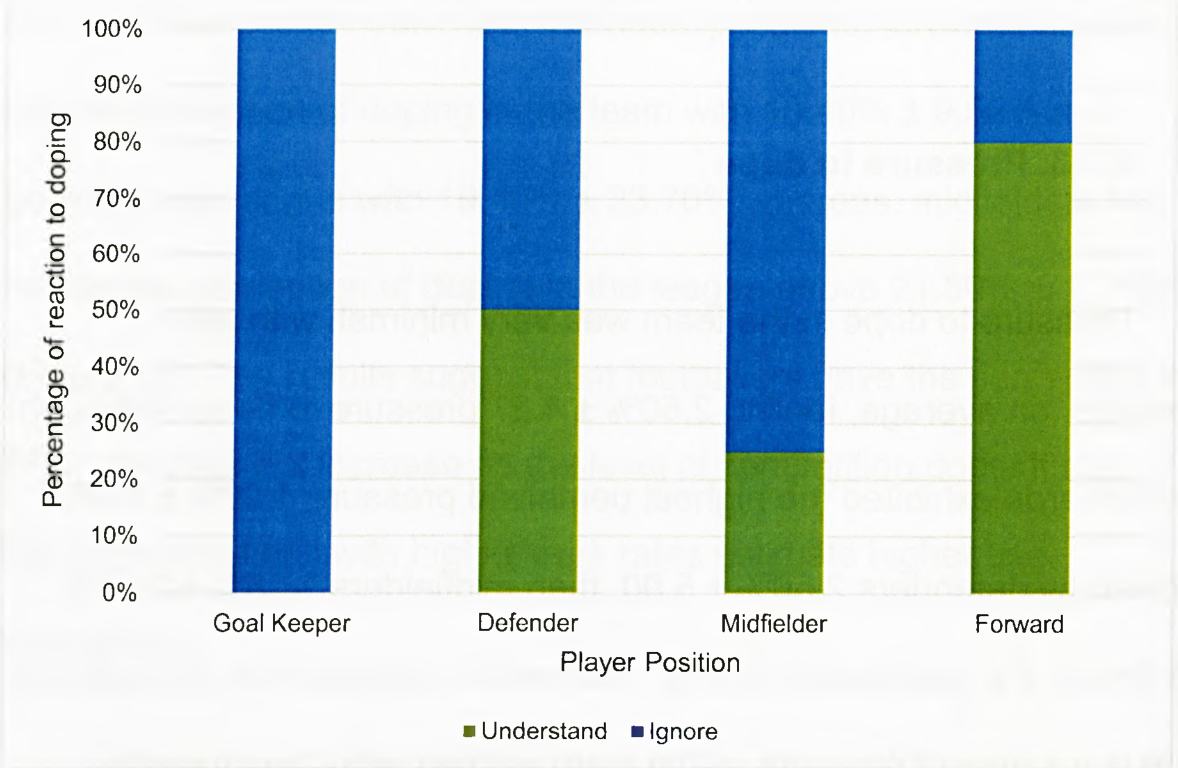


Figure 16: Reaction to team mate doping by position

6.3.5. Attitudes towards PPD use

Four attitude measures were used, two indirect attitude measures and two direct attitude measures. One direct measure (FPU) and two indirect measure (FDA & PEGA) were focused on doping for functional use and one direct measure (RBG) was focused on general rule breaking.

6.3.5.1. Functional attitude

Results from the FDA scale show the team had a mean score of 44.07 ± 31.28. Negative scores suggest that the respondents are against using PPD's for functional purposes and positive scores suggest respondent are in favour of PPD use in this context. When broken down into individual positions, the goalkeeper scored the lowest score with-29.00 a score, which suggests an aversion towards PPD use in this context. Midfielders 42.00 ± 20.31, forwards 45.00 ± 32.95 and defenders 63.25 ± 10.Eighteen all had positive attitudes towards PPD functional use.

Results from the PEGA scale show the team had a mean score of 25.71 ± 17.97. Negative scores suggest that the respondents are against using PPD's to further goals and positive scores suggest respondent are in favour of PPD use in this context. All positions had positive attitudes towards PPD use for goals, defenders scoring the highest, with a score of 34.00 ± 7.11. Midfielders were next with a score of 29.25 ± 11.12, forwards had a score of 25.00 ± 18.95, and the goalkeeper scored the least with -18.00.

Results from the FPU scale show the team had a mean score of 13.71 ± 10.30. The scale was scored between five and fifty, with high scores suggesting respondents are against PPD use in general, and low scores suggesting they are in favour of it. Defenders, with16.50 ± 16.13, scored the highest, although it was a relatively low score. Forwards were next, with a score of 13.80 ± 9.42, midfielders had a score of 11.75 ± 11.80 and the goalkeeper scored 10.00. The overall low scores suggest all factions of the team have a positive attitude towards PPD use in general.

On a whole, the results from the attitudes towards functional use of PPD's highlighted positive attitudes within the team. Functional use, in general, scored higher than use to attain a goal. The goalkeeper scored the lowest in all instances and generally had a negative attitude towards functional use.

6.3.5.2. Moralistic attitude

Results from the RBG scale provided a mean team score of 12.77 ± 9.72. It was scored between five and fifty, with high scores suggesting respondents are against breaking the rules and low scores suggests they are in favour of it. When broken down into individual groups, the goalkeeper scored the lowest 5.00, midfielders were the next lowest, with a score of 7.00 ± 3.46, forwards scored 10.60 ± 7.64 and defenders scored the highest with 21.75 ± 11.12.

6.3.6. PPD implicit association

Explicit measures show that the team has a positive attitude towards doping, in a functional and moralistic sense. The Brief Implicit Association Test gave a different view. Overall, the team's mean D score for morality was 0.23 ± 0.27. Positive scores suggest that the respondents associate PPD use with negative moralistic terms and negative scores indicate an association with PPD use and positive moralistic terms.

Goal keepers exhibited the highest negative PPD moralistic association, with a score of 0.52 ± 0.00, and forwards exhibited the highest positive PPD moralistic association, with a score of -0.02 ± 0.10 (*Figure 17*).

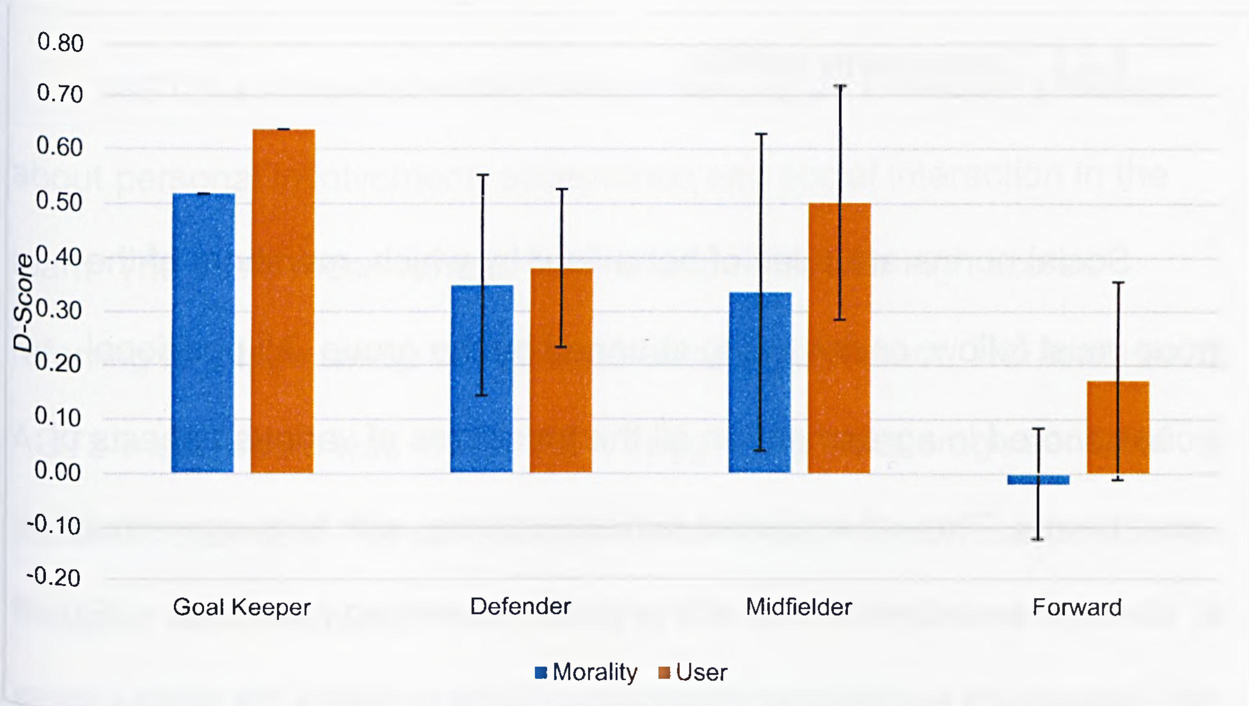


Figure 17: Morality and user Implicit association D scores by position for association of PPDs with morality and PPD's with themselves

Overall the team's mean D score for associating PPD's with themselves was 0.36 ± 0.23. Positive scores suggest that the respondent's associate PPD use with others and negative scores indicate an association with PPD use with themselves. As a whole, the team associates PPD use with others. Again, the goal keeper exhibited the highest PPD association with others with a score of 0.64 ± 0.00, and forwards exhibited the lowest association of PPD with others, with a score of 0.17 ± 0.18 (*Figure 17*). Again, positional exertion seems to have an influence on the implicit association with players' low physical exertion, like goalkeepers having a negative association with PPD's.

6.3.7. Team norm profile

Social norms are rules of behaviour by which, members of the group must follow, or risk being shunned by the group. All positional groups scored in agreement on all the measures of various aspects of social norms. They all exhibited similar patterns, with high agreement to all statements and reducing, with regards to learning from others (*Figure 18*). The results suggest that regardless of the position, the team agrees about the social norms of the group.

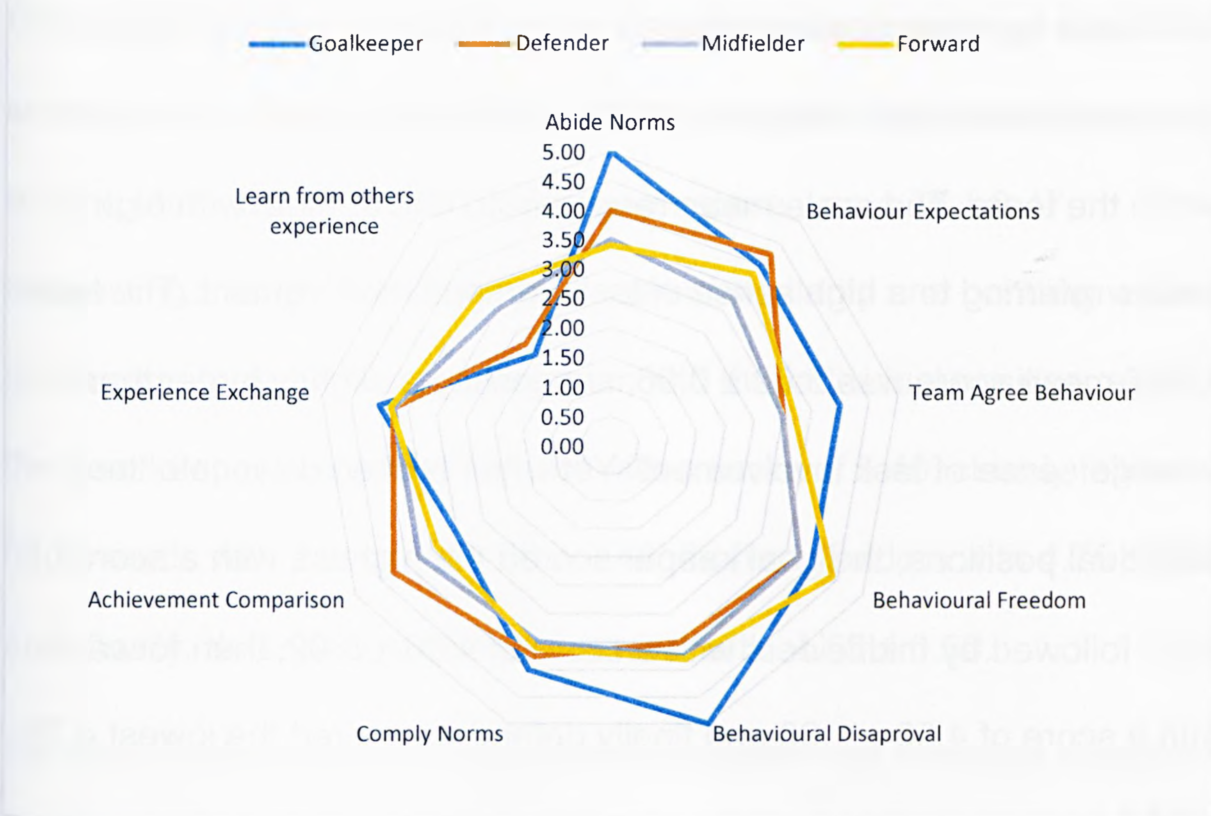


Figure 18: Norm profile for each playing position

6.3.8. Team Cohesion

AGTS is a five-item scale which refers to an individual's feelings about personal involvement, acceptance and social interaction in the team. The scale mean ranges from one to nine, with high scores referring to a high sense of social personal involvement. The team score AGTS mean score was 4.77 ± 0.67, suggesting an average sense of social involvement. Yet when broken down into the individual positions, forwards had the lowest mean score of 4.64 ± 0.83, followed by midfielders 4.60 ± 0.16, then defenders 5.05 ± 0.91 and the goalkeeper scored the largest with 5.00.

