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Effects of Permitted Forms of Performance Enhancement on Determinants of Doping in UK Student-Athletes

A thesis submitted for the Degree of PhD in the University of Birmingham

By

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Declaration

I confirm that the thesis is my own work; and that all published or other sources of material consulted have been acknowledged in notes to the text or the references.

I confirm that the thesis has not been submitted for a comparable academic award.

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Abstract

Elaborating psychosocial mechanisms that influence doping in sport is important considering societal concerns around health harms and fairness in sport. A key influence identified in the literature is the use of dietary and ergogenic supplements (Backhouse *et al.*, 2013; Ntoumanis *et al.*, 2014). Despite the associated risks of supplement use, evidence shows a high prevalence of use amongst athletes (Daher *et al.*, 2022) but limited knowledge of the risks (Daher *et al.*, 2021; Trakman *et al.*, 2016). This is of particular concern given evidence to show possible 'gateway effects' of supplement use on doping (Backhouse *et al.*, 2013; Hurst, 2023). A related theoretical model is the Incremental Model of Doping Behaviour that builds on the underlying concept of the gateway model, with two alterations; firstly, it frames progression to doping in terms of performance gains, rather than a desire to cheat. Secondly, it incorporates, and distinguished between, explicit functional and moral attitudes to performance enhancement. However, research to date has not investigated gateway effects over time, and the IMDB remains largely untested, thus limiting conclusions that can be drawn.

Motivations for supplement use by athletes have been widely studied, but to date, no research has qualitatively examined athlete's perceptions of possible gateway effects of supplement use. Related, findings from research on educational interventions with athletes are equivocal (Bates *et al.*, 2019; Hauw, 2016) and no research has qualitatively examined athlete's views on optimal educational modalities in relation to supplement use. In particular, research has not yet explored whether the use of supplements could be positioned as an alternative, rather than precursor, to doping.

The present thesis sought to address these gaps in the literature. Chapter 2 provides a narrative review of relevant literature on athlete nutrition and supplement use, attitude

research and its relevance to doping, methodological issues in extant literature, the rationale for exploring these issues in adolescent athletes and the choice of reflexive thematic analysis. Chapter 3 describes the development of the two scale instruments used in the quantitative chapter. Evidence to support distinctions between functional and moral attitudes is presented alongside evidence to show validity and stability of the measures. Further empirical support is shown for a novel taxonomy of supplements and medication grouping supplements into conceptually sound categories based on factor analysis.

Chapter 4 presents the results of two-wave (Study 1) and three-wave (Study 2) cross-lagged panel analyses. The findings show strong support for the stability of the novel attitude variables over time and limited cross-lagged effects between muscle building supplements and functional doping attitudes. Results are somewhat inconsistent and methodological issues that may have affected the results are discussed.

Chapter 5 presents qualitative work exploring athlete's approach to nutrition and supplement use and their views on optimal nutrition education, in individual interviews (Study 3) and focus groups (Study 4). Data analyses reveal a complex pattern of influences that reflect disparate strands of extant literature, previously largely unconnected. Athletes had poor knowledge of nutrition and supplements but many used supplements frequently. Drivers for this are discussed, including convenience, poor food skills and multiple influences (e.g. peers, coaches, lifestyle). Discussions on educational interventions, alongside reviews of the literature, highlighted the need for personally relevant, multi-faceted approaches that encompassed both knowledge and skill acquisition. The implications of this thesis for policy and practice are discussed in Chapter 6.

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List of Abbreviations

(A)AS	(Androgenic) Anabolic Steroids
ADO	Anti-Doping Organisation
ADRV	Anti-Doping Rule Violation
AIS	Australian Institute for Sport
APCC	Association of Police and Crime Commissioners
APED	Appearance and Performance Enhancing Drugs
ASP	Athlete Support Personnel
CLP(M)	Cross-Lagged Panel (Model)
DMAA	1,3-dimethylamylamine
DMD(S)	Doping Moral Disengagement (Scale)
DSRE	Doping Self-Regulatory Efficacy
EPO	Erythropoietin
FMDAS	Functional & Moral Doping Attitudes Scale
IAT	Implicit Association Test
IMDB	Incremental Model of Doping Behaviour
IPED	Image & Performance Enhancing Drugs
ISE	International Standard for Education
MCM	Meta-Cognitive Model
MD	Moral Disengagement
MMR	Mixed Methods Research
MODE	Motivation and Opportunity as Determinants
NADO	National Anti-Doping Organisation

NS	Nutritional Supplement(s)
NSAID	Non-Steroidal Anti-Inflammatory Drugs
OTC	Over-The-Counter (medicines)
PEAS	Performance Enhancement Attitude Scale
PED	Performance Enhancing Drug
PGA	Pan-Arab Games
RRT	Randomised Response Techniques
RTA	Reflexive Thematic Analysis
SIA	Sports Integrity Australia
SM(U)	Social Media (Users)
SRE	Self-Regulatory Efficacy
SSBS	Sports Supplement Belief Scale
SSC	Single Sample Count
TA	Thematic Analysis
TP1	Time Point 1 (also TP2 and TP3)
TPB	Theory of Planned Behaviour
UQM	Unrelated Question Model
USADA	United States Anti-Doping Agency
WADA	World Anti-Doping Agency
WCA	World Championship in Athletics

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Chapter 1: Introduction

Current research suggests a somewhat uncomfortable position for anti-doping efforts. Evidence supports strong associations between use of nutritional sports supplements (NS) and various measures of doping, with greater supplement use linked to significantly increased risk of doping (Backhouse *et al.*, 2013; Hildebrandt *et al.*, 2012; Mallick *et al.*, 2023). Further evidence shows supplements may be contaminated with banned substances, adding to concerns about athlete's use (Martinez-Sanz *et al.*, 2017; Mathews, 2018). Understandably, anti-doping organisations are keen to promote abstinence wherever possible, especially given the number of anti-doping rule violations (ADRVs) linked to supplement use (Lauritzen, 2022).

Despite the risks, evidence shows extremely high prevalence of supplement use amongst athletes, with higher rates amongst elite athletes (Daher *et al.*, 2022; Garthe & Maughan, 2018; Knapik *et al.*, 2016). Substantial research explores drivers for athletes' supplement use, however much of this work is quantitative and therefore fails to capture rich detail around the relationship (see e.g., Braun *et al.*, 2009; Nieper, 2005; Schwenk & Costley, 2002; Sekulic *et al.*, 2019). Other research extensively explores athlete knowledge around supplements, but largely fails to adequately connect knowledge to dietary practice (Giraldi *et al.*, 2015; Jovanov *et al.*, 2019; Roy *et al.*, 2021). Related, work exploring athlete nutrition suffers the same pitfalls (Birkenhead & Slater, 2015; Dunn *et al.*, 2007; Heaney *et al.*, 2011), leaving research exploring barriers to optimal nutrition and supplement use research as somewhat disparate strands in the literature. Some qualitative research explores athlete approaches to supplement use and nutrition, but there is little that adequately explores them in relation to the identified associations with doping in extant literature.

These issues are especially important to explore with adolescent athletes as evidence shows they are vulnerable to risk-taking behaviours (Casey, 2008) and that poor dietary habits, including extensive use of supplements can develop at a very young age (Chung *et al.*, 2021; Kucharczuk *et al.*, 2022). A more in-depth examination of these issues can be found in the literature review (Chapter 2).

Much of the research showing associations between supplement use and doping is rooted in perceptions of a 'gateway effect', derived from earlier work in psychoactive drug use (Kandel *et al.*, 1992) whereby use of substances is seen to follow a linear sequence from 'soft' (non-prohibited) substances to 'hard' (banned) substances. Support for this has been shown in both quantitative (Backhouse *et al.*, 2013; Hildebrandt *et al.*, 2012; Hurst, 2023) and qualitative research (Blank *et al.*, 2016; Boardley *et al.*, 2015). An alternative, but related model is the Incremental Model of Doping Behaviour (IMDB) that proposes an incremental mechanism by which athletes may progress from permitted performance enhancement to doping (Petróczi, 2013a). The IMDB remains untested outside of one study and neither of these models have been tested in longitudinal research, consequently, effects of permitted performance enhancement on determinants of doping over time have not been explored.

Furthermore, the IMDB proposes an attitudinal mindset that distinguishes between functional and moral attitudes. Such attitudes have not previously been explored in research testing the gateway hypothesis.

Thus, there is a need to test temporal relationships between supplement use and attitudinal determinants of doping and further, to qualitatively explore athlete's perceptions of the relationship between supplement use and doping. Given the focus on attitudes, the IMDB provides a suitable framework for testing these.

Given the prevalence of supplement use by athletes, it seems reasonable to suggest appropriate educational initiatives that could position permitted performance enhancers as alternatives, rather than precursors, to doping. However, research on optimal education modalities is equivocal and scant research has qualitatively explored development of such initiatives from the athlete's perspective.

For parsimony, the research presented above is explored in much greater detail in the literature review in Chapter 2. The rest of the introduction will explore the aims of the research, methodological approaches and structure of the thesis.