ATGT is a four-item scale which refers to an individual's feelings about personal involvement with group tasks, productivity, goals and objectives within the team. The scale mean ranges from one to nine, with high scores referring to a high sense of task personal involvement. The team ATGT mean score was 5.02 ± 0.96, suggesting a slightly larger than average sense of task involvement. Yet when broken down into the individual positions, the goal keeper scored the highest, with a score of 6.25, followed by midfielders with a score of 4.88 ± 0.92, then forwards with a score of 4.50 ± 1.00 and finally defenders scored the lowest 4.76 ± 0.47.

GIS is a four-item scale which refers to an individual's feelings about the similarity, closeness and bonding within the team, which revolve around the team as a social unit. The scale mean ranges from one to nine, with high scores referring to a high sense of similarity and bonding within the team. The team GIS mean score was 4.52 ± 0.97, suggesting an average sense of similarity within the team in social situations. Yet when broken down into the individual positions, the goal keeper scored the highest with a score of 5.75, followed by forwards with a score of 4.60 ± 1.38, then the defenders with a score of 4.56 ± 0.75 and finally, midfielders with the lowest score of 4.06 ± 0.43. .

GIT is a five-item scale which refers to an individual's feelings about the similarity, closeness, and bonding within the team. The team will revolve around team tasks. The GIT team mean score was 4.76 ± 0.47, suggesting a larger than average sense of similarity and bonding whilst conducting tasks. When broken down into the individual position, again the goal keeper scored the highest with a score of 5.40, closely followed by forwards with a score of 4.80 ± 0.42, then midfielders with 4.75 ± 0.53 and finally, defenders scoring the lowest with 4.55 ± 0.50.

Significant relationships were observed between the cohesion measures and the PPD attitude measures. AGTS positively correlated with FPU scale $r= 0.737$, $n=14$, $P<0.01$ and with the RBG scale $r= 0.617$, $n=14$, $p=0.03$. GIS negatively correlated with FDA scale $r= -0.636$, $n=14$, $p=0.01$ and PEGA $r= -0.672$, $n=14$, $p=0.01$ and positively correlated with FPU $r= 0.543$, $n=14$, $p=0.05$. GIT also negatively correlated with the FDA scale $r= -0.713$, $n=14$, $P<0.01$ and PEGA $r= -0.753$, $n=14$, $P<0.01$ and positively correlated with FPU $r= 0.627$, $n=14$, $p=0.02$.

6.4. AMF Study 2 Results

6.4.1. Social network analysis

Social network analysis highlighted seven hubs (Groups) within the team, mainly bridged by eight members (*Figure 19*). Group A & C had the biggest number of members with six in the group and group F and G had the smallest number of members with three (*Table 18*). All groups consisted of players from a variety of offensive and defensive positions. Group A had the biggest number of bridges in their group with five and Group B had the least with one (*Table 18*: Number, age, position and bridges in each group. Group B had the player (*Figure 19*) with the highest bridgeness with a score of 0.57. This indicates that this team member may have the largest influence over attitudes.

Table 18: Number, age, position and bridges in each group

	No	Age	Positions	No of Bridges	Mean Bridgeness
Group A	6	20.33 ± 1.51	RB/OL/TE/LB/CB/CB	5	0.21 ± 0.17
Group B	5	21.00 ± 1.58	RB/OL/TE/WR/DL	1	0.10 ± 0.23
Group C	6	20.33 ± 2.01	TE/WR/DL/SF/SF/SF	2	0.19 ± 0.21
Group D	4	21.00 ± 1.63	OL/WR/CB/SF	3	0.20 ± 0.17
Group E	4	20.50 ± 2.65	OL/OL/LB/CB	3	0.22 ± 0.25
Group F	3	20.67 ± 1.53	TE/WR/DL	3	0.26 ± 0.11
Group G	3	22.67 ± 1.16	DL/DL/SF	2	0.11 ± 0.12

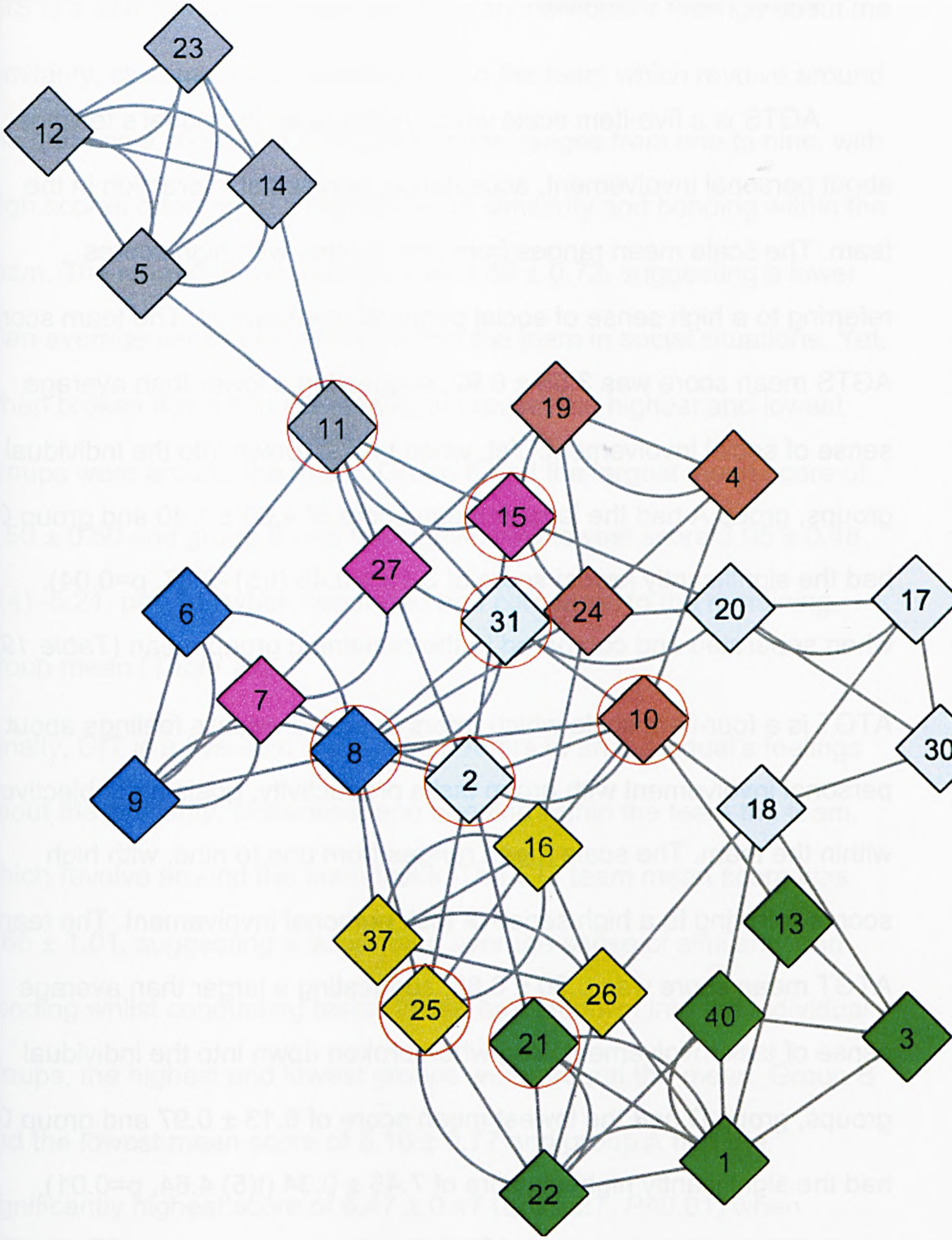


Figure 19: Social network diagram for AMF. Green (Group A), Grey (Group B), Light Blue (Group C), Yellow (Group D), Red (Group E), Purple (Group F) and Pink (Group G). Red circles indicate the strongest bridges in each subgroup.

6.4.2. Team cohesion

AGTS is a five-item scale which refers to an individual's feelings about personal involvement, acceptance, and social interaction in the team. The scale mean ranges from one to nine, with high scores referring to a high sense of social personal involvement. The team score AGTS mean score was 3.55 ± 0.92, suggesting a lower than average sense of social involvement. Yet, when broken down into the individual groups, group A had the largest mean score of 4.00 ± 1.40 and group C had the significantly lowest score of 3.13 ± 0.45 (t(5) -2.87, p=0.04), when separated and compared to the remaining group mean (*Table 19*).

ATGT is a four-item scale which refers to an individual's feelings about personal involvement with group tasks productivity, goals and objectives within the team. The scale mean ranges from one to nine, with high scores referring to a high sense of task personal involvement. The team ATGT mean score was 6.90 ± 0.88, suggesting a larger than average sense of task involvement. Yet, when broken down into the individual groups, group D had the lowest mean score of 6.13 ± 0.97 and group C had the significantly highest score of 7.45 ± 0.34 (t(5) 4.64, p=0.01), when separated and compared to the remaining group mean (*Table 19*).

GIS is a four-item scale which refers to an individual's feelings about the similarity, closeness and bonding, within the team which revolve around the team as a social unit. The scale mean ranges from one to nine, with high scores referring to a high sense of similarity and bonding within the team. The team GIS mean score was 4.89 ± 0.72, suggesting a lower than average sense of similarity within the team in social situations. Yet, when broken down into the individual groups, the highest and lowest groups were around the mean. Group F had the largest mean score of 5.50 ± 0.50 and group B had the significantly lowest score 3.95 ± 0.48 ($t(4)$ -5.21, $p=0.01$) when separated and compared to the remaining group mean (*Table 19*).

Finally, GIT is a five-item scale, which refers to an individual's feelings about the similarity, closeness, and bonding within the team the team, which revolve around the team tasks. The GIT team mean score was 5.65 ± 1.01, suggesting a larger than average sense of similarity and bonding whilst conducting tasks. When broken down into the individual groups, the highest and lowest groups were around the mean. Group B had the lowest mean score of 5.16 ± 0.77 and group A had the significantly highest score of 6.47 ± 0.47 ($t(5)$ 5.27, $P<0.01$) when separated and compared to the remaining group mean (*Table 19*).

*Table 19: GEQ subscales, group means compared against the combined means of the other groups. ^{H} Indicates the group with the highest group mean, ^{L} indicates the group with the lowest mean and * indicates groups with a significant difference.*

	AGTS		ATGT		GIS		GIT	
	G mean	Other G Means	G mean	Other G Means	G mean	Other G Means	G mean	Other G Means
Group A	4.00 ± 1.40^H	3.45 ± 0.77	6.92 ± 0.72	6.89 ± 0.93	5.13 ± 0.86	4.83 ± 0.69	6.47 ± 0.47^H	5.46 ± 1.01*
Group B	3.88 ± 1.06	3.49 ± 0.90	6.25 ± 1.12	7.02 ± 0.80	3.95 ± 0.48^L	5.07 ± 0.61*	5.16 ± 0.77^L	5.75 ± 1.04
Group C	3.13 ± 0.45^L	3.66 ± 0.98*	7.45 ± 0.34^H	6.77 ± 0.93*	5.04 ± 0.73	4.85 ± 0.73	5.47 ± 1.01	5.70 ± 1.03
Group D	3.20 ± 0.49	3.61 ± 0.96	6.13 ± 0.97^L	7.01 ± 0.83	4.94 ± 0.24	4.88 ± 0.77	5.80 ± 1.32	5.63 ± 0.99
Group E	3.85 ± 1.17	3.51 ± 0.90	7.13 ± 0.97	6.86 ± 0.88	4.81 ± 0.63	4.90 ± 0.74	5.30 ± 1.47	5.70 ± 0.95
Group F	3.47 ± 0.42	3.56 ± 0.96	7.25 ± 0.90	6.86 ± 0.89	5.50 ± 0.50^H	4.82 ± 0.71	5.93 ± 0.31	5.62 ± 1.06
Group G	3.13 ± 0.61	3.60 ± 0.94	7.25 ± 0.66	6.86 ± 0.90	5.08 ± 0.29	4.87 ± 0.75	5.20 ± 1.31	5.70 ± 0.99
TEAM	**3.55 ± 0.92**		**6.90 ± 0.88**		**4.89 ± 0.72**		**5.65 ± 1.01**	

6.4.3. PPD framed attitudes

6.4.3.1 Morally framed attitudes

The results of the direct method of testing the team's attitude towards 'rule breaking' to advance athletic performance (RBG) exhibited a team score of 6.74 ± 5.12. The scale was scored between three and thirty, with high scores suggesting respondents are against breaking the rules and low scores suggests they are in favour of it. When broken down into the individual groups, group F had the lowest mean score of 4.67 ± 1.53 and group A had the highest score of 9.17 ± 10.42 when separated and compared to the remaining group mean (*Table 20*). The team, as a whole, exhibited a strong attitude towards breaking the rules.