The present thesis seeks to explore several related research questions; (i) are there causal influences of supplement use on explicit moral and functional doping attitudes over time, (ii) what permitted forms of performance enhancement are used by student-athletes and why and (iii) how can we present these forms of performance enhancement as alternatives to doping, rather than precursors as they are commonly represented in the extant literature?

Some aspects of these require quantitative measurement and analysis, whilst others (the 'why' and 'how') require qualitative exploration. The following section will address the rationale behind the methods chosen.

1.1 Methodological Approach: Quantitative vs Qualitative

Much debate exists on the relative merits of quantitative vs qualitative research, leading to some polarisation around the "objective" vs "subjective" nature of each. However, Ercikan & Roth (2006) argue this dichotomy is unwarranted. They argue that data are just a *representation* of observed phenomena in the 'real world' and that the distinction between quantitative and qualitative research rests only on how data are presented (or measured) and the nature of research questions.

McCusker & Gunaydin (2015) explore the use of quantitative research within the context of optimal modalities for specific research questions. They argue that quantitative research has several benefits; (i) it is cost-effective and efficient, allowing large-scale exploration with relatively minimal resources (e.g., a quantitative survey can be conducted online and managed with minimal resource), (ii) the tools employed (e.g. survey instruments), if properly validated, can be used by other researchers and therefore allow meaningful comparisons across studies, finally (iii) the researcher can maintain objective separation from the subject matter.

A key criticism of these points, especially when exploring complex, nuanced human behaviour, is that reducing such behaviour to numbers in a snapshot fashion risks losing important contextual detail (McCusker & Gunaydin, 2015). As Rahman (2016) points out, such research "…measures variables at a specific moment in time, and disregards whether the photograph happened to catch one looking one's best or looking unusually disarranged" (p106). This is, of course, a limitation of the large sample sizes that such research generally requires, especially with more complex analyses (Ivankova & Wingo, 2018). It is challenging to measure hundreds of people in any 'meaningful' depth. A related issue is relevance; large samples are of little use if they are not representative of the relevant population (Kaplan *et al.*, 2014).

Thus, quantitative research has limitations especially in explorations of complex behavioural relationships. Whilst theoretically objective, the choice of sample size, measurement instrument and analytical procedure can all influence the outcome (Aitken *et al.*, 2018; Sharma, 2021). So if the researcher is to truly 'remain objective' they must exercise rigour and caution when interpreting findings. However, for some types of enquiry it is the most appropriate option (McCusker & Gunaydin, 2015).

Qualitative research by comparison, aims to answer questions around the 'why' rather than the 'how much' (Lucidi *et al.*, 2015; McCusker & Gunaydin, 2015). Surprisingly, there is no universally agreed definition of what qualitative research actually is, something that no doubt feeds accusations of qualitative research being 'vague' (Shannon-Baker, 2016; Timans *et al.*, 2019). Aspers & Corte (2019) define qualitative research as a process of studying phenomena in terms of the *meanings* people attribute to them, thus it is something of an umbrella term for a variety of research modalities.

Smythe & Giddings (2007) talk of qualitative research questions being phrased as questions, rather than the testable statements typically employed in quantitative research. It allows the data to be 'messy' and move outside narrow constraints of measurement instruments. Rahman (2016) makes the case that qualitative research can be flexible. Data can be rich and detailed and provide deeper insight than that elicited via standardised tools designed to work at the aggregate level.

There are of course, limitations to qualitative research, some of which will be explored in more detail later in this chapter when the specific qualitative methodologies of the present studies are discussed. More generally, qualitative research is labour-intensive and time-consuming. Given this, sample sizes tend to be small and consequently, there are issues of generalisability (Ercikan & Roth, 2006; Rahman, 2016). A further limitation is that data analysis is complex and open to interpretation (Aspers & Corte, 2019; Jones *et al.*, 2013). Indeed, the entire process of qualitative data collection and analysis can be coloured by the researcher's own viewpoints and interpretations of the phenomena. This will also be explored more later but briefly, this can limit taking a broader view across a body of literature to reach meaningful conclusions.

Clearly, each approach has its place in research, and it is not the intention here to defend one approach over another. The choice of approach depends on the nature of the enquiry and perhaps, the limitations of available resources. Within the present study, both approaches are necessary.

1.2: Mixed Methods Research (MMR)

Multiple methods are required to answer the research questions. Whilst some distinguish between 'multiple methods' and 'mixed methods' (Ivankova & Wingo, 2018; Timans *et al.*, 2019), the argument largely rests on whether (and how) the differing methods are integrated within research design. Simply using both methods may not necessarily equate to 'mixed methods' if the findings are not integrated in a meaningful way (Timans *et al.*, 2019). No universally agreed definition of mixed methods can be applied here and the issue of integration has been the cause of significant debate (Fetters & Freshwater, 2015).

For simplicity then, this thesis will follow the definition provided by Creswell *et al.* (2011), with further guidance from Leko *et al.* (2022). Creswell *et al.* (2011, p4) defines mixed methods as; (i) focused on questions that require "…real-life contextual understandings, multi-level perspectives, and cultural influences." (ii) employing rigorous quantitative and qualitative research methods to assess the magnitude, frequency, meaning and understanding of constructs, (iii) uses multiple methods, (iv) intentionally integrates methods to maximise the strengths of each and (v) employing a philosophical/theoretical position to frame the enquiry.

With regard to the last two points; intentional integration of methods and philosophical/theoretical position, we first turn to the 'Quality Indicators' described by Leko *et al.* (2022), the first of which is "Meaningful and Purposeful Integration" (p434). The authors suggest several processes by which methods may be integrated, stressing that researchers should specify how they integrate and how this serves the research purpose.

For the purposes of this thesis, integration takes place in two ways; the first is within the second research question, whereby supplement use is quantitatively measured, but reasons for use are qualitatively explored. Secondly, within the final overall discussion of the thesis, in which the various studies are brought together and discussed as a single body of work within the framework of the IMDB, taking guidance from the '1+1=3' approach suggested by Fetters & Freshwater (2015) , whereby "qualitative + quantitative = more than the individual components" (p116). It should be noted that the second research question necessarily involves differing timelines within that question, something that has been raised as a potential barrier to 'true' MMR (Bryman, 2016) however, the study as a whole necessarily involves a multi-phasic design (Creswell *et al.*, 2011) due to the longitudinal nature and as long as there is meaningful integration, the over-arching approach can reasonably be defined as MMR (Leko *et al.*, 2022).

With regard to the philosophical/theoretical position, MMR can take more than one position depending on the lines of enquiry (Creswell *et al.*, 2011). The overarching philosophical position for this thesis is one of pragmatism as it seeks to understand processes and meaning behind the phenomena under investigation, whilst moving towards practical solutions (Shannon-Baker, 2016), whilst a post-positivist position underscores the qualitative analyses specifically (Ryan, 2006).

The use of MMR to explore the research questions in this thesis is appropriate to elaborate associations between supplement use and attitudes over time, the 'why' and the 'how' behind those associations and suggestions for the development of future initiatives to address the issues raised.

1.3 Quantitative Methodology

To examine possible temporal influences between supplement use and functional and moral doping attitudes it is necessary to employ longitudinal research (Caruana *et al.*, 2015). A longitudinal design following a single cohort, with periodic testing using identical instruments at each time point, allows us to explore sequences of events. This in turn allows determination of whether changes in one variable (e.g.

supplement use) both precede and predict changes in another variable (e.g. doping attitudes) (Caruana *et al.*, 2015). There are several analytical approaches to such data described within the literature, but a common approach is the use of the cross-lagged panel model (CLPM).

Kearney (2017) describes the primary goal of CLPM analyses as the determination of causal relationships between variables. The models are 'crossed' because they offer the opportunity to explore reciprocal relationships between variables, and 'lagged' because they examine these relationships over multiple time-points. As Kearney states, CLP models compare:

"…the relationship between variable X at Time 1 and variable Y at Time 2 with the relationship between variable Y at Time 1 and X at Time 2" (p1)

CLPM also allows exploration of synchronous correlations between variables at each time point, indicating stationarity and autoregressive relationships for each variable across time points, indicating stability of the variables (Kearney, 2017; Orth *et al.*, 2021).

Whilst popular, CLPM has been criticised. A key paper by Hamaker *et al.* (2015) suggests the traditional CLP model does not account for the time-invariant stability of constructs, especially unobserved variables and consequently can result in imprecise estimates. Hamaker suggests a Random Intercept Cross-Lagged Panel Model (RI-CLPM) as an alternative. However, the notion that CLPM should be discarded in favour of RI-CLPM has been challenged by other researchers (Lüdtke & Robitzsch, 2021; Orth *et al.*, 2021). Orth *et al.* (2021) examined seven competing models, both RI-CLPM and CLPM to try and resolve the debate. Their recommendation is that both models have their strengths and weaknesses and as such, it is incumbent on the researcher to determine which model best suits their purpose[1]. Based on their recommendations, the CLPM approach is used here.

[1] A thorough exploration of the statistical arguments behind these challenges is beyond the scope of the present review but see Orth *et. al.* (2021) and Lucas (2023) for detailed explanations of the issues.

1.4 Qualitative Methodology

There are two strands to the qualitative methodology in the present thesis; firstly, the process of data collection via semi-structured interviews, with individuals and focus groups. Secondly, analysis of the data, guided by the Thematic Analysis approach of Virginia Braun and Victoria Clarke. The use of semi-structured interviews is considered here, discussion of thematic analysis can be found in Chapter 2.

1.4.1 Semi-Structured Interviews & Focus Groups: Rationale and Criticisms

Semi-structured interviews have several benefits; they allow the combination of formal structure to guide the process, which can then be repeated across multiple interviews, thereby facilitating aggregation of data (Bryman, 2015). They also provide flexibility to explore topics and issues raised by interviewees (Rubin & Rubin, 2012).

Within the present research, allowing respondents flexibility in their responses facilitated a somewhat narrative approach to their answers (and also my data collection as interviewer), allowing them to elaborate threads and stories that may have been 'stifled' with a wholly structured approach. Jovchelovitch & Bauer (2000) argue that, by telling their stories, people recall events, put them into sequence, find explanations for them and explore meaning around them. As the interviewer I am keen to elicit these stories, although aware of the need to retain structure to ensure meaningfully focused data analysis.

Semi-structured interviews have other benefits, Gillham (2000) suggests such an approach is ideal for exploring sensitive subjects, although the success of that depends on the ability of the interviewer to build rapport with the interviewee. In this, I am thankful that my past career working with harm reduction services allowed me to build substantial experience interviewing people about extremely sensitive subjects and, perhaps more importantly, hearing them.

There are limitations to be considered. Diefenbach (2009) notes that interviews are a social situation and, as with any such situation, participants (including the interviewer) may have expectations and responses can be influenced by perceived differences in status between interviewer and interviewee.

In the context of the present thesis, although I was a Doctoral student, I was also a university staff member and I recognise that may have skewed participant's responses, especially those situated within my university.

Other issues raised by Diefenbach (2009) include the possibility for social desirability bias when discussing sensitive topics and the process of selecting participants. Accessing suitable participants necessarily involves relying on the goodwill of strangers (Rubin & Rubin, 2012). This process can potentially result in a somewhat narrow set of viewpoints, shared by a group of people who have agreed to be interviewed. It is incumbent on the interviewer to be aware of these limitations and manage them appropriately.

Focus groups were also conducted with groups of student-athletes known to each other. This point is important as creating groups unknown to each other can potentially lead to inhibitions that stifle debate (Bloor *et al.*, 2001). Whilst focus groups share many of the same benefits (and limitations) as individual interviews, interaction between group participants can lead to greater reflection and responses that individual participants may not give (Guest *et al.*, 2017). This is potentially a double-edged sword in that participants may be led by the strongest group member and relevant individual responses can become lost (Acocella, 2011). Again, it is incumbent on the interviewer to be aware and manage the process appropriately. Equally, it is important to be aware that a 'managed process' may also influence the data. However, research shows that focus group participants may divulge more on sensitive issues in a group setting than they do in individual settings (Guest *et al.*, 2017) and are thus a valuable approach to elaborating complex sensitive issues.

1.4.2 The Reflexive Interviewer

Pezalla *et al.* (2012) considers the importance of "researcher-as-instrument" that is central to both interviews and subsequent analyses. The central theme of this argument is that, whilst interview schedules provide a framework to guide interviews and hold them within the desired topic space, it is the researcher who is the actual 'instrument' that collects data.

The researcher ideally seeks to create a ‘conversational space’ in which participants feel comfortable sharing information, especially where such information may sensitive (Abell *et al.*, 2016; Pezalla *et al.*, 2012). How that process is facilitated is a subject of some debate. Tanggaard (2007) cautions against the use of empathy, suggesting it can create a somewhat superficial ‘friendship’ with the interviewee. Abell *et al.* (2016) are similarly cautious about the use of self-disclosure by the researcher, as the perception of ‘superior’ knowledge on the topic may shift the dynamic of the interview, creating distance between researcher and interviewee. Furthermore, whilst the interview is a primary research tool in qualitative research, researchers are often not trained to perform them (Bryman & Cassell, 2006).

Evidence suggests appropriate training can be beneficial and lead to reflexive researchers, well-versed in managing interview situations (Roulston *et al.*, 2008). Pezalla *et al.* (2012) however, highlight the influence of personal characteristics. They discuss three interviewers from the same team, all of whom had identical training courses, but all of whom produced very different results in the same study. The influence of the researcher’s personality and shifting dynamics of interviews contributed to variation in the themes that grew out of the interview experience, a key point frequently highlighted in the literature (see e.g., Bryman & Cassell, 2006; Pezalla *et al.*, 2012; Tanggaard, 2007).

Thus, it is important for the researcher to recognise their own role in the dynamic of the interview and how they may shape or contribute to the stories that evolve from those interactions. The researcher is inherently implicated in the data produced, long before they turn to analysis (Bryman & Cassell, 2006).

For me, this means recognising that the interviews revolved around subjects with which I was intimately connected. Nutrition and supplement use, especially in the context of performance enhancement, have been central to my work for many years, but also to aspects of my personal life as I sought to achieve performance gains in my gym-based exercise and in my chosen sport of bouldering (rock climbing). My views have shifted over the years and continue to do so as I learn more. This may colour my impressions of what I see as outdated approaches or it may serve to focus my attention on matters of perhaps more personal interest to me, rather than my participant. It is most certainly something that I should hold close as I seek to explore the stories in my data.

1.5 Research Aims & Questions

The current thesis aims to address the following overarching research questions:

1. What are the effects over time of using nutritional supplements, medications and performance enhancing technology on explicit functional and moral doping attitudes in student athletes?
2. What permitted forms of performance enhancement are commonly used by student athletes and why?
3. How can permitted forms of performance enhancement be presented most effectively to portray them as alternatives to, rather than precursors for, doping?

And, within the quantitative work, to test the following a priori hypotheses:

a) use of protein supplements, creatine, vitamin preparations and OTC analgesics, in particular, would be high in this population and

b) the use of NS, OTC medications and performance enhancing technologies would lead to positive changes in functional, but not moral, doping attitudes over time.

1.6 Structure of the Thesis

Following this introduction; the literature review in Chapter 2 provides an in-depth exploration of extant research relevant to the research questions. The review draws on wide literature from psychology, sociology, education and policy to further build the rationale and theoretical positions that underpin the thesis.

Chapter 3 presents the development of a novel scale for assessing explicit attitudes, based on the tenets of the IMDB as well as the development of an empirically supported approach to measuring supplement. Chapter 4 describes the longitudinal quantitative analyses (Studies 1 & 2), whilst Chapter 5 describes the qualitative analyses (Studies 3 & 4).

Finally, Chapter 6 provides a summary discussion and integrates the findings from chapters 4 & 5 within the framework of the IMDB.

Chapter 2: Literature Review

2.1 Introduction

The overarching themes of this thesis were twofold; firstly to determine temporal effects of supplement use on doping attitudes. Secondly, to determine whether permitted forms of performance-enhancing supplements could be viably positioned as alternatives, rather than precursors, to the use of banned substances.

As the project progressed, it became apparent that extant literature around supplement use by athletes is methodologically diverse, especially around definition and measurement of key constructs and therefore challenging to draw conclusions from. Furthermore, reasons why athletes use supplements and patterns of use are not adequately elaborated. The present chapter explores extant research relevant to the themes identified above, to frame the methodological approaches employed (see Chapters 3, 4 & 5) and the findings presented in data chapters (Chapters 4 & 5) and to elaborate the threads that run throughout the thesis.

Given the wide-ranging themes and mixed-methods approach within this thesis, a narrative approach has been taken for the literature review. This review does not seek to answer narrow research questions as would a systematic review (Munn *et al.*, 2018). Equally; a scoping review, whilst methodologically more robust, is largely descriptive and as such, does not offer the freedom to weave disparate strands together (Sukhera, 2022). I will first examine the various methods by which doping is defined and measured and then go on to explore the themes and constructs explored in later chapters.

2.2 Defining and Measuring Doping

The World Anti-Doping Agency (WADA) defines doping as “the occurrence of one or more of the anti-doping rule violations set forth in Article 2.1 through Article 2.11 of the Code” (WADA, 2021b p19). Whilst operationally useful for anti-doping, this definition goes beyond the scope of this thesis as it includes behaviours not directly linked to the use of banned substances (e.g., association with someone serving an anti-doping ban). This thesis is primarily concerned with the *intentional use (or planned* *intentional use) of performance-enhancing substances banned under the WADA Code* (WADA, 2020)[2] and consequently uses that as the definition of doping throughout.

Whilst defining doping appears straightforward, measuring it in a manner that provides insight in a research context is more complex. The most obvious method to measure whether an athlete is doping is physical testing (e.g. urine or blood samples) to determine the presence of banned substances or metabolites. This process can sometimes go awry, such as the recent Peter Bol case (Pender, 2023), and some have suggested a lack of objectivity in the interpretation of results (Nissen-Meyer *et al.*, 2022). However, it remains the primary method for detecting doping in athletes in competitions.