The results of the MDA Scale exhibited a team mean score of 10.86 ± 16.46, yet, when broken down into the individual groups, group E had the significantly largest mean score of 26.50 ± 6.60 ($t(3)$ 3.35, $p=0.04$) and group A had lowest score 9.40 ± 18.39 when separated and compared to the remaining group mean (*Table 20*). Negative scores suggest that the respondents are against using PPD's when they are morally framed and positive scores suggest respondent are in favour of PPD use in this context. The results suggest all team members are in favour of PPD use when morally framed.

6.4.3.2. Performance framed attitudes

The results of the direct method of testing the team's attitude towards 'functional PPD use' to enhance performance (FPU) exhibited a team mean score of 6.87 ± 2.73. The scale was scored between four and forty, with high scores suggesting respondents are against PPD use in order to increase performance and low scores suggests that they are in favour of it. When broken down into the individual groups, group C had the highest mean score of 7.50 ± 2.07 and group A had the lowest score 6.17 ± 3.13. When separated and compared to the remaining group mean (*Table 20*), no significant differences were found. The team, as a whole, exhibited a strong attitude towards PPD use to increase performance.

The results of the indirect method of testing attitudes towards PPD use to enhance goals (PEGA) exhibited a team mean score of 18.61 ± 12.63. When broken down into the individual groups, group C had the lowest mean score of 15.00 ± 3.03, although, not statistically, the score was close to being significantly different from the other groups (t(5) -2.08, p=0.08). Group A had the highest score of 23.33 ± 8.33 when separated and compared to the remaining group mean (*Table 20*), no significant differences were found with this group. Negative scores suggest that the respondents are against using PPD's to further goals and positive scores suggest respondent are in favour of PPD use in this context. The results suggest all team members are in favour of PPD use to further goals.

As a team, no significant differences were observed between indirect methods of testing for attitudes towards PPD use for rule breaking and PPD use for goals ($t(28)=0.67$, $p=0.51$), suggesting a positive attitude towards PPD use, whether it be for rule breaking or achieving goals. Although, it should be noted that PPD use for 'goals' scored more towards acceptance. Similarly, no significant difference was observed between the direct methods of testing attitudes towards PPD use for rule breaking and PPD use for performance ($t(30)=0.12$, $p=0.91$).

*Table 20: PPD Attitude scales, indirect measures (MDA, PEGA) and direct measures. MDA & RGB scales both have a moralistic approach and PEGA & FDU scales had a functional approach. ^{H} Indicates the group with the highest group mean, ^{L} indicates the group with the lowest mean and * indicates groups with a significant difference.*

	MDA SCALE		**PEGA SCALE**		**FPU SCALE**		**RBG SCALE**	
	G mean	Other G Means	G mean	Other G Means	G mean	Other G Means	G mean	Other G Means
Group A	9.40 ± 18.39^{L}	18.54 ± 11.42	17.20 ± 12.85	12.12 ± 10.86	6.17 ± 3.13^{L}	7.04 ± 2.67	9.17 ± 10.42^{H}	6.16 ± 2.88
Group B	16.75 ± 20.80	17.00 ± 11.90	10.60 ± 20.97	18.44 ± 7.84	6.60 ± 2.70	6.92 ± 2.78	6.20 ± 2.95	6.85 ± 5.47
Group C	14.83 ± 8.38	17.52 ± 14.00	15.00 ± 3.03^{L}	17.67 ± 12.18	7.50 ± 2.07^{H}	6.72 ± 2.88	6.67 ± 2.25	6.76 ± 5.63
Group D	20.50 ± 3.41	16.40 ± 13.85	18.75 ± 7.89	16.88 ± 11.47	7.00 ± 2.94	6.85 ± 2.76	5.75 ± 3.40	6.89 ± 5.36
Group E	26.50 ± 6.60^{H}	15.44 ± 13.14*	19.75 ± 9.36	16.73 ± 11.30	7.25 ± 4.03	6.81 ± 2.59	6.00 ± 4.24	6.89 ± 5.30
Group F	22.00 ± 17.44	16.38 ± 12.65	23.33 ± 8.33^{H}	16.44 ± 11.13	7.00 ± 4.36	6.86 ± 2.62	4.67 ± 1.53^{L}	6.96 ± 5.33
Group G	11.66 ± 4.16	17.57 ± 13.52	20.33 ± 2.31	16.78 ± 11.51	6.70 ± 1.53	6.89 ± 2.85	7.33 ± 4.04	6.68 ± 5.28
TEAM	**10.86 ± 16.46**		**18.61 ± 12.63**		**6.87 ± 2.73**		**6.74 ± 5.12**	

6.4.4. Prevalence, perception, and pressure

On average, the team perceived that the 7.81% ± 18.68% of the team was using PPD's. When broken down into their individual groups, Group D scored the highest in perception at 25.00% ± 37.86%, which was not significantly different from the other group means. Groups C and F both scored the lowest with a perception of 0.00% ± 0.00%. Group A 2.50 ± 4.18 ($t(5)$ -3.85, p=0.01) and group E 0.50 ± 1.00 ($t(3)$ -16.78, P<0.01) were all significantly larger than the mean of the remaining groups, yet groups C and F were without *t* values, due to their lack of standard deviation.

The team perception of PPD use in the league was higher than the team level at 20.97% ± 22.42%. When broken down into their individual groups, group D again scored the highest with a score of 35.50% ± 28.07%, Group G scored the lowest with a score of 3.67% ± 5.51%, which was significantly lower than the separated means $t(2)$ -6.02, p=0.03. Group F also scored significantly lower ($t(2)$ -4.75, p=0.04), with a score of 6.67% ± 5.77%.

Finally, the team's perception of PPD use in the league above was again higher than the perception of the league, with a score of 35.58% ± 21.40%. When broken down into the groups, group D again scored the highest with a score of 47.50% ± 22.17%. Group G scored the lowest with a mean score of 15.00% ± 13.23%. None of the groups were significantly different. All groups showed a perceptual increase as the level of competition increased from their team, to the league and the league above.

As a whole, the team felt relative low pressure to dope with a mean score of 18.36% ± 28.88%. When broken down into individual groups, group B felt the highest pressure, with a score of 44.00% ± 37.82%. Groups C and G felt the least pressure, with scores of 0.00% ± 0.00%, *t* values were not calculated by SPSS due to the low standard deviation, but it is assumed the difference would be significant.

*Table 21: Perceptions of pressure and doping in the team, in the division and the division above. ^{H} Indicates the group with the highest group mean, ^{L} indicates the group with the lowest mean, * indicates groups with a significant difference and ?* indicates significant differences between the group and the other means but SPSS didn't produce data as the standard deviation was 0.*

	Pressure		Team doping		Division doping		Division above	
	G mean	Other G Means	G mean	Other G Means	G mean	Other G Means	G mean	Other G Means
Group A	10.00 ± 20.00	20.40 ± 30.62	2.50 ± 4.18	9.08 ± 20.58*	26.67 ± 35.17	19.60 ± 18.98	35.00 ± 21.68	32.00 ± 21.75
Group B	44.00 ± 37.82^{H}	13.46 ± 24.81	15.00 ± 21.21	6.42 ± 18.28	33.00 ± 17.89	18.65 ± 22.74	42.00 ± 21.68	30.77 ± 21.29
Group C	0.00 ± 0.00^{L}	28.80 ± 30.62*	0.00 ± 0.00^{L}	9.68 ± 20.42*	15.00 ± 13.78	22.40 ± 24.03	26.67 ± 25.03	34.00 ± 20.70
Group D	30.00 ± 46.90	16.67 ± 26.17	25.00 ± 37.86^{H}	5.26 ± 13.60	35.50 ± 28.07^{H}	18.81 ± 21.25	47.50 ± 22.17^{H}	30.37 ± 20.80
Group E	25.00 ± 25.17	17.41 ± 29.69	0.50 ± 1.00	8.89 ± 19.82*	15.50 ± 13.70	21.78 ± 23.51	23.75 ± 12.50	33.89 ± 22.29
Group F	23.33 ± 25.17	17.86 ± 29.61	0.00 ± 0.00^{L}	8.64 ± 19.50*	6.67 ± 5.77	22.50 ± 23.04*	33.33 ± 25.17	32.50 ± 21.50
Group G	0.00 ± 0.00^{L}	20.36 ± 29.75*	16.67 ± 28.87	6.86 ± 17.78	3.67 ± 5.51^{L}	22.82 ± 22.79*	15.00 ± 13.23^{L}	34.46 ± 21.40
TEAM	18.36 ± 28.88		7.81 ± 18.68		20.97 ± 22.42		35.58 ± 21.40	

6.4.5. Past, present, future doping

All team members expressed that they weren't currently using PPD's. When asked if they had knowingly used PPD's in the past, as a team, 3.2% answered yes. The majority answered no, with 90.3% and 6.5% said that they would prefer not to answer. When broken down into individual groups, groups B, C, D and F all answered no, they hadn't used before. Groups E and G had members who preferred not to say, and group A had one person who had used before (*Figure 20*).

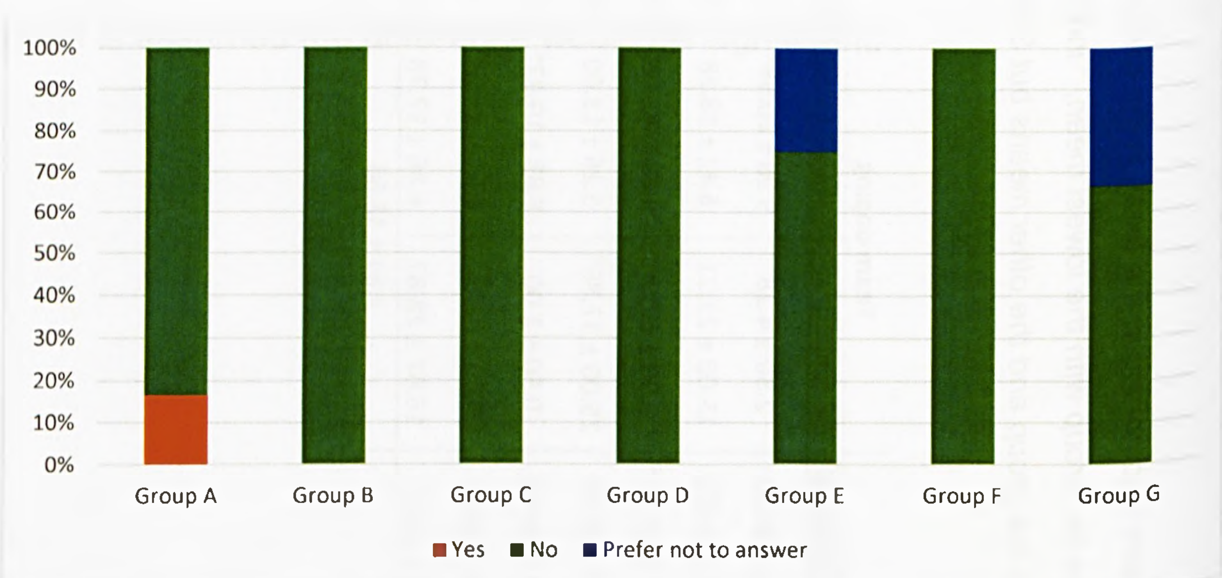


Figure 20. Past PPD use

When the teams were asked if they would use PPD substances in the future, none said yes, 77.4% said no, and 22.6% said that they weren't sure. When broken down into individual groups, groups C, E and F all answered 100% no and groups A, B, D and G had members who weren't sure, with group G having the largest number of members would prefer not to say (*Figure 21*).

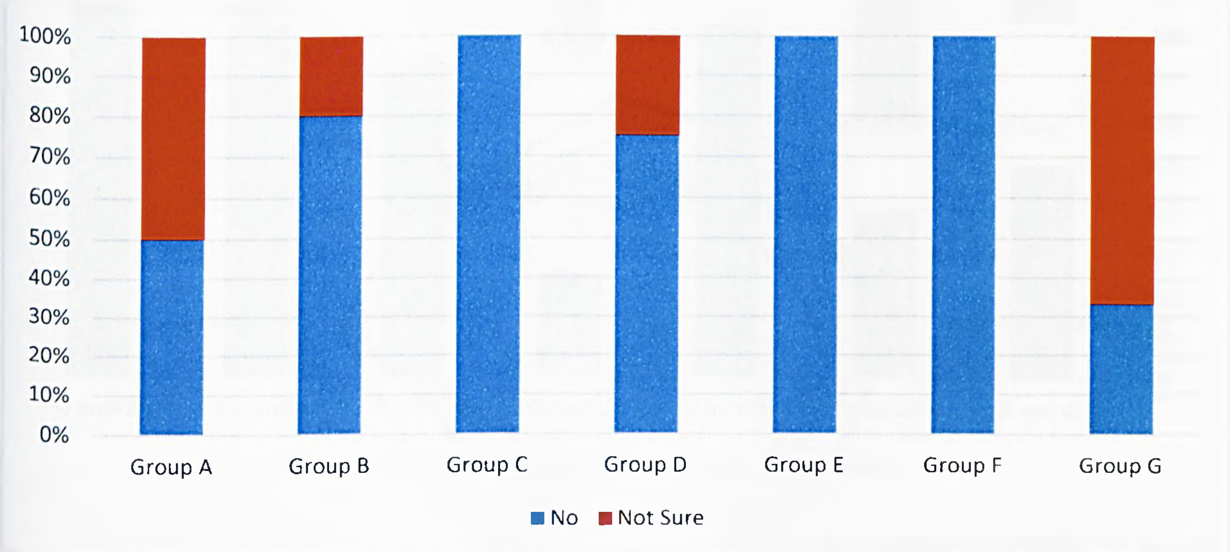


Figure 21: PPD future use

When asked what the team would do if they found out a team member was partaking in PPD behaviour, 64.5% indicated that they would ignore it, 22.6% of the team said they would understand, without making judgement, 9.7% indicated they would report it to the coach, and 3.2% would follow the example, not wanting to get left behind. When broken down into the sub groups, groups F and G would 100% ignore PPD use. Group E and C would predominately ignore it but had members that would also understand. Groups A and B had a mix between ignore, understand and report. Group A predominately would ignore, and group

B would evenly ignore or report, with a few members who would understand *(Figure 22)*.

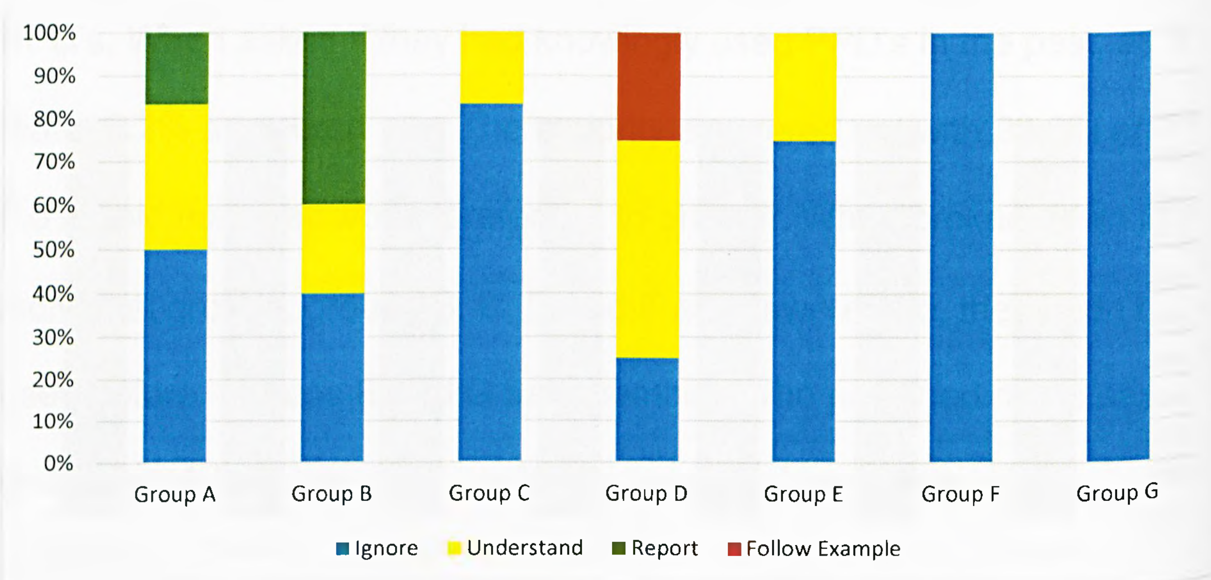


Figure 22: Reaction to team PPD use

6.4.6. Team norm profile

Social norms are rules of behaviour by which members of the group must follow or risk being shunned by the group. All groups exhibited similar profile patterns (*Figure 23*). All groups, apart from group G, exhibited mid to low scores in adhering to the norms of the group, which can have negative connotations, if the norm of the team is not to use PPD's. Similarly, the team disagreed with the statement 'people often compare their achievements with those of others'. This is surprising, considering there is large internal competition within the team.

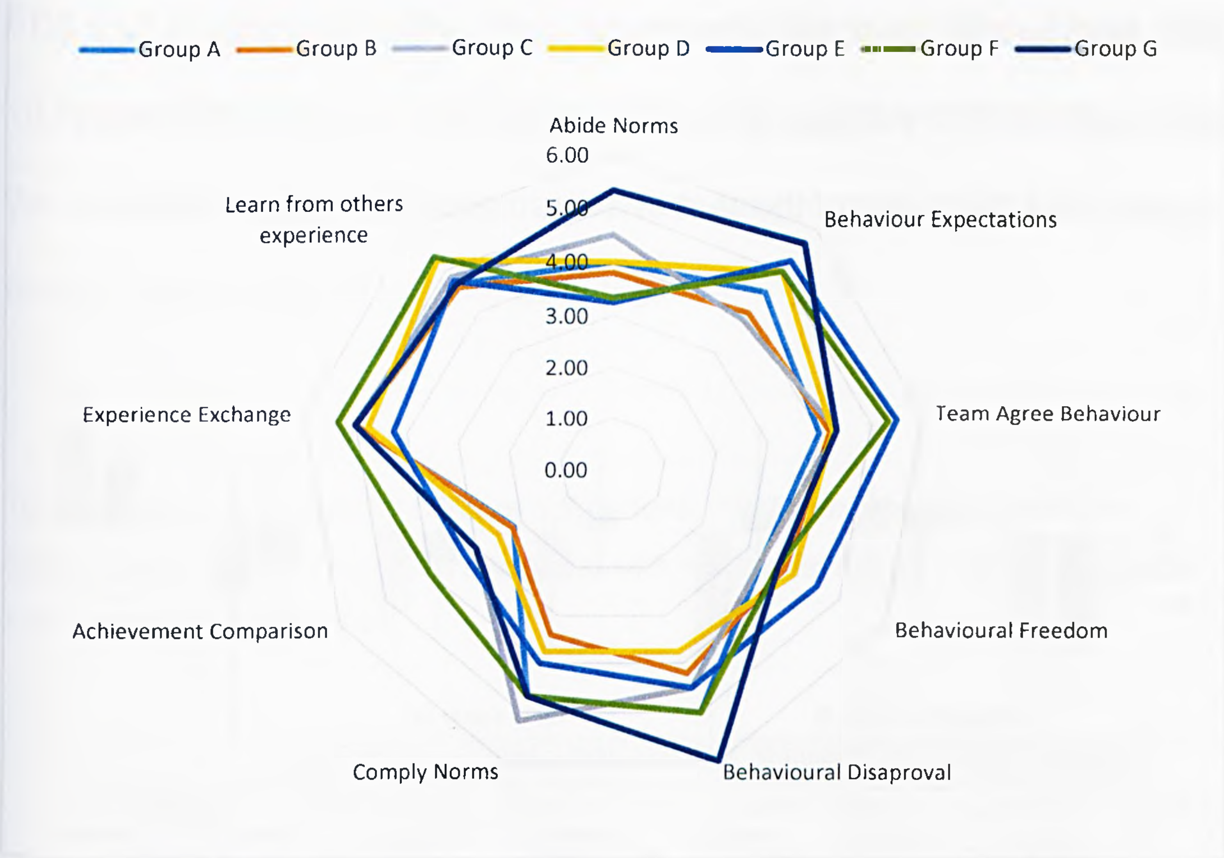


Figure 23. Norm profile for each social group.

6.4.7. Implicit association

The first brief implicit association test conducted was to ascertain whether the respondents associated PPD use with themselves or with others. Positive scores suggest that the respondents associate PPD use with others and negative scores indicate an association with PPD use with themselves. As a team, the results indicate an overall slight association of PPD use with themselves, with a score of -0.04 ± 0.26 (*Table 22*). When broken down into individual groups (*Figure 24*), group A was significantly lower than the group mean, with a score of -0.33 ± 0.18 (t(5)-4.97, *P*<0.01). Group G's score of 0.20 ± 0.11, was significantly higher than the mean of the rest of the groups (t(2) 4.16, p=0.05).

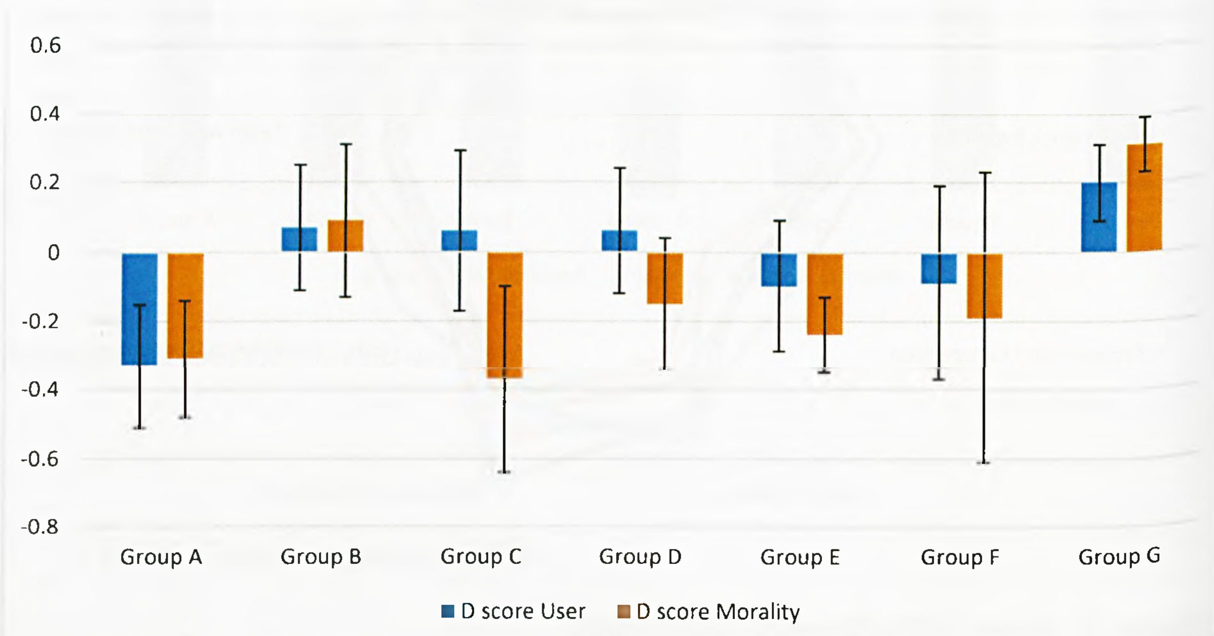


Figure 24: Morality and user Implicit association D scores by social group

The second brief implicit association test conducted was to ascertain whether the respondents associated PPD use as a moralistic action or not. Positive scores suggest that the respondents associate PPD use as not morally acceptable and negative values indicate PPD use is morally acceptable. As a team, the results indicate an overall slight association of PPD use as morally acceptable, with a score of -

0.12 ± 0.31 (*Table 22*). When broken down into individual groups (*Figure 24*), group C was significantly lower than the group mean with a score of -0.37 ± 0.27 (t(5)-2.70, p=0.04) (*Table 22*). Group G's score of 0.31 ± 0.08 was significantly higher than the mean of the rest of the groups (t(2) 10.00, p=0.01). Not only groups C and G had significant differences from the mean of the rest of the team, likewise, for groups D (t(3) 3.09, p=0.05) and A (t(5) -3.34, p=0.02) also.