In a research context, this approach is impractical. It is financially burdensome , especially with the sample sizes typically required in quantitative research (Maennig, 2014). Testing also requires consent to take samples and as such, it is unlikely any athlete involved in doping would volunteer (Gleaves *et al.*, 2021), thereby limiting the applicability of results. This especially applies to research around doping prevalence, as it seeks to determine specific behaviour within a very large population.

2.2.1 Measuring doping prevalence.

Research that seeks to determine prevalence of doping within a large athlete population cannot rely on findings from doping control tests. Even without the previously mentioned issues, not all athletes are selected for testing pools and evidence suggests that the oft-quoted prevalence (derived from doping control tests) of 1-2% seriously underestimates actual prevalence (e.g., Botrè *et al.*, 2014; de Hon *et al.*, 2015).

Several reasons why this may be the case have been put forward, from performance-enhancing substances not yet known to analytical services (Botrè *et al.*, 2014), issues around interpretation of analytical results (Nissen-Meyer *et al.*, 2022) and measures taken by athletes that circumvent doping controls and methodological issues in data collection (de Hon *et al.*, 2015). Alternative measures have been

[2] An updated prohibited list came into effect in January 2023 and a subsequent revision is due before the end of 2023, however the studies presented in this thesis pre-date these lists and therefore the previous prohibited list is referenced throughout.

employed to determine doping prevalence, but estimates vary significantly across studies and sport types. For example; research employing Randomised Response Techniques (RRT) suggests a 'true' figure between 14-39% (de Hon *et al.*, 2015) in elite sport[3]. A review of the prevalence literature by Gleaves *et al.* (2021) noted even greater estimates, but highlighted significant variability between sports, heterogeneity of research methods and issues around use of self-report measures and concluded that the evidence base is "weak and disparate" (p1909).

It is worth noting some methodological issues arise from the complexity of anti-doping rules. For example, substances that are only banned in certain sports, or in (but not out of) competition, or for which there are Therapeutic Use Exemptions (TUE), that may impact research outcomes. Given these nuances, a poorly worded survey may not accurately capture the matter of interest (Petroczi, 2016). Equally, such nuance renders comparisons between similar studies complicated at best, moot at worst, depending on the instruments used and the context in which they were delivered. Thus, there is a need for reliable research instruments.

The RRT model previously mentioned is seen as a solution to at least some of the issues with self-report measures. A key feature of RRT is that prevalence of sensitive behaviours can only be estimated at the sample or population level. Such anonymity at the individual level is presumed to add weight to the notion that figures produced from RRT surveys may be closer to the 'true' figure. Athletes may admit to behaviours that they would otherwise deny in more direct measures (Bohner & Dickel, 2011). However, it should be noted that, even with RRT estimates can vary, even *within* a single study.

A key paper exploring prevalence at two different elite sporting events (World Championships in Athletics (WCA) and the Pan Arab Games (PAG); (both 2011) employed two different random response methods to determine prevalence; the Unrelated Question Model (UQM) and the Single Sample Count (SSC) (Ulrich *et al.*, 2018). Only the results of the UQM analyses were eventually reported, with prevalence

[3] No universally agreed definition of "elite" currently exists within the literature, or within sport generally. All references to 'elite' athletes within this thesis are therefore based on the operational definitions provided within each cited study.

estimates of 43.6% at the WCA and 57.1% at the PAG. Petroczi *et al.* (2022) revisited both the unpublished SSC data for these studies (collected contemporaneously) and the evidence synthesis provided by Gleaves *et al.* (2021), showing lower prevalence estimates based on the SSC (21.2% and 10.6% for the WCA and PAG respectively). The authors note that there is no way of determining which of these sets of figures is 'correct' but offer some insight into possible causes for the disparity.

Both models employ a randomised approach that adds statistical noise to the data thereby providing participants with anonymity by masking individual responses. For example the UQM adds noise within the question, for example by asking what half of the year someone else's birthday (e.g., a family member) is in before asking participants to answer each question. If the date falls within one half of the year, respondents may be asked to respond 'yes' to the sensitive question (regardless of whether that answer is correct), if it falls in the other half, they are asked to respond honestly to the question. The birthdate is not known to the researcher, but the probability of a birthdate falling in one half or the other is known, thereby facilitating calculation of how many respondents answered yes honestly to the sensitive question. The SSC adds noise by simply asking participants to indicate how many questions they answered affirmatively.

The authors note that the UQM may be more precise, as it offers smaller confidence intervals, although crucially, this is dependent on an assumption of honest responses. A pitfall of the UQM is that non-compliance with survey instructions is difficult to determine without extensive experimental manipulation. Conversely, the SSC is better able to determine non-compliance, but offers less precision and requires substantially more data processing for analysis (Petroczi *et al.*, 2022, p14). The issue of non-compliance with survey instructions is key here; Petroczi *et al.* (2022) note that non-compliance is rarely considered, but may be as high as 40% of the sample (p4) and highlight evidence of non-compliance within both the WCA and PAG data collections. Reasons for non-compliance are impossible to determine, however, randomised response models rest on an assumption of honest responses and non-compliance would significantly affect the outcome. Whilst indirect measures address some issues of direct measures, there is no imperative for the respondent to be honest (Gleaves *et al.*, 2021; Petroczi *et al.*, 2022).

This is not to say that indirect measures don't have value; Gleaves *et al.* (2021) note that indirect measures may provide more reliable estimates by mitigating issues found in other measures (e.g., social desirability). However, they advise caution in interpreting results and note the complexities of administering such measures, not least the large sample sizes required to reach the expected distribution of added 'noise' (p1924).

These issues are arguably compounded for research that seeks to understand the *development* of doping behaviour, not least because they seek to explore future (and potentially hypothetical) behaviour. Some studies employ simple questions about prior/current doping use, but such measures are clearly open to issues around reliability of recall and of course, the issues with direct measures previously discussed (Gucciardi *et al.*, 2016; Petroczi *et al.*, 2011). Evidence suggests elite sport students do not honestly report their use of banned substances (Thevis *et al.*, 2008) and it seems reasonable to assume other athletes would not. The alternative to direct questions (or doping tests) then, is to employ indirect measures, but rather than the randomised models previously mentioned, research turns to measures of proxies for doping behaviour. Several such measures have been proposed within the literature.

2.2.2 Proxy measures of doping.

Proxy measures of doping seek to explore a participants' possible propensity for doping via indirect measures that allow athletes to avoid direct disclosure of doping behaviour. For example, Gucciardi *et al.* (2010) employed a single-item measure of 'doping susceptibility' that defined susceptibility as "*the absence of a firm resolve not to engage in doping activities or to give any consideration at all to an offer to do so*"(p481). Athletes were provided a hypothetical doping scenario and asked to respond what consideration they would give to engaging in that scenario, any response other than "None at all" is deemed to denote susceptibility to doping. Other measures have employed similar approaches such as 'doping intentions' (Barkoukis *et al.*, 2013; Lazuras *et al.*, 2015), 'doping likelihood' (Kavussanu & Ring,

2017) and ‘doping willingness’ (Stanger *et al.*, 2020; Whitaker *et al.*, 2014). What such measures have in common is that they explore behaviours related to intentional doping in hypothetical scenarios. Whilst this approach may circumvent social desirability pitfalls of more direct questions, they require the respondent to predict their behaviour in a hypothetical situation and evidence suggests this may not be accurate (e.g., Baumeister *et al.*, 2007). An alternative approach is the measurement of attitudes towards doping, in the belief that attitudes may predict behaviour.

2.3 Attitudes: Definition, Measurement and Associations with Doping Behaviour.

Bohner & Dickel (2011) define attitudes as “*an evaluation of an object of thought”* (p392) but note that there is considerable variation in operational models of attitudes. In particular, whether attitudes are stable constructs, situationally constructed, or somewhere in-between, is a matter of considerable debate in the literature (Kirby *et al.*, 2016).

Bohner & Dickel (2011) elaborate the continuum along which different models sit. At one end are ‘stable-entity’ models that see attitudes as “*Long-term memory structures…*” (Bohner & Dickel, 2011, p393) such as the MODE (Motivation and Opportunity as Determinants, (Fazio, 2007)) model which links the object of thought to a global evaluation through which the attitude is formed. Similarly, the meta-cognitive model (MCM, Petty *et al.* (2007)) links the object to prior summary evaluations, but suggests there may be several evaluations linked to that object, with varying degrees of association. What both models have in common is the view that stable evaluations are associated with objects and drive attitudes related to that object.