*Table 22: User and morality D score differences. H Indicates the group with the highest group mean, L indicates the group with the lowest mean, * indicates groups with a significant difference*

	D score User		**D score Morality**	
	G mean	Other G Means	G mean	Other G Means
Group A	-0.33 ± 0.18 L	0.03 ± 0.23*	-0.31 ± 0.17	-0.07 ± 0.32*
Group B	0.07 ± 0.18	-0.06 ± 0.28	0.09 ± 0.22	-0.16 ± 0.32
Group C	0.06 ± 0.23	-0.06 ± 0.27	-0.37 ± 0.27 L	-0.06 ± 0.29*
Group D	0.06 ± 0.18	-0.05 ± 0.25	-0.15 ± 0.19	-0.15 ± 0.31*
Group E	-0.10 ± 0.19	-0.03 ± 0.27	-0.24 ± 0.11	-0.10 ± 0.33
Group F	-0.09 ± 0.28	-0.03 ± 0.27	-0.19 ± 0.42	-0.11 ± 0.31
Group G	0.20 ± 0.11 H	-0.06 ± 0.26*	0.31 ± 0.08 H	-0.16 ± 0.29*
TEAM MEAN	-0.04 ± 0.26		-0.12 ± 0.31	

6.4.8. Game time

Group D had members with the largest amount of game time, with all of them playing 100% of the games. Members of group C played predominantly only 25% of the games. The rest of the groups had a mixture of 25%, 75% and 100% playing time (*Figure 25*).

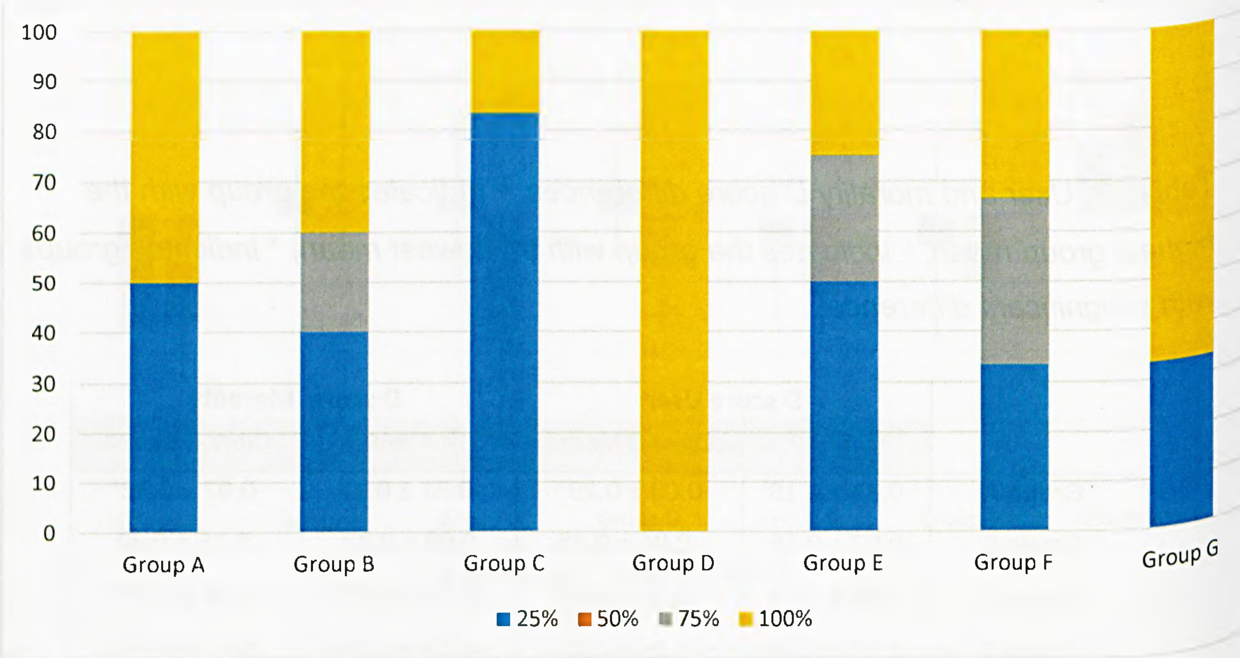


Figure 25: Percentage of game time by group

6.5. Study 1 FB Discussion

Although FIFA states that UK football is relatively drug free, which can be attributed to their anti-doping program, the focus of this study was to ascertain whether footballers' attitudes towards PPD use is negative, and if positional requirements affect their attitudes. Below, the paper discuses each individual position.

6.5.1. Forwards

Forwards in this team posed one of the highest risks of being influenced into using PPD's. This positional group had members who may have used PPD's in the past and there was potential for them to use again. These members have the potential to positively influence PPD use within the group via previous experiences. This group had the highest estimation of use of PPD's in the team, This may be because they had knowledge of users, or, as some members from this group may have used PPD's previously, they may assume others share the same the attitude (Dunn et al., 2012). Research suggests that forwards perform the most maximal sprints and the most explosive jumps

(Jonathan Bloomfield et al., 2007). Forwards are also required to be physically stronger than other positions as they are involved in contact situations at high intensities (Jonathan Bloomfield et al., 2007). These performance requirements and the effect that PPD's have on them, may help mould the forwards attitude towards PPD use. The attitude scores for all measures of this group were all positively skewed towards PPD use. The most prominent of these measures were both the functional measures FDU and FDA where they scored the second highest in all of the groups. This was mirrored by the user D score with forwards associating PPD's (although not with themselves), with others the least out of all of the groups. Forwards also had a positive attitude towards PPD use to achieve goals (PEGA), although, it was the lowest positive attitude of all of the groups. They also believed that breaking the rules for personal gain was moral, indicated by the RBG and the moral D score. Forwards openly cheat in the form of diving into the penalty box. If they are successful, their team is awarded a penalty and if unsuccessful, the worst that will happen is that they will receive a warning in the form of a yellow card (Morris & Lewis, 2010). This shows a willingness for forwards to break the rules in order to benefit the team. All of these results suggest that forwards, as a position, are more favourable towards PPD use. This could be one of the reasons they felt the highest level of pressure to use PPD's and, possibly, why forwards, predominantly, were more likely to understand if one of their team mates were caught using PPD's.

6.5.2. Goalkeeper

The goalkeeper, compared to the other groups, was a single entity, so results should be attributed to this case. The goalkeeper in the context of this study posed the least risk for PPD use. The goalkeeper felt the least amount of pressure, with a score of 0% and also, perceived the team as being totally clean as well. Goalkeepers are typically the tallest of all positions and also have the largest body mass (Bloomfield et al., 2005). They are required to perform explosive jumps in the form of dives, in order to save goals. This makes them candidates for PPD use. One of the few positive doping cases was a goalkeeper named Billy Turley who was banned for two years for taking Nandrolone (Malcolm & Waddington, 2008). With this said, out of all of the positions, the goalkeeper requires the least amount of physicality, as they are not having to travel distances or sprint or jump on a regular basis. Therefore, PPD's are less likely to influence their performance (J. Bloomfield et al., 2005). The goalkeeper also scored the lowest on all of the attitude scores, scoring the only negative score in the FDA and PEGA scales, suggesting an aversion towards PPD functional use. Although, the FPU and the RBG scales results suggest the goalkeeper was in favour of PPD use and rule breaking in general. In team sports, the use of PPD's by other team member can benefit the team as a whole, even if members of the team view the action as not for them or as immoral. This notion is supported by the results of the D scores where the goal keeper associated PPD use as being immoral and for others the most out of all of the positional groups. Also, the goal keeper would choose to completely ignore it, if a member of their team was using.

6.5.3. Midfielders

The midfielders, along with the forwards, had players in their team who may have used PPD in the past and may use it in the future. Similar to the forwards, they also had the highest perception of PPD use in the league. This may be due to the fact that there may have been previous users in this group. This may also be the reason that they would predominantly ignore it, if someone in their team was using. Although midfielders perform less high intensity movements, they do cover the greatest distance (Bloomfield et al., 2007), meaning endurance based PPD's are more likely to benefit this type of player. Results from the

RBG suggest that midfielders, in this study, are predominantly for rule breaking. This is opposite to what was observed in the D score, where PPD use was scored as immoral. This may suggest that they are in favour of cheating, but not by PPD means. Although midfielders scored highly towards functional PPD use, in the FDA, FDU and PEGA measures, results from the D score showed that they associated PPD's with others.

6.5.4. Defenders

Defenders had no one who had used previously or who would use in the future. It's important to note that defenders produced the second highest score for pressure felt to use PPD's. Defenders cover significantly less distance than other positions. Centre backs perform similar amounts of jumps to strikers and they perform significantly more dives to tackle. Defenders require similar, if not more strength, to combat strikers (J. Bloomfield et al., 2005; Jonathan Bloomfield et al., 2007). Defenders scored the highest on the FDA and PEGA scales suggesting an agreement towards functional PPD use, although, they scored the highest in the FPU scale, suggesting that they are against functional PPD use. The defenders associated PPD's with others and as an immoral action. They would equally ignore or understand if a member of the team was using.

6.5.5. The team

Further analysis of the group cohesion measures identified that group integration-task, group integration-social and individual attraction to group-social, positively correlated with the indirect measure of functional PPD use. The 'individual' construct represents the interaction of motives to remain in a group and the 'social' construct refers to the refers to maintaining and developing social relationships in the group (Zakrajsek, Abildso, & Hurst, 2007). This suggests that the positive attitude towards functional PPD use may be motivated by group dynamics. Social capital has been defined as 'the features of social organisation, such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit' (B. R. Maycock & Howat, 2007b, P855). Shared norms, shared activity, a sense of obligation, a sense of belonging, high social interaction, social trust and social reciprocity have all been said to enhance social capital and in turn reinforce social norms. Social capital can manifest when PPD subgroups apply their social norms (Maycock & Howat, 2007). The results from the social norm profiles showed very similar patterns between player positions. The functional use of PPD's benefits the team as a whole. Attitudes towards benefiting the team as a whole, like using PPD's to increase personal performance, may be viewed as a way to increase comradery within the team.

Conversely, group integration-social and group integration-task was shown to be negatively correlated with the indirect functional PPD scale and the indirect performance enhancement goal attitude. The 'group' context refers to similarities and bonding in the group. This suggests that, in this team, if the group social similarities is low, the attitude towards PPD's, as a functional use, and a process of goal achievement, increases. A study on Swedish high school adolescents identified that students with low to average peer relations showed a higher use of PPD's, yet it was not an individual contributor in the multivariate model (Kindlundh, Hagekull, Isacson, & Nyberg, 2001). Conversely, high social similarities exhibit low PPD functional use and a process of goal achievement scores. A review on PPD prevention methods identified that peer disapproval can be a relatively strong deterrent for PPD use (Petróczi, Dodge, Backhouse, & Adesanwo, 2014). It could be conceived that, as bonding increases within the team, antidoping messages, instilled by relevant authorities, become the norm of the group.

Conversely, positive and negative relationships with the cohesion measures could be explained by the use of social drugs. Recreational drugs are used significantly more than PPD's in UK football (J Dvorak et al., 2006; I Waddington, Malcolm, Roderick, & Naik, 2005). It is possible that drug use commonality, and not PPD use is influencing the positive relationship with the cohesion measures. This would explain the group integration-social and individual attraction to group-social but not the group integration-task. Again, it can't be denied that a performance boost, influenced by PPD use, would benefit the team, regardless of whether or not the action is moral.

6.5.6. Conclusion

In conclusion, forward players in FB presented as being the highest at risk and goalkeepers as the least at-risk of using PPD's. This could be driven by their required performance attributes, but further research will be required. Anti-doping programmes should not dismiss FB players as potential PPD users and should highlight players that are more-likely to be at risk.

6.6. Study 2 AMF Discussion

6.6.1. Subgroups

To date, very little research has been conducted in regards to social networking analysis in team sports (Lusher, Robins, & Kremer, 2010). Cohesive subgroups are subgroups with individuals who have ties to one another (Lusher et al., 2010). Within these subgroups norms and behaviour may be different than that of the rest of the team (Lusher et al., 2010). The AMF team exhibited seven subgroups, varying in number of members and positions played. These results suggest that these groupings did not occur via positional similarities. This also means that analysing positional subgroups, similar to the FB study, may neglect to identify true interactions within a team. Social network analysis can be used to identify key characteristics of social subgroups within a team which may pose a risk of PPD use, as well as subgroups which may be against it. Analysing aspects of PPD use, from a team view, may neglect to identify rogue factions which could influence the whole team over time. Multiple significant differences were observed for a variety of different PPD aspects in this study, but only attitude measures (Petróczi, 2007), D scores (Brand et al., 2014) and social projection measures (Petróczi, Mazanov, et al., 2008) have predictive value.

6.6.2. Standout group in attitude measure

No significant differences were found between the groups for the RBG, FPU and the PEGA scales. Group E was found to score significantly higher on the MDA scale, suggesting a significantly more positive attitude towards PPD use, when it is morally framed. On the RBG scale, group E scored below the mean of the group, suggesting that this group leaned more towards rule breaking than the rest of the team average. Whereas, group E's FPU score was above the team mean, suggesting they were against PPD functional use more than the rest of the team average, group E scored the highest in the PEGA scale, suggesting they were leaning more towards PPD use to achieve goals than the rest of the team. On a whole, this provides a picture of a group who are the rule breakers of the team, with an attitude towards using PPD's to achieve goals, The D scores support this by associating PPD's with themselves and moral. Group E consisted of two offensive linemen, a line backer and a corner back. Offensive linemen are required to block the opposing team from getting to the quarter back. They require explosive power in their arms (bench press) and their legs (squat) and large amounts of mass. Line backers are required to back up the defensive linemen. They are required to fill in the gaps that the defensive line leave open. Agility is the overriding physical attribute. Corner backs' primary role is to defend the receivers. This position requires speed and agility. In this group, the offensive line would benefit from PPD use the most, as their physical requirements involve explosive power and size. A study on 2552 retired AMF players found ninety five (16.3%) had previously used steroids (Horn et al., 2009). This was the highest prevalence out of all the positions. Group E had members who would prefer not to answer when asked if they had used in the past, though they didn't say yes. Not saying no suggests a level of admission. This may explain why this groups would predominantly ignore, but also understand, if a team mate was found to be using PPD's. In sports where PPD use is engrained into the culture of the sport, previous PPD users can educate potential users on how to use within their sport (Lentillon-Kaestner, Hagger, & Hardcastle, 2012). Providing this information can ease concerns, thus increase the likelihood of future use. Research has shown that teams and peers, as a source of information regarding PPD's, can act as a mediator to future PPD use (MacKinnon et al., 2001). The group's perception of doping within the team, was significantly lower than the mean of the rest of the team, but shows progression in estimation from the team level to the league. Young players have been shown to be more likely to use PPD's if they perceive the opposing team was using PPD's (Stilger & Yesalis, 1999).

The results from this study also shown that there was a perceptual increase as the level of competition increased. The incremental model of doping behaviour posits that the path towards PPD use is incremental, in this case, the progression of performance intensity (Petróczi, 2013). The view that others may be using PPD's and that PPD's may be required to progress to a higher competition level may explain the amount of pressure felt by members in the group to use personally. An aspiring player wishing to progress in the sport may feel PPD use is a necessity in order reach the top. In the GEQ, Group E scored higher than the team mean for AGTS, ATGT and GIT and slightly below the mean for GIS. Out of all four subscales, group E scored the highest on the ATGT scale which represents the groups attraction to personal involvement in the team's tasks (Carron et al., 2002). PPD use is an individualistic endeavour in that it is the individual who administers the PPD's, yet the motivation to use can stem from team dynamics. Doping, as an individual, rather than as a collective, has its benefits. Article 11 of the WADA code highlights that, if two or more members of a team are caught using PPD's, the whole team may face consequences:

> *"If more than two members of a team in a Team Sport are found to have committed an anti-doping rule violation during an Event Period, the ruling body of the Event shall impose an appropriate*

sanction on the team (e.g., loss of points, Disqualification from a Competition or Event, or other sanction) in addition to any Consequences imposed upon the individual athletes committing the anti-doping rule violation."

(Dimeo, Allen, Taylor, Robinson, & Dixon, 2014, P1).

Conversely, this also means that, if more than one individual is using PPD's within a team, use by other members will not incur further repercussions to the team, thus reducing the perception of risk. It should also be noted that the internal competition felt between players may also play a part. The elevated individual attraction to involvement in task can refer to the need to be involved in actual game time, the item 'I'm not happy with the amount of playing time I get,' highlights this notion. A study of twenty seven US high school AMF players found that PPD users had more playing times than non-users did (Stilger & Yesalis, 1999). In this group there was a fairly even mix of game time with players playing 100%, 75% and predominantly 25% of the season.

Bridgeness is a measure of connectivity between networks. This group exhibited three bridges within the group of four. This group also exhibited the second highest level of bridgeness, suggesting multiple links to other groups within the team.

6.6.3. Standout group in the BIAT measures

Both D scores were the only other significant PPD attitude difference between the groups. Group A associated PPD's with themselves and as a moral action significantly more that all of the other groups. This group was made up of players from various positions and was the only group who had a member admit to previously using a PPD. Research has shown that team members who have previously used PPD's can inform potential users within the team on various aspects of use (Lentillon-Kaestner et al., 2012). In the GEQ, group A scored the highest mean above the team mean on the AGTS and GIT scores and the second highest on the second highest in the GIS measures. This group was one of two with the highest number of members suggesting a highly social group. This may justify the attraction and group social subscales (AGTS & GIS). This may pose a risk if the player who had previously used PPD's is perceived to have social capital within the team (B. R. Maycock & Howat, 2007). This group was also one of two groups who had members that would report if team members were using PPD's. Yet this group scored the highest of all the groups on the RBG scale, suggesting that they have more of a rule breaking attitude than the rest of the team, yet they associate PPDs as a moral action. It has been said that morality can be rationalised to justify immoral behaviour (Tsang, 2002). The model of moral rationalisation and evil behaviour (the author interchanges immoral and unethical behaviour to refer to one who violates moral principles) posits that moral rationalisation can occur when motivations compete with morality. This can cause the individual to reconstrue the moral behaviour as moral (Tsang, 2002). Reconstructing immoral behaviour as moral reduces the cost of being immoral. This behaviour can also be progressive in nature, thus further supporting the incremental model of doping behaviour (Petróczi, 2013). The MDA scale also supports this moral rationalisation. As the scale interlinks behaviour with outcome expectancy, someone who has a positive attitude towards immoral behaviour should show a positive score, but the extent to how positive it is suggests how much the respondents behaviour will match their expectancy. Although group A showed a positive score, it was relatively low, suggesting a positive attitude towards immoral use. This attitude didn't exactly match the outcome expectancy.

Interestingly enough, this groups' attitude towards PPD use, as a functional process, was the most positive out of all of the groups (FPU). It has been suggested that some athletes see PPD use as a functional process and not a moralistic one (Petroczi et al., 2011). The study suggests that PPD use may exist in the domain of supplement use and not moralistic behaviour. A conceptual paper by Petróczi, (2013) highlighted the functional use of PPD's. The behaviour is said to be derived from previous patterns exhibited prior to PPD's being an issue. For instance, athletes who use supplementation as a means to support their training. The issue is that PPD's can be perceived to exist in this domain. The continual use of legal supplements provides a blueprint for behaviour to be learned. This is dependent on positive feedback for progression which can eventually lead to PPD use. Goal achievement, whether they be performance enhancement or career goals, tends to the driving force as capacity increase is required. In this study, group A exhibited a more goal orientated attitude towards PPD use as the PEGA score was the highest of all the indirect measures, where scores nearly double the MDA scale and nearly triple the FPU scale. Social projection has been utilised to observe functional motivations (Petroczi et al., 2011). Individuals who have positive attitudes towards PPD use are more likely to inflate their projection of use. The premise is that users internally justify their own use with the belief that others are partaking in the same behaviour and in order to remain competitive, one must also partake. In this study, group A estimated doping in the division above the mean of the team, whereas, estimation of team doping was below the team mean. Similarly, to the other groups, as the perceived competition increased, so did the perceptual prevalence of PPD use.

This group exhibited 5 bridges within the group of 6. This group also exhibited a high level of bridgeness.

CHAPTER 5. KEY FINDINGS AND ANTI-DOPING APPLICATION

7.1. Targeted anti-doping

This thesis demonstrated that Google Trends software has the potential to identify concentrated areas where individuals seek to purchase AAS over the Internet (3.7.3: Google Geographical prevalence). Anti-doping agencies can utilise this data to pick areas to focus anti-doping education. Targeted interventions have been suggested for other illicit behaviour (Davidson et al., 2003). Police agencies have even utilised geographical drug interventions in the form of 'hotspot policing', which was attributed to a reduction in illicit drug related behaviour (Mazerolle, Soole, & Rombouts, 2007).

7.2. Barriers to PPD use

In this thesis, social stigma was one of two perceived barriers to doping (4.9.2. Perceived barriers). AAS and GH have both been said to receive increased stigmatisation than other PPD's because there is a perception that they violate ideologies of a 'natural' body (Carstairs, 2003), and they can be classified with other injecting drug users (Simmonds & Coomber, 2009). The perception of stigma can cause users to hide their behaviour from friends and even family members (Hanley & Coomber, 2016). Incorporating family members into anti-doping education may help to enhance efficiency of the programme (Velleman, Templeton, & Copello, 2005). Parents can help to reinforce messages taught in anti-doping sessions, as well as open frank conversations about PPD use. This approach is more successful with adolescents. The other barrier to doping was access. As PPD's are easily accessed on the Internet, it is difficult for antidoping to use this in a credible programme.

7.3. Supplement education

It is important for anti-doping agencies to acknowledge the evolving athlete mindset (Petróczi, 2013), in that supplement use is an ever growing aspect of athlete nutrition. This thesis identified various points which can feed into supplement education.

7.3.1. Number of supplements

Results from this thesis highlighted that the number of legal supplements positively related to PPD use (5.6.3. Dangers of progression). Other studies have also observed multiple supplement use prior to PPD use (Papadopoulos et al., 2006). A study by Hildebrandt et al., (2012) also highlighted protein, creatine, and prohormones as supplements used prior to PPD use. Anti-doping should focus on providing sports supplement profiles by which athletes can see an ideal pattern of allowed supplements for their sport. This knowledge may reduce the number of supplements by reducing the need for personal experimentation. Interventions using food profiles have been shown to change undesired behaviour (Goulet, Lamarche, Nadeau, & Lemieux, 2003)

7.3.2. Legal hormones gateway

Legal supplements that mimic illegal ones are also more than likely to be prohibited in sporting competitions (5.7.4. Phase 4: Mimicking). Anti-doping education should aim to educate on the pitfalls of prohormones. Research funded by WADA in 2015, highlighted that there are prohormones on the market which contain steroids which have been officially removed from the market (e.g. Madol, Superdrol) (Delbeke & Van Eenoo, 2015). The study also pointed towards the ever-evolving steroid market. WADA constantly has to test supplements for their potential to circumvent the rules. This information must then be passed onto WADA accredited labs so that athletes using these substances will be identified. One of the major problems with prohormones is that they can be freely available to everyone. This may cause conflict for athletes. Supplements that are prohibited in sport but allowed in everyday life pose a risk. Firstly, because individuals in an athlete's social group, that aren't in competitive sports, can freely use these supplements. Their experiences can be passed on and may influence athletes to use these supplements. Secondly, access has been identified as a strong barrier to PPD use. The fact that prohormones are readily available removes this perceived barrier. Anti-doping education should point out the difference between illegal PPD's and legal PPD's, as well as highlight the difference in responsibilities to athletes, compared to the everyday population.

7.3.3. Conscious supplementation

In this thesis, it was highlighted that there is a conscious phase to supplementation (5.7.2. Phase 2: Conscious manipulation) a phase where supplements are obtained for specific reasons and not just because it has been recommended. Currently, UKAD provide information on supplementation on its website, it covers; what a supplement is, what are the basic risks, assess the need, assess the risk, assess the consequence and limitation of the informed sport (UKAD, 2016b). The 'assess the needs' section informs athletes that they should focus on everything else first i.e. training, lifestyle and contact a specialist, for example a nutritionist, GP etc. about supplementation. Providing athletes with balanced information about supplementation will allow for athletes to better identify risks. Balanced interventions, whereby, negatives of PPD use, in conjunction with positives, have been shown to increase the level of agreement on the adverse effects associated with PPD use (Goldberg et al., 1991). Anti-doping should provide balanced education as well as provide risks of using supplements. It should be noted that UKAD provides a link to a website (LGC group, 2016) which can provide information about contaminated supplements but, again, it doesn't go into how to make choices about which supplements best fit a particular type of sport. A decision tree may be the easiest medium for an athlete to follow, starting with a general genre, i.e. endurance or explosive sport. Next may be the required outcome, and finally end with a supplement suggestion. In-between these three stages would be other important factors like allergies etc.

7.3.4. Functional supplementation and potential alternatives

In this thesis, the endocrine system was identified as a body system which would benefit from supplementation (4.9.1. Motivated by the body). The majority of supplements designed to support the endocrine system are prohibited in athletic communities. Anti-doping should provide alternatives to using PPD's so that perceived deficiencies can be appeased. Research has shown that providing individuals with alternatives to PPD can increase belief and knowledge of alternatives and shift an implicit association from health towards performance (R. James et al., 2010). By changing outcome expectancy of alternatives, UKAD would be providing valid options to appease their perceived deficiency (Petróczi & Aidman, 2008).