Early models of attitude formation were essentially constructed as single-attitude models; we hold a single evaluation about an object in memory and access it as needed (see Bohner & Dickel, 2011). Later models took a dual-attitude approach, in order to address issues that arose when measuring attitudes, in which people are perceived to hold both explicit (conscious) and implicit (automatic) attitudes that are formed and stored independently and can have entirely different, even oppositional, valences (Petty *et al.*, 2007). Such models see dual attitudes as derived from differing cognitive processes, with implicit attitudes arising from evaluative associations and explicit attitudes arising from propositional processes (Gawronski & Bodenhausen, 2006). Furthermore, these dual attitudes are assumed to be independent and to be called upon in different situations. Explicit attitudes are seen as prevalent (and therefore most likely to influence behaviour) in contexts where people are giving thought to the situation, as opposed to implicit attitudes that influence more spontaneous behaviour (Petty *et al.*, 2007).

At the other end of the continuum sit constructionist process models (e.g., Schwarz, 2007) that see attitudes as constructed contemporaneously, based on information accessible at that time. This information can include prior evaluations, but these evaluations are not seen as central to the process. As with any continuum, other models sit between these two positions (e.g., Cunningham *et al.* (2007) iterative reprocessing model which posits that attitudes are constructed contemporaneously using stable evaluations).

A thorough exploration of the history of research on attitudes is beyond the scope of the present review, however, it is important to note the research detailed above to understand the development of tools to measure attitudes and, perhaps more importantly, how those tools may influence research outcomes.

***2.3.1 Measuring attitudes*.**

Single-attitude models gave rise to the use of simple self-report measures to measure attitudes, in the belief that people were able to explicitly access stored evaluations and would be comfortable divulging them (see e.g., Likert, 1932; Thurstone, 1928). However; later research shows neither of these propositions necessarily hold true (see Bohner & Dickel, 2011 for a review). People may hold attitudes they are unable to access explicitly and, more importantly in a research context, they may wish to portray themselves in a way they perceive as socially desirable (Krosnick *et al.*, 2005). Thus, as with the prevalence studies, *measurement* of attitudes may not reflect *actual* attitudes. The issue of social desirability is, of course, especially important when measuring sensitive behaviours such as doping (Gucciardi *et al.*, 2010; Gucciardi *et al.*, 2015).

Whether research in this field accurately captures individual's attitudes to behaviours is a matter of debate (Petroczi *et al.*, 2008a), even before considering whether those attitudes could reasonably be held to predict behaviour. Consequently, when examining the literature on attitudes, it's important to consider two key factors; Firstly, what theoretical construct of attitudes did the research employ? In single-attitude models the way the attitude is *measured* may be seen to reflect an automatic (implicitly held) attitude *or* an explicit, deliberative attitude based on the automatic attitude and information accessed contemporaneously. Conversely, dual-attitude or constructionist approaches see the measurement process as accessing different (explicit or implicit) mental representations that may be held at the same time but are otherwise separate. Thus, whilst different theoretical approaches may use similar (or even identical) methods to measure attitudes, the interpretation of their results must consider the original theoretical lens, especially if we seek to draw conclusions across multiple studies.

Secondly; it should be noted that the terms 'implicit' and 'explicit' can refer either to the attitude construct itself, or to the way in which it is measured (Fazio & Olson, 2003). For example, an explicit (or direct) *measure* is transparent in asking respondents to report their attitudes (e.g., measures using Likert or semantic differential scales) (Petty *et al.*, 2008). Conversely, implicit (or indirect) measures do not directly ask attitudes about a subject, but instead rely on other observations to infer attitudes. Such measures are seen as useful for sensitive subjects (e.g., doping) (Petty *et al.*, 2007). An example is the Implicit Association Test (IAT) (Greenwald *et al.*, 1998), which uses participant response times to determine implicitly held attitude evaluations.

In the IAT test the participant is presented with a screen and two buttons, and (for example) differently valenced combinations of images and words (e.g. Dog/Cat, Good/Bad) and told to press a specific button for specific stimuli. In a dog-positive task, the participant may press the left button for any stimuli showing dogs or positive words and the right button for cats or negative words. In a cat-positive task, the first button would be assigned to cats and positive words and button two to dogs and negative words. Differences in response time (button press) between differently valenced combinations are believed to reflect stronger implicit associations (Greenwald *et al.*, 2009). So responding faster to 'Dog/Good' than to 'Cat/Good' would suggest stronger association with the belief that dogs are good. The IAT has seen extensive use in doping research (see e.g., Baumgarten *et al.*, 2016; Brand *et al.*, 2014a; Brand *et al.*, 2011), with evidence to show positive associations between implicit attitudes and doping behaviour (Brand *et al.*, 2014b)

Regardless of the theoretical lens, examination of the association between attitudes and doping plays a significant role in extant research around the psychology of doping behaviour (Petroczi *et al.*, 2008a; Petroczi *et al.*, 2011). Whether those attitudes can be used to accurately predict behaviour, especially sensitive behaviour such as doping however, remains a matter of debate.

Again, there are methodological issues across the literature; Kirby *et al.* (2016) note the lack of theory behind earlier research and issues around custom-made attitude measures. The development and psychometric detail of these measures is often poorly reported, confounding efforts to determine whether measures are reliable and valid (Petroczi & Aidman, 2008). Other research suggests that definitions of key constructs such as "doping attitudes" are so poor in many studies that actually, it was athlete's knowledge around doping, rather than their attitudes towards it, that was being tested (Backhouse *et al.*, 2007). Thus, there is a need for measures that have been appropriately validated. One widely used example is the Performance Enhancement Attitude Scale (PEAS) (Petróczi & Aidman, 2009).

The PEAS examines "an individual's predisposition toward the use of banned performance enhancing substances and methods" (Petroczi, 2007; p7). The extensive use of this scale in doping research facilitates comparisons across studies and overall, evidence shows a consistently positive relationship between higher PEAS scores (more favourable views on use of performance enhancement) and self-reported doping (Petroczi & Aidman, 2008). The PEAS exists in several forms, with most comprising 17, 11, 8 or 6 items (Nicholls *et al.*, 2017) as well as versions translated into other languages such as Spanish (Morente-Sánchez *et al.*, 2014), French (Hauw *et al.*, 2016) Polish (Sas-Nowosielski & Budzisz, 2018) and Turkish (Uysal *et al.*, 2022), demonstrating its validation across different cultures and different settings.

As with any such measure, the PEAS is not without issues. For example, the shorter versions exist partly due to reliability issues with the 17-item version noted in some studies, although some of these may be due to cultural differences rendering specific items less applicable (see e.g., Gucciardi *et al.*, 2010; Hauw *et al.*, 2016; Morente-Sánchez *et al.*, 2014). Further, the fact that the PEAS is a self-report measure leaves it open to response bias, especially when used in conjunction with self-reported doping (Kirby *et al.*, 2016; Morente-Sanchez & Zabala, 2013).

An early review of studies the PEAS by Petróczi & Aidman (2009) noted acceptable model fit for the 17-item version across the nine studies they examined. Whilst they did mention the fact that mean PEAS scores were consistently below the anticipated/theoretical mean (suggesting athlete's generally held more unfavourable views on performance enhancement than expected) they also note that scores were largely normally distributed across most of the studies (Petróczi & Aidman, 2009 p393). Measures of reliability were acceptable to good across the studies and positive associations were noted with self-reported intention to use doping and prior doping use. Thus, on the basis of this review, the scale appears to possess good psychometric properties and as such could be considered tool for identifying potential vulnerability to doping. Other studies testing versions translated into other languages have noted issues with cross-cultural validity of specific items (Hauw *et al.*, 2016), but with proper validation of a translated version, the scale still showed acceptable psychometric properties.

Nicholls *et al.* (2017) tested various versions of the PEAS with 1,154 participants aged 12-68 years old. They noted the original 17 item scale performed poorly both across the whole sample and within sub-samples of adult and adolescent athletes. The shorter (11, 8 or 6 item) versions performed better, with the 8-item providing the best fit for adult athletes. Equally; some of the translated versions required removal of specific items, reducing the scale to 11 items (see e.g., Sas-Nowosielski & Budzisz, 2018). A more recent systematic review of the PEAS based on 82 studies (with a sub-sample of 44 used for meta-analysis) suggests it requires further refinement and validation.

Folkerts *et al.* (2021), report that the PEAS now exists in more than 20 languages and with nine different versions. Importantly, no single item from the original scale is present is every version. Differing language versions aside; the authors note that the lack of consistent use of any individual item across all versions suggests a need to refine the PEAS to facilitate consistency in such research.

Further issues noted include the trend for negative PEAS scores, even amongst self-reported doping users and questions around whether the PEAS actually measures moralised attitudes rather than moral attitudes (e.g., normative rather than personally held) (Folkerts *et al.*, 2021). Evidence suggests the athlete's environment is key in developing explicitly expressed attitudes to doping (e.g., Barkoukis *et al.*, 2019) and it's important to bear in mind the PEAS is an explicit measure, with all the caveats previously mentioned. Finally; whilst the PEAS appears to measure some form of moral aspects of doping; given the inconsistent findings with even self-admitted doping users, it is questionable how reliable a predictive tool it may be for doping behaviour (Folkerts *et al.*, 2021, p12). Nonetheless, it remains the dominant measure in doping attitude research.

Whether attitudes reliably directly predict doping behaviour, especially future behaviour is equivocal, but they do appear to reliably predict other variables that influence behaviour when measured together.