7.4. Educating on social risks

Through modelling, a study has suggested that muscle building supplements carries its relationship with PPD's through the number of PPD users in their social group and a belief that PPD's are efficacious and safe (Hildebrandt et al., 2012). It highlights the importance of social circles on potential PPD use. This thesis has shown a potential for social networking analysis to aid anti-doping programs (6.6.2. Standout group in attitude measure). Anti-doping programmes can utilise this research to educate coaches in identifying and treating individuals and groups that may be at risk of doping. Anti-doping education can be delivered in smaller social groups rather than a team setting. Group specific feedback interventions involve individuals assessing one's behaviour against the norms of the group, and has been shown to reduce alcohol consumption (Lewis & Neighbors, 2006). Anti-doping can similarly educate in small groups and get them to divulge their perception of PPD use within their social group and the team as a whole.

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APPENDIX 2. INFORMATION SHEETS

APPENDIX 3. QUESTIONNAIRES

A3a. Study 1 questionnaire: Estimating prevalence single sample count vs unrelated method.

Estimating prevalence single sample count vs unrelated question method version 2

About this project

With this questionnaire, we are testing new methods to ask people about sensitive issues such as prohibited performance enhancing drug use (e.g. EPO, dianabol etc). A prohibited performance enhancing drug can be defined as any substance on the WADA prohibited list.

The methods ensure that we cannot link your answer to the sensitive question directly to your survey (which gives you with extra protection beyond anonymity) but allow us to make population level estimates. You will be randomly allocated one of two questionaires, they both contain the same questions just in a different order.

By voluntarily responding to the following questions you are providing us with important information that we greatly value. It is a very short survey (takes maximum 2-4 minutes to complete) but please consider the questions carefully and give accurate and truthful answers.

Please note there are no wrong or right answers we are interested in your honest opinion.

By completing this questionnaire you are agreeing to participate.

Estimating prevalence single sample count vs unrelated question method version 2

Demographics

This section is to inform the researchers of your background.

Gender?

- Male
- Female

What is your age?

Age ______

What is your residential region?

- East Midlands
- East of England
- Greater London
- North East England
- North West England
- South East England
- South West England
- West Midlands
- Yorkshire and the Humber
- Scotland
- Wales
- Ireland
- Northen Ireland
- Non UK resident

Highest educational level?

- GCSE (or equivilant)
- A Levels (or equivilant)
- Undergraduate degree
- Post graduate degree

What is your sporting event?

______

What is your sporting level?

- Recreational
- Amateur
- Semi-professional
- Professional

Estimating prevalence single sample count vs unrelated question method version 2

Estimation models

Indirect estimation models allow for the respondents to answer sensitive questions honestly, whilst this information cannot be related to the individual.

In the next two sections there are two variations, the single sample count (SSC) method and the unrelated question model (UQM).

Please read each variation carefully. Follow the instructions and answer all questions truthfully.

Estimating prevalence single sample count vs unrelated question method version 2

Unrelated question model

Unrelated question model (Part 1)

Please consider a birthday (your friend, your father, etc.).

Is this birthday in the first third of a month (1st to 10th)?

If yes, answer Question 1. If not, answer Question 2.

Question 1: Is the birthday you are thinking of in the first half of the year?

Question 2: Have you used a prohibited performance enhancing drug in the last 12 months?

Your answer is to either Question 1 or Question 2: Yes / No

Unrelated question model (Part 2)

Please consider another birthday (your friend, your father, etc.).

Is this birthday in the first third of a month (1st to 10th)?

If yes, answer Question 1. If not, answer Question 2.

Question 1: Is the birthday you are thinking of in the first half of the year?

Question 2: I have taken tribulus or another herbal hormone booster in the past 12 months?

Your answer is to either Question 1 or Question 2: Yes / No

Estimating prevalence single sample count vs unrelated question method version 2

Single sample count

Single sample count (part 1)

Please read the following statements and tell us how many of the following statements are true to you. Write the total number of "Yes" responses in the box below. Please note 0 is an even number.

1. My birthday is in the last 6 months (July – December) of the year.

2. My house number is an even number.

3. I have taken prohibited performance enhancing drugs in the past 12 months.

4. The last digit of my phone number is an odd number

5. My mother's birthday falls between January and June

Total number of "Yes" answers

Single sample count (part 2)

Please read the following statements and tell us how many of the following statements are true to you. Write the total number of "Yes" responses in the box below. Please note 0 is an even number.

1. My mothers birthday is in the first 6 months (January – June) of the year.

2. My house number is an odd number.

3. I have taken tribulas or another herbal hormone booster in the past 12 months.

4. The last digit of my phone number is an even number

5. My birthday falls between July and December

Total number of "Yes" answers

Estimating prevalence single sample count vs unrelated question method version 2

Preference

This section is for you to disscus which of the two variations you prefer.

Which one of the two variations was the easier to understand?

- Single sample count
- Unrelated question model

Which one of the two variations, do you trust more to protect you the most?

- Unrelated question model
- Single sample count

Any other feedback?

A3b. Study 3 and 4 Questionnaire: Profiling potential users

Stages of banned performance substance use

About this project

The aim of this questionnaire is to gain an insight into past, current and potential users of banned performance enhancing drugs. Examples of these include any anabolic androgenic steroids like Nandrolone and Winstrol as well as any other drugs that may be considered illicit.

This questionnaire consists of seven short sections followed by an implicit association tests (to be conducted in a quiet space).

On a whole the survey and implicit association test should take 10-15 minutes.

By voluntarily responding to the following questions you are providing us with important information that we greatly value. Please consider the questions carefully and give accurate and truthful answers.

By completing this questionnaire you are agreeing to participate in this study.

Stages of banned performance substance use

Demographics

This section is to inform the researchers of your background.

* 1. Please enter the first 2 letters of your residential postcode followed by the last 4 digits of your phone number,

For example someone with a postcode of KT1 2EE and a phone number of 07787654321 would have the code KT1234.

Please use the same number for each test. This will be used primarily as an ID and will be used to match your tests together.

* 2. Gender?

Male Female

* 3. What is your age?

Age in years

4. How many years have you been training for?

Years

Months

* 5. Type of gym user

Recreational

Health and Fitness

Body Builder

Athlete

* 6. Stage of steroid use

- Thinking about using
- Using
- Never considered
- Past user but not currently

In reference to your answer how long?

Stages of banned performance substance use

Social

The aim of this section is to gain an idea of how users and potential users interact in their social groups.

Individuals in your social group are people you can arrange a face to face meeting with (i.e. can contact them via a phone call and will agree to meet with you) in order to exchange pleasantries on your personal life.

7. How many people in your social group are avid gym users

Number

8. Of this group of people how many use banned substances like steroids

Number

9. and from the group of users how many have you socialised with outside of the gym environment

Number

10. and from that group how many (if any) have offered you steroids or helped with obtaining steroids.

Number

11. Have you ever been offered steroids from someone outside your social group

- ◯ Yes
- ◯ No

Stages of banned performance substance use

Barriers

This section refers to perceived barriers of your training goals and barriers to steroid use

* 12. How much do you believe the following body's systems restricts your training goals?

	Extremely Restricting	Very Restricting	Somewhat Restricting	Slightly Restricting	Not Restricting
Energy system limitations (i.e. lack energy support)	◯	◯	◯	◯	◯
Endocrine system (i.e the lack of hormones for growth)	◯	◯	◯	◯	◯
Nervous system (i.e. lack of stimulation)	◯	◯	◯	◯	◯

13. How much do you believe the following blocks your ability to obtain and use steroids?

	Extremely Inhibiting	Very inhibiting	Somewhat inhibiting	Slightly inhibiting	Not inhibiting
Access to the drugs	◯	◯	◯	◯	◯
Administration of the drugs	◯	◯	◯	◯	◯
Credible Information	◯	◯	◯	◯	◯
Potential stigma attached	◯	◯	◯	◯	◯
Finance	◯	◯	◯	◯	◯
Psychological side effects	◯	◯	◯	◯	◯
Physiological side effects	◯	◯	◯	◯	◯
Not interested in steroids	◯	◯	◯	◯	◯

Stages of banned performance substance use

Steroid effectiveness

In this section you are required to rate the effectiveness of steroids.

You will be asked for 3 advantages and 3 disadvantages of using steroids.

14. List 3 advantages of using steroids (starting with the most to least important)

1 [ ]

2 [ ]

3 [ ]

15. List 3 disadvantages of using steroids (starting with the most to least important)

1 [ ]

2 [ ]

3 [ ]

16. When comparing the three advantages in Q14 against the 3 disadvantages in Q15 how effective do you believe steroids are

- ◯ Extremely effective
- ◯ Effective
- ◯ neither effective or ineffective
- ◯ Ineffective
- ◯ Extremely ineffective

Stages of banned performance substance use

Supplement time line

17. In what order did you start taking supplements from the following categories

	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Not used
Protein supplement (powder, bars etc)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Legal Hormone boosters	☐	☐	☐	☐	☐	☐	☐	☐	☐
Energy re-synthesis (i.e Creatine)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vitamins and minerals	☐	☐	☐	☐	☐	☐	☐	☐	☐
Branch chain amino acids	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fat Burners	☐	☐	☐	☐	☐	☐	☐	☐	☐
Illegal hormone boosters (Pro hormones)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Stimulant (Pre workout Supplement)	☐	☐	☐	☐	☐	☐	☐	☐	☐

18. For the previous question give a reason as to why you started to use that particular supplement, for example using vitamins and minerals because you don't get it from natural sources

Protein supplement (powder, bars etc)

Legal Hormone boosters

Energy re-synthesis (i.e. Creatine)

Vitamins and minerals

Branch chain amino acids

Fat Burners

Illegal hormone boosters (Pro hormones)

Stimulant (Pre workout Supplement)

Stages of banned performance substance use

You and Prohibited Performance Enhancing Drugs

This section refers to how confident you are you can achieve the same lifestyle and goals without taking prohibited performance enhancing drugs

19. The following are statements refer to how confident you are about achieving certain tasks without steroids.

Please rate how much you agree with the following statements:

	1 Strongly agree	2	3	4	5	6	7	8	9	10 Strongly disagree
I can achieve my performance goals (e.g. lift heavier)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
I can achieve my aesthetic goals	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
I can be confident in everyday tasks	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
I can exercise as hard as my training partners	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
I can talk with the same friends about exercise	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
I can attract a suitable spouse	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
I can meet my training potential	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Stages of banned performance substance use

What next?

Follow Up

20. In addition we would like to follow this up in 12 months, it would be appreciated if you could leave an email address so that we could contact you (this is not a requirement but would be appreciated)

A3c. Study 5 questionnaire: Drugs and team sports

Drugs and team sports

About this project

This is a completely anonymous survey. By voluntarily responding to the following questions you ar e providing us with important information that we greatly value.

All information you provide will be kept confidential and will only be used for the purposes of this res earch. It should take no more than 20 minutes to complete this survey.

**The survey questions relate to the characteristics of your team and your personal view on sport succ ess,
performance enhancement, dietary supplements and prohibited performance enhancing substances (doping), such as anabolic steroids, stimulants and hormones.**

Please answer ALL questions to provide us with a detailed and accurate view. There are no right or wrong answers but please be as honest as possible. Remember, this questionnaire is completely anonymous. Nobody will know how you answered these questions.

Drugs and team sports

Demographics

This section is to inform the researchers of your background.

1. Please enter the ID number you have been providied with.

2. What is your age? (years)

3. What is your playing position in the team?

4. What is the highest level you played?

- University team
- Regional team
- National team

5. Playing time this season

- at least 25% of games
- at least 50% of games
- at least 75% of games
- 100% of games

6. Do you currently use prohibited performance enhancing drugs or methods?

- Yes
- No
- I prefer not to answer

7. Have you ever knowingly used a prohibited performance enhancing substance?

- Yes
- No
- I prefer not to answer

8. Do you intend to use prohibited performance enhancing substances in the future to enhance your athletic performance?

- Yes
- No
- I prefer not to answer

Drugs and team sports

The team

The following set of questions are designed to asses various aspects of your relationship with your team.

9. The following questions are designed to assess your feelings about your personal involvement with your group. How much do you agree with the following statements.

	1 Strongly Disagree	2	3	4	5	6	7	8	9. Strongly agree
I enjoy the social interactions I have with my group.	○	○	○	○	○	○	○	○	○
I'm happy with the amount of exercise I get with my group	○	○	○	○	○	○	○	○	○
I am going to miss the members of my group when the semester ends	○	○	○	○	○	○	○	○	○
I'm happy with my group's level of desire to exercise	○	○	○	○	○	○	○	○	○
Some of my best friends are in this group	○	○	○	○	○	○	○	○	○
This group gives me enough opportunities to improve my personal fitness	○	○	○	○	○	○	○	○	○
I enjoy meeting the people in my group	○	○	○	○	○	○	○	○	○
I like the type of exercise we do with this group.	○	○	○	○	○	○	○	○	○
For me, this group is an important social group to which I belong	○	○	○	○	○	○	○	○	○

10. The following questions are designed to assess your perceptions of your team as a whole. Please select a number from 1 to 9 that best indicates your level of agreement with each of the statements.

	1. Strongly agree	2	3	4	5	6	7	8	9. Strongly disagree
Our group is united in trying to reach its goals for exercise.	○	○	○	○	○	○	○	○	○
Members of our group would rather go out as a group than go out on their own.	○	○	○	○	○	○	○	○	○
We all take responsibility for the exercise adherence of our group.	○	○	○	○	○	○	○	○	○
Our group spends time socializing before or after class/group meetings.	○	○	○	○	○	○	○	○	○
Our group members have similar aspirations for the group's exercise adherence	○	○	○	○	○	○	○	○	○
Our group would like to spend time together if the semester was to end	○	○	○	○	○	○	○	○	○
If members of our group have problems exercising, everyone wants to help them	○	○	○	○	○	○	○	○	○
Members of our group stick together outside of class or group meetings	○	○	○	○	○	○	○	○	○
Our group members communicate freely about each others responsibilities to exercise.	○	○	○	○	○	○	○	○	○

11. Now think of general social situations, not training or games, when you are answering the following questions.

	1 Strongly disagree	2	3	4	5	6	7	8	9. Strongly disagree
there are many social norms that players are supposed to abide by	○	○	○	○	○	○	○	○	○
there are very clear expectations for how team members should act in most situations	○	○	○	○	○	○	○	○	○
players agree upon what behaviours are appropriate versus inappropriate in most situations	○	○	○	○	○	○	○	○	○
players have a great deal of freedom in deciding how they want to behave in most situations	○	○	○	○	○	○	○	○	○
if a team member acts in an inappropriate way, others will strongly disapprove.	○	○	○	○	○	○	○	○	○
players almost always comply with social norms	○	○	○	○	○	○	○	○	○
people often compare their and their loved ones' achievements with those of others	○	○	○	○	○	○	○	○	○
people often exchange opinions and experiences	○	○	○	○	○	○	○	○	○
people tend to learn from each other's experiences.	○	○	○	○	○	○	○	○	○

12. Assume that your team becomes aware of one of the teammembers using prohibited drugs (e.g. steroids or growth hormones) to help his athletic performance.

- ○ Try to convince the player to stop, and offer help
- ○ Follow the example, not wanting to left behind
- ○ Understand without agreeing or making a judgement. It is a personal choice
- ○ Report it to the coach and authorities
- ○ Exclude the player from social activities, not wanting to socialise with a chea
- ○ Ignore. It none of the team's business
- ○ Other (please specify)

13. If 100% mean everybody and 0% means nobody, what percentage do you think are using performance enhancing drugs in your team.

0 100

14. If 100% mean everybody and 0% means nobody, what percentage do you think are using performance enhancing drugs in your league.

0 100

15. If 100% mean everybody and 0% means nobody, what percentage do you think are using performance enhancing drugs in the league above.

0 100

16. If 0% represents no pressure at all and 100% represents very strong pressure, how much pressure do you feel for using prohibited performance enhancing substances or methods?

0 100

Drugs and team sports

Doping beliefs

Please mark the point on the scale for each statement that represents your opinion the best.

17. Please rate the following performance enhancement strategies by selecting the button that corresponds the best to your opinion

	1. Good	2	3	4	5	6	7	8	9	10. Bad
Training hard to improve athletic performance is...										
Violating antidoping rules to improve athletic performance is...										
Taking prohibited performance enhancing substances to improve athletic performance is...										

18. Please rate the following performance enhancement strategies by selecting the button that corresponds the best to your opinion

	1. Right	2	3	4	5	6	7	8	9	10. Wrong
Training hard to improve athletic performance is...										
Violating antidoping rules to improve athletic performance is...										
Taking prohibited performance enhancing substances to improve athletic performance is...										

19. Please rate the following performance enhancement strategies by selecting the button that corresponds the best to your opinion

	1. Safe	2	3	4	5	6	7	8	9	10. Risky
Training hard to improve athletic performance is...										
Violating antidoping rules to improve athletic performance is...										
Taking prohibited performance enhancing substances to improve athletic performance is...										

20. Please rate the following performance enhancement strategies by selecting the button that corresponds the best to your opinion

	1. Worthwhile	2	3	4	5	6	7	8	9	10. Worthless
Training hard to improve athletic performance is...										
Violating antidoping rules to improve athletic performance is...										
Taking prohibited performance enhancing substances to improve athletic performance is...										

21. Please rate the following performance enhancement strategies by selecting the button that corresponds the best to your opinion

	1. Wise	2	3	4	5	6	7	8	9	10. Folish
Training hard to improve athletic performance is...										
Violating antidoping rules to improve athletic performance is...										
Taking prohibited performance enhancing substances to improve athletic performance is...										

22. Indicate your agreement with the following statements:

	Strongly disagree	-2	-1	+1	+2	Strongly agree
Using doping is morally wrong						
Using doping gives unfair advantage						
If I use doping, I will feel I cheat						
If I use doping, I will not harm others						
Using doping is not against the spirit of sport						
Using doping is against fair play						
If I use doping, I will violate the anti-doping rules						
Performing to the best of my ability is an important personal goal to me.						
I need to increase my performance to reach my personal performance goal.						
If I increase my performance, my income will be higher						
If I improve my performance, I will compete in higher level.						
I will be a better athlete if I enhance my performance.						
If I increase my performance with doping, my income will be higher.						
If I use doping, I will be a more competitive athlete						

	Strongly disagree	-2	-1	+1	+2	Strongly agree
If I refrain from using performance enhancing drugs, I can see the results of my natural ability						
Using doping after injury will not aid my recovery.						
Using doping will not help me training hard						
If I don't use doping, I will not benefit from my hard work and training as much as I want to						
Using doping can help to improve my athletic performance						
If I use doping, I will not know what I am capable of without drugs						
If I use doping, I will remain competitive.						
Using doping can make my results better						

23. Please tell us how important the following aspects are to you:

	Extremely undesirable	-2	-1	+1	+2	Extremely desirable
Doing what morally right for me is...	◯	◯	◯	◯	◯	◯
Gaining unfair advantage for me is...	◯	◯	◯	◯	◯	◯
Cheating for me is...	◯	◯	◯	◯	◯	◯
Harming others for me is...	◯	◯	◯	◯	◯	◯
Keeping the sport clean of drugs for me is...	◯	◯	◯	◯	◯	◯
Fair play for me is...	◯	◯	◯	◯	◯	◯
Adhering to the anti-doping rules for me is...	◯	◯	◯	◯	◯	◯
Making my results better is...	◯	◯	◯	◯	◯	◯
Remaining competitive for me is...	◯	◯	◯	◯	◯	◯
Knowing what I am capable of for me is...	◯	◯	◯	◯	◯	◯
Improving my athletic performance is...	◯	◯	◯	◯	◯	◯
Getting return on my hard work and training for me is...	◯	◯	◯	◯	◯	◯
Training hard for me is...	◯	◯	◯	◯	◯	◯
Recovering fully and quickly after injury for me is...	◯	◯	◯	◯	◯	◯
Seeing how far my natural talent can take me is.	◯	◯	◯	◯	◯	◯
Being a competitive athlete for me is...	◯	◯	◯	◯	◯	◯
Increasing my income for me is...	◯	◯	◯	◯	◯	◯
Being a better athlete for me is...	◯	◯	◯	◯	◯	◯
Competing at the higher level for me is...	◯	◯	◯	◯	◯	◯
Higher income for me is...	◯	◯	◯	◯	◯	◯
Reaching my personal performance goals for me is...	◯	◯	◯	◯	◯	◯
Achieving the goals I set to myself is...	◯	◯	◯	◯	◯	◯

APPENDIX 4. INQUISIT SCRIPTS

A4a. Inquisit adjustable part of the BIAT script 'Me' 'Not me'.

Full script available at:
http://www.millisecond.com/download/library/briefiat/

```
<item attributeAlabel>
/1 = "ME"
</item>

<item attributeA>
/1 = "I"
/2 = "Myself"
/3 = "Mine"
/4 = "My"
</item>

<item attributeBlabel>
/1 = "NOT ME"
</item>

<item attributeB>
/1 = "They"
/2 = "Their"
/3 = "Them"
/4 = "Others"
</item>

<item targetALabel>
/1 = "SUPPLEMENT"
</item>
```

```
<item targetA>
/1 = "Vitamin"
/2 = "mineral"
/3 = "Protein"
/4 = "Superfood"
</item>

<item targetBLabel>
/1 = "PERFORMANCE PROHIBITED DRUG"
</item>

<item targetB>
/1 = "Steroids"
/2 = "drugs"
/3 = "Stimulant"
/4 = "Hormone"
</item>
```

A4b. Inquisit adjustable part of the BIAT script 'Moral' 'Immoral'.

Full script available at:
http://www.millisecond.com/download/library/briefiat/

```
<item attributeAlabel>
/1 = "MORAL"
</item>

<item attributeA>
/1 = "Fair"
/2 = "Honourable"
/3 = "Honest"
/4 = "Right"
</item>

<item attributeBlabel>
/1 = "IMMORAL"
</item>

<item attributeB>
/1 = "Unfair"
/2 = "Dishonourable"
/3 = "Dishonest"
/4 = "Wrong"
</item>

<item targetALabel>
/1 = "SUPPLEMENT"
</item>
```

```
<item targetA>
/1 = "Vitamin"
/2 = "mineral"
/3 = "Protein"
/4 = "Superfood"
</item>

<item targetBLabel>
/1 = "PERFORMANCE PROHIBITED DRUG"
</item>

<item targetB>
/1 = "Steroids"
/2 = "drugs"
/3 = "Stimulant"
/4 = "Hormone"
</item>
```

A4c. Inquisit adjustable part of the BIAT script 'Advantage' 'Disadvantage'.

Full script available at:
http://www.millisecond.com/download/library/briefiat/

```
<item attributeAlabel>
/1 = "ADVANTAGE"
</item>

<item attributeA>
/1 = "Faster"
/2 = "Bigger"
/3 = "Stronger"
/4 = "Muscular"
</item>

<item attributeBlabel>
/1 = "DISADVANTAGE"
</item>

<item attributeB>
/1 = "Damage"
/2 = "Rage"
/3 = "Imbalance"
/4 = "Sterility"
</item>

<item targetALabel>
/1 = "SUPPLEMENT"
```

</item>

<item targetA>
/1 = "Vitamin"
/2 = "mineral"
/3 = "Protein"
/4 = "Superfood"
</item>

<item targetBLabel>
/1 = "PERFORMANCE PROHIBITED DRUG"
</item>

<item targetB>
/1 = "Steroids"
/2 = "drugs"
/3 = "Stimulant"
/4 = "Hormone"
</item>

APPENDIX 5. PUBLICATIONS

Shah, Iltaf, Petroczi, Andrea, James, Ricky A and Naughton, Declan P (2013) Determination of nitrate and nitrite content of dietary supplements using ion chromatography. *Journal of Analytical & Bioanalytical Techniques*, S12(003), http://dx.doi.org/10.4172/2155-9872.S12-003

Shah, Iltaf, James, Ricky, Barker, James, Petroczi, Andrea and Naughton, Declan (2011) Misleading measures in Vitamin D analysis: a novel LC-MS/MS assay to account for epimers and isobars. *Nutrition Journal*, 10(46), http://dx.doi.org/10.1186/1475-2891-10-46

James, Ricky, Nepusz, Tamas, Naughton, Declan P and Petroczi, Andrea (2013) A potential inflating effect in estimation models: cautionary evidence from comparing performance enhancing drug and herbal hormonal supplement use estimates. *Psychology of Sport and Exercise*, 14(1), pp. 84-96, http://dx.doi.org/10.1016/j.psychsport.2012.08.003

Vargo, Elisabeth Julie, James, Ricky A., Agyeman, Kofi, MacPhee, Thomas, McIntyre, Ross, Ronca, Flaminia and Petroczi, Andrea (2014) Perceptions of assisted cognitive and sport performance enhancement among university students in England. *Performance Enhancement & Health*, 3(2), pp. 66-77. http://dx.doi.org/10.1016/j.peh.2015.02.001

Petroczi, Andrea, Ocampo, Jorge A Vela, Shah, Iltaf, Jenkinson, Carl, New, Rachael, James, Ricky A, Taylor, Glenn and Naughton, Declan P (2015) Russian roulette with unlicensed fat-burner drug 2,4-dinitrophenol (DNP): evidence from a multidisciplinary study of the internet, bodybuilding supplements and DNP users. *Substance Abuse Treatment, Prevention, and Policy*, 10(39), http://dx.doi.org/10.1186/s13011-015-0034-1.