2.3.2 Theory of Planned Behaviour: The attitude-behaviour relationship.

The nature of the attitude-behaviour relationship, specifically, whether attitudes can accurately predict behaviour, forms perhaps the largest body of research around attitudes in social psychology (Ajzen, 2001). Much of this is embedded within the Theory of Planned Behaviour (TPB) (Ajzen & Madden, 1986), which posits that intentions are the primary determinant of behaviour. Intentions, in turn, are theorised to be influenced by subjective norms (perceived social 'pressures' to engage in the behaviour or not), perceived behavioural control and attitudes towards the behaviour.

Kirby *et al.* (2016) posit that these factors are underpinned by relevant beliefs about the behaviour, coupled with evaluation of the potential consequences. Subjective norms are underpinned by normative beliefs around what significant others expect and the degree to which an individual is motivated to meet such expectations. Finally, perceived behavioural control is influenced by beliefs about factors that enable/inhibit performance of the behaviour.

This complex structure provides a theoretical lens that is believed to offer robust predictive value for the relationship between attitudes and behaviour (Ajzen, 2001). Meta-analysis of the efficacy of the TPB shows strong support for the model, with the model showing good predictive power. Specifically; both perceived behavioural control and intentions were strong predictors of behaviour and attitudes were strong predictors of intentions (Armitage & Conner, 2001). Thus, within social psychological research, attitudes are believed to *indirectly* predict behaviour via intentions. Armitage & Conner note that subjective norms were a weaker predictors of intentions, and that the relative influence of the three elements is believed to vary across different behaviours and situations (Ajzen, 1991; Armitage & Conner, 2001).

One key issue of course, is the measurement of these various elements of the TPB within the context of heavily sanctioned and stigmatised behaviour such as doping. The potentially more accurate implicit measures that overcome issues around social desirability accompanying self-report measures, are harder and more costly to implement (Kirby *et al.*, 2016; Petroczi *et al.*, 2008a). Consequently, the most used measures are self-report scales explicitly measuring various constructs, the findings of which should obviously be interpreted with caution, for reasons elaborated above. Beyond this, the bulk of the research within this paradigm is cross-sectional and as such is hampered in its efforts to reliably elaborate causal or predictive effect of attitudes upon actual behaviour (Kirby *et al.*, 2016). Some longitudinal research has been conducted to try and overcome this last limitation, conducted within the broad paradigm of TPB but extending it to include other factors.

Lucidi *et al.* (2008) examined a range of psychosocial variables believed to influence doping intentions across a large (*n*=762) sample of adolescent students at two time points, three months apart. They assessed doping and supplement use within the previous three months at time point two. Other variables included behavioural intentions, doping attitudes, subjective norms, perceived behavioural control, moral disengagement, and doping self-regulatory efficacy.

Moral disengagement (MD) is a series of psychosocial mechanisms proposed by Bandura (1991) that allow individuals to overcome feelings of guilt or other cognitive dissonance that occurs when undertaking morally questionable behaviours. Examples of these mechanisms include 'euphemistic labelling' (e.g., recreational anabolic steroid users may refer to the practice as 'gear use' rather than 'drug use'), or 'advantageous comparison' (e.g., 'This <other, broadly similar behaviour> is much worse by comparison'). Bandura's original theory comprised eight mechanisms, of which six have been found to be relevant to doping (see e.g., Boardley *et al.*, 2014; Boardley *et al.*, 2015; Boardley *et al.*, 2018). Greater levels of MD have been extensively linked to doping in the literature (see e.g., Boardley *et al.*, 2015; Jowett *et al.*, 2023; Kavussanu *et al.*, 2016; Ring & Hurst, 2019)

Self-regulatory efficacy (SRE) refers to an individual's ability to resist external pressures to engage in questionable behaviours (Bandura *et al.*, 2001) so the greater the level of SRE, the less likely an individual is to dope (Boardley *et al.*, 2017).

Lucidi *et al.* (2008) reported that, at time point 1, stronger intentions to use doping were associated with more positive doping attitudes, stronger beliefs that significant others would approve of doping, stronger beliefs that doping could be justified and weaker SRE. At time point 2, self-reported use of doping and supplements was strongly and positively associated with stronger intentions and moral disengagement at time point 1. However, whilst they reported doping use as being significantly correlated to supplement use, they did not record supplement use at baseline and were therefore unable to show a causal effect of supplement use over time.

This work was extended by Zelli *et al.* (2010), who additionally examined social influences on doping intentions amongst adolescents. They found that, in situations where adolescents were incited to use doping by others, they were more likely to express positive doping attitudes and stronger intentions to use doping in the future when they held favourable views on the other party's intentions in soliciting doping use. To what degree these findings can be translated to athletes, especially elite athletes, is obviously open to question; but their results do at least provide some evidence for the potential influence of others, depending on how those influences are perceived.

A later meta-analysis, based on the constructs of the TPB, by Ntoumanis *et al.* (2014) reported the strongest correlates of doping intentions as; use of sports supplements, perceived social norms, and positive doping attitudes. Further analysis revealed that attitudes, perceived social norms and SRE directly predicted doping intentions and indirectly predicted doping behaviours. Equally, self-efficacy and morality were negatively associated with doping intention, suggesting these may act as protective factors. Whilst compelling, it is important to recognise the reported limitations of this study. Notably the small number of studies, extensive use of self-report measures and the fact that effect sizes were derived from cross-sectional studies employing correlations, thus leaving the effect sizes as statistically significant but not indicative of cause. The authors note, as with so many reviews in this field, that the evidence base is lacking in terms of both methodological rigour and volume.

Related, a later review by Blank *et al.* (2016) largely confirmed the findings of Ntoumanis *et al.* (2014) but noted that intentions did not significantly predict behaviour, raising questions about the TPB model that sees intentions as the most proximal indicator. They did, however, note that situational temptations and attitudes positively predicted doping intentions, current behaviour and subjective norms positively predicted doping susceptibility and that doping behaviour was predicted by situational temptations, attitudes, and doping beliefs. The authors further note that the fact that intentions did not predict behaviour may reflect the debate about whether doping should be considered a rational and intentional behaviour (see e.g., Petróczi, 2013a; Petroczi & Aidman, 2008). Further, evidence suggests sporting culture is a key influence and the authors note none of the studies they reviewed examined such macro-level factors. It is also worth noting that this review focused on elite athletes, rather than the broader scope of the earlier review by Ntoumanis *et al.* (2014) and athletes at this level may experience different environmental factors that could influence doping behaviour (Mallick *et al.*, 2023). Nonetheless, these reviews highlight a complex interplay of factors, grounded in the TPB but also extending beyond it, that influence doping intentions and behaviour. Clearly, attitudes remain integral to this relationship, but there is still work to do to elaborate their exact role.

Ntoumanis *et al.* (2014) suggested the practical implications of their study to be education and interventions around positive social and normative influences that promote ethical decision-making around doping use, and this resonates with findings of other studies described above. There is though, one factor described with this study that produced a somewhat contradictory suggestion. The authors note that athletes' could be encouraged to "*….pursue performance improvements through the use of legal substances* [e.g. sports supplements] *and methods"* (p1621)., However, the findings of this study highlighted the influence of sport supplement use on doping and the authors further note that (a) sports supplements may be contaminated with banned substances, leading to inadvertent doping and potential sanctions (Geyer & Gmeiner, 2015; Geyer *et al.*, 2008) and (b) that supplement use may act as a 'gateway' to doping substances.

A seminal paper by Backhouse *et al.* (2013) examining the influence of nutritional supplement use on doping reported that supplement users were three-and-a-half times more likely to report doping use than non-users and expressed significantly more favourable doping attitudes and beliefs that doping is effective. The notion of a 'gateway effect' leading from nutritional supplement (NS) use to doping has been widely explored within more recent doping literature, but the nature of the relationship remains unclear. Further, the 'gateway' model, grounded in work by Denise Kandel in the 1970's and beyond, has limitations that apply equally to its application in sports doping.

To explore this relationship more deeply it is necessary to examine the original theoretical model and its subsequent application to doping. It is further necessary to examine wider research around athletes' use of NS, including their knowledge and motivations for use, especially given the potential risks previously highlighted.

2.4 Supplement Use and Doping: The Gateway Model and IMDB

A number of studies have linked the use of NS by athletes to more favourable attitudes towards doping and increased risk of doping behaviours (Backhouse *et al.*, 2013; Barkoukis *et al.*, 2020; Hurst *et al.*, 2019; Hurst *et al.*, 2021a; Ntoumanis *et al.*, 2014). Hoffman *et al.* (2008) examined use of NS and anabolic steroids (AS) amongst adolescents and reported that NS use increased with age and that increased NS use positively predicted AS use. This finding was stronger for supplements used to gain muscle mass (e.g. protein drinks) and this is echoed in other research (e.g: Hildebrandt *et al.*, 2012).

Some research suggests NS use could act as a gateway to doping use (Backhouse *et al.*, 2013; Barkoukis *et al.*, 2020). Growing out of the work on psychoactive drugs by Denise Kandel, 'gateway theory' posits a linear, sequential and hierarchical development of substance use (Kandel & Faust, 1975; Single *et al.*, 1974). Kandel's original work examined the self-reported use of psychoactive substances (both licit and illicit) by a large sample of adolescent students (*n*=5,468) between two time points approximately six months apart, with a further sub-sample (*n*=945) assessed at a third time point after students had graduated from high school. Broadly, the identified sequence started with the use of beer/wine and then progressed to 'hard liquor' and cigarettes, then 'marijuana' then other illicit drugs, with psychedelic drug use typically preceding use of cocaine and/or heroin. This model has significantly influenced legislation and policy, especially in the USA and UK (Lynskey & Agrawal, 2018) and remains a significant contributor, highlighted by recent calls to inform preventative and treatment activities with evidence around 'gateway drugs' (*APCC leads respond ...* 2023).

Whilst a large body of research has replicated Kandel's findings on associations between earlier and later drug use, causal relationships in that sequence are still a matter of debate (Lynskey & Agrawal, 2018). Some research within the field of psychoactive drugs suggests both early drug use and subsequent progression may result from common causes, rather than early drug use being causal itself (Degenhardt *et al.*, 2010; Lynskey & Agrawal, 2018; Morral *et al.*, 2002). Indeed, Kandel herself has noted that studies examining the gateway model do not meet the requirements to show causal effects (Kandel *et al.*, 2006).

A similar debate exists in sport. The concepts of the gateway model have been applied to research demonstrating associations between NS use and doping but causal mechanisms have not been tested (Backhouse *et al.*, 2013). However, several studies have highlighted the influence of psychosocial factors associated with the progression from NS to doping.

Hurst *et al.* (2021b) note that ego orientation is indirectly related to doping likelihood, with ego-oriented athletes who use NS more likely to dope. Backhouse *et al.* (2013) noted significant differences between NS users and non-users regarding doping attitudes and beliefs, with NS users reporting significantly more favourable attitudes. This finding was somewhat replicated by Barkoukis *et al.* (2015) who noted significantly stronger doping intention and more favourable doping attitudes amongst NS users and suggested a "shared mental representation" of NS use for performance enhancement and doping. However, the authors stress their findings do not imply a causal relationship; approximately 90% of the NS users in their sample did not report doping.

Qualitative studies also support a possible progression from NS to doping, especially when permitted NS are no longer seen to be providing sufficient enhancement (Boardley & Grix, 2013; Boardley *et al.*, 2014), but this again highlights the potential influence of other common factors influencing such decisions.

More recent retrospective research by Hurst (2023) shows violation of the temporal sequence, with some participants reporting concurrent initiation of doping and supplement use and a small percentage reporting doping *before* supplement use. It is of course, important to bear in mind these data are derived from retrospective self-report surveys and as such, are potentially open to bias and errors in recall. However, it remains an important finding that challenges the classic gateway model. Other research by Hurst *et al.* (2023) reviews 26 cross-sectional studies examining associations between NS use and doping. Their findings indicate doping was 2.74 times more prevalent in NS users than non-users and that NS users reported significantly stronger doping attitudes and intentions. They also report that NS users with stronger morality and who were more task-oriented were less likely to dope. Their findings then, offer more support for the notion that NS use can lead to doping, but also that this could be attenuated by other psychosocial factors.

Hurst *et al.* (2023) also report a lack of distinction between different types of NS in the papers reviewed, despite limited evidence suggesting different types of NS may exert differing influences on doping outcomes (Hildebrandt *et al.*, 2012; Hurst *et al.*, 2021a). This last point is a key limitation in this field. The lack of clear and universally agreed definitions of what constitutes a "supplement" across studies limits the conclusions that can be drawn. Furthermore, distinguishing between different *types* of nutritional supplement and other (non-banned) substances that may be routinely used by athletes is logically key to our understanding of the associations with doping.

For example, beyond the use of "nutritional" supplements (e.g., based on actual nutrients such as protein, carbohydrate or micro-nutrients), research shows significant prevalence of over-the-counter (OTC) medication use among athletes (Alaranta *et al.*, 2008; Lazic *et al.*, 2011) , especially analgesics such as nonsteroidal anti-inflammatory drugs (NSAIDs) (Tscholl *et al.*, 2009; Warner *et al.*, 2002). Although research is limited, there is evidence to suggest the prevalence of medication use, especially NSAIDs, is higher amongst athletes than age-matched controls (Alaranta *et al.*, 2006) and that athletes, especially student athletes, use alarmingly high levels of some OTC medicines (Ciocca, 2005; Warner *et al.*, 2002). Brennan *et al.* (2021) reported the non-medical and extra-medical use of NSAIDs noting that excessive use of NSAIDs was common amongst athletes and unlikely to be medically justified. Also relevant is Dietz *et al.* (2016) who examined use of analgesics and doping in triathletes and reported significantly higher prevalence of doping in athletes who used analgesics than amongst those who did not. Multiple studies show use of analgesics, especially among student athletes, is frequently accompanied by use of other OTC medicines and NS (see e.g.: Locquet *et al.*, 2017; Shehnaz *et al.*, 2014; Tscholl *et al.*, 2010; Tscholl *et al.*, 2008), suggesting common patterns of NS and medication use that may influence subsequent doping behaviours.

The gateway model appears as relevant here as with NS, OTC medicines appears to represent a similar risk to NS use but is not as widely studied and research in this area suffers all the same methodological issues. Thus, there is a need for the development of reliable measures that clearly delineate different types of NS and OTC medicines.

The relationship between the use of permitted substances[4] and doping is complex and influenced by a variety of psychosocial variables. The gateway model may be a useful starting point here, but seems in need of refinement to elaborate these complex relationships. A related theory that may be an option is the Incremental Model of Doping Behaviour (IMDB) (Petróczi, 2013a, 2013b). The IMDB also posits a progression from NS use to doping but, unlike the gateway hypothesis, proposes that athletes' attitudes around the *functionality* of performance enhancement, and how this meets their athletic goals is key and further, integrates other psychosocial variables (e.g., morality) and all performance enhancing substances and methods. This theoretical approach, along with the need for longitudinal research and refined measures previously noted, underpins the current research.

2.4.1 The Incremental Model of Doping Behaviour.

The IMDB suggests doping is a goal-oriented, learned behaviour in which the end goal is not 'cheating', but athletic enhancement to maximise performance. The IMDB proposes that functional attitudes are integral to 'the doping mindset' (Petróczi, 2013a, 2013b), whereby the decision to use performance enhancing substances is driven by beliefs about the necessity or value of performance enhancement to achieve performance goals, but moderated by attitudes about the behaviour required to do so (e.g., moral attitudes towards doping behaviour). It is important to note that functional and moral attitudes are not portrayed as dichotomous, but rather as two elements of the interplay of psychosocial factors that influence doping behaviour. Thus, the model describes an effect of supplement use on functional attitudes, but not moral attitudes. The model also describes the influence of motivational goals

[4] Throughout this thesis reference is made to 'permitted' and 'banned' substances (or 'licit' and 'illicit'). Banned substances are those listed on the World Anti-Doping Agency Prohibited List 2022. The term 'permitted' (or 'licit') is used to denote substances taken by athletes that do not appear on that list.

on behaviour and importantly, posits that such goals change as an athletes' career progresses, moving from (predominantly) enjoyment to mastery to performance.

Furthermore, the IMDB brings together the use of different methods, including NS, OTC medicines and enhancement technologies (e.g., altitude masks). The IMDB posits that it is the continued and prolonged use of such methods to enhance performance that incrementally leads an athlete towards doping. Equally, the IMDB proposes such use may change over time, dependent on an athlete's goals at different stages of their athletic career, with higher competitive levels likely to elicit greater use of performance enhancing methods and perhaps greater risk of doping behaviour. This is supported by extant research showing NS use is positively correlated with age and the desire to achieve Olympic or World Champion status (Dietz *et al.*, 2014) and that elite athletes use significantly more NS than non-elite athletes (Knapik *et al.*, 2016).

To date, just three studies have shown support for elements of the IMDB. Hurst *et al.* (2019) examined the mediating role of sport supplement beliefs on the relationship between sport supplement use and doping attitudes/intentions. Their findings showed athletes who held stronger beliefs in the functional effectiveness of sport supplements held more positive doping attitudes and reported stronger doping likelihood.

Secondly, Hurst *et al.* (2021b) examined relationships between achievement goals, supplement use, supplement use beliefs and doping likelihood. They reported that ego (not task) orientation was indirectly related to doping likelihood via both sports supplement use and sports supplement beliefs. Ego orientated athletes were more likely to use NS, more likely to see them as functionally effective and more likely to dope. Whilst achievement goals are not part of the IMDB, they could arguably form part of the doping mindset posited within the model, albeit one that was not considered in its original form. Regardless, the relationship between beliefs in functional benefits of performance enhancement supplements, supplement use and doping is part of the IMDB and this study shows further support for that association and the onward association with doping.

The third cross-sectional study (Hurst *et al.*, 2022) reports an indirect relationship between NS use and doping via sport supplement beliefs, moderated by moral values and moral identity. Athletes who held stronger beliefs in the functional benefits of supplements, were more likely to dope if they had low moral values and did not believe being a moral person was important to them. This shows support for the influence of functional attitudes and importantly, moderation by moral values, as proposed by the IMDB (Petróczi, 2013a).

Thus, the IMDB offers a comprehensive theoretical framework that explicitly draws together both a range of different performance enhancement methods as well as acknowledging the influence of psychosocial variables. However, whilst the studies above show support for some elements of the IMDB, there is a need to examine the theoretical model via longitudinal research that distinguishes between functional and moral doping attitudes as explicit constructs. Additionally, evidence suggests there may be differing effects on doping outcomes for different types of nutritional supplement.

2.4.2 The Influence of Different Types of Supplements.

Hildebrandt *et al.* (2012) reported that participants using muscle building and weight loss supplements held more positive beliefs about the efficacy and safety of illicit Appearance and Performance Enhancing Drugs (APEDs) (e.g. anabolic steroids) compared to users of health/wellbeing supplements. Positive beliefs about the efficacy and safety of APEDs were associated with higher levels of self-reported illicit APED use. They also noted the association between NS and illicit APED use was partly explained by social norms. Essentially, that social networks provided support for initiation into APED use and minimised risk assessment of APEDs. This finding is in line with research showing the impact of social groups on drug use initiation (Branstetter *et al.*, 2011) and other broader research, detailed previously, highlighting the influence of environmental factors. The authors reviewed their findings in the context of the gateway model, but concluded that further, longitudinal, evidence was required. However, it is noteworthy that the association with stronger functional beliefs is in line with the IMDB model.

Similarly, in another cross-sectional study, Hurst *et al.* (2021a) noted that users of 'ergogenic' and 'medical' supplements reported more favourable doping attitudes (as measured by PEAS) compared to non-users and additionally (along with 'sport food/drink supplement' users) reported stronger beliefs in the efficacy of supplements for performance enhancement. The relationship between supplement use and doping attitudes was mediated by sport supplement beliefs in all three supplement categories. This again shows some support for the influence of functional beliefs in the supplement – doping relationship, as posited by the IMDB.

These studies show compelling evidence for differential effects of different supplement 'types' on doping outcomes, however, research around supplement use by athletes has several methodological issues that warrant consideration.

2.4.3. Methodological Issues in Supplement Research

A key issue that hampers research in this area is the lack of consensus on how to define supplements (Garthe & Maughan, 2018). Garthe (2019) notes the complexity of finding such consensus due to the diverse range of biologically active ingredients that may be found in supplements. Maughan *et al.* (2018a) provide a reasonably workable definition: "*A food, food component, nutrient, or non-food compound that is purposefully ingested in addition to the habitually consumed diet with the aim of achieving a specific health and/or performance benefit*" (p439). The range of substances that could fit this description is extremely broad and importantly, from the perspective of athlete's use, this definition does not distinguish between substances prohibited or not under the World Anti-Doping Agency (WADA) code (WADA, 2020). It could be argued that banned medications such as anabolic steroids would fit under "...a non-food compound that is purposefully ingested…with the aim of achieving a specific health and/or performance benefit", but they clearly do not occupy the same space as vitamins or protein drinks. This definition also excludes supplements frequently used primarily for aesthetic purposes (e.g., collagen).

However, in comparison to other definitions (see below), I believe Maughan's definition is the most practical starting point. It is important to be explicit about the caveats here, but for the purposes of creating lists (either study or participant-led) for research purposes it is simple, it distinguishes from foodstuffs consumed as part of meals and is broad enough to incorporate everything an athlete may be taking. The latter point is important; no researcher can guarantee being aware of every possible supplement (permitted or otherwise) available to athletes. Thus, there needs to be some flexibility in approach. Therefore, this is the definition used in studies in the present thesis. However, it is important to review other definitions and taxonomies for comparison.

One alternative is that of the Australian Institute for Sport (AIS), which posits a four-group categorisation system based on the available evidence base for safety and efficacy of specific nutrients. Broadly; substances in Group A have the best evidence and Group D have the least (or are banned)(AIS, 2022). There are just 19 supplements in Group A, divided into 'Sports Foods' (e.g., protein supplements, electrolytes etc), 'Medical Supplements' (e.g. iron, calcium) and 'Performance Supplements' (e.g., creatine, bicarbonate). Notably, all of these are food supplements, that is they represent single sources of substances that can be found in a balanced diet (e.g. protein, creatine), rather than substances that may be used but not typically found in a normal diet (e.g. Ketones – Group B). This categorisation forms the basis of that used within several key papers, especially Garthe & Maughan (2018), (Lazic *et al.*, 2011) and Hurst *et al.* (2021a).

This categorisation is very much open to question. For example, the "Medical supplements" category is defined as "*Used to treat clinical issues, including diagnosed nutrient deficiencies*" (p127), but examples provided were vitamin and mineral supplements. Under the heading of "Other supplements" the AIS group supplements for: Weight loss (shakes, tablets), increased energy, increased libido, prevention of hair loss. Given that weight loss and 'energy boost' products likely contain stimulants (Saper *et al.*, 2004), including some banned under the WADA code or with potentially serious adverse effects (Hoxha & Petróczi, 2015), it would seem important to clearly distinguish these. This suggests the categorisation is perhaps not operationally useful from either a supplement user's or researcher's perspective.

Burke *et al.* (2006) discuss a range of possible taxonomies based on factors such as function, active ingredients, or scientific merit (evidence of efficacy). Whilst some of these may be useful in specific contexts, they all have drawbacks. For example, 'function' requires further definition (biological action or intended use/outcome?), 'main active ingredients' will place supplements with multiple ingredients in several categories simultaneously and 'scientific merit' may not be considered by end-users when choosing what to use and is thus of limited benefit. Burke and colleagues also provide several definitions of supplements for the purposes of their research. They define supplements as meeting one or more of these conditions:

- *They provide a convenient and practical means of meeting a known nutrient requirement to optimise daily training or competition performance (for example, a liquid meal supplement, sports drink, carbohydrate gel, sports bar).*
- *They contain nutrients in large quantities in order to treat a known nutritional deficiency (for example, an iron supplement).*
- *They contain nutrients or other components in amounts that directly enhance sports performance or maintain/restore health and immune function—scientifically supported or otherwise (for example, caffeine, creatine, glycerol, ginseng).*

(Burke *et al.*, 2006, p486)

Whilst these definitions consider patterns of, or drivers for, use (e.g., convenience), they also reference sufficient (or excessive) dosage as being necessary for inclusion. Whether a supplement actually contains labelled ingredients at the specified dose is often debatable as the supplement industry is poorly regulated and numerous quality issues have been identified (Maughan *et al.*, 2011). Equally, end-users may not be aware of appropriate dosages for any given active ingredient, regardless of whether the supplement contains it.

There remains no universally agreed definition or taxonomy of supplements. Extant research therefore requires careful examination when attempting to draw conclusions, as different studies are not all examining the same things. This is especially relevant when attempting to categorise supplements into meaningful groups. The studies by Hurst and Hildebrandt are good examples of this.

Firstly, the categorisation of supplements in both studies is open to question. Hurst *et al.* (2021a) employed the taxonomy elaborated by Garthe & Maughan (2018) with the inherent issues detailed above. The original taxonomy proposes that supplements are "often" grouped in this way, based on their intended use, but offers no empirical evidence to support this categorisation. Also, different types of supplement may be used for multiple different reasons by different people (or the reason may change over time) (Garthe & Maughan, 2018). For example, whey protein is commonly classed as an ergogenic supplement but may simply be used to correct perceived nutritional shortfalls in protein intake. Alternatively, pre-workout supplements frequently contain stimulants (e.g. the banned substance 1,3-dimethylamylamine a.k.a DMAA) designed to enhance training performance but which may also (or alternatively) be used for weight loss. Thus, the taxonomy imposed may not always fit all users.

The work by Hildebrandt *et al.* (2012) employed a novel scale (APED-C) for assessing use of APEDs (both licit and illicit) that asked participants to group their current and prior supplement use into one of three categories ('Health/Wellbeing', 'Muscle Building' and 'Weight loss'). The instrument further asked age of first use for each substance and how it was used (e.g., self-directed, prescribed etc). No details are provided of the development and validation of this instrument. Whilst asking participants to categorise supplements themselves into their intended use may alleviate potential issues around imposed taxonomies, the limited categories available raise questions about the reliability of the categorisation. It also highlights another key issue in this field, that of measurement.

Measures of supplement use can range from a single question (e.g., 'Do you use supplements?') through to complex surveys listing multiple substances. Some ask questions around patterns of use (e.g., reasons for using, frequency of use etc) whilst others ignore these factors. Clearly, a single question, especially one that ignores patterns of use, is open to wide interpretation as to what a “supplement” is and may treat people using vitamins occasionally the same as someone using multiple supplements daily. Multiple reviews of the literature note the heterogeneity of measures used across studies and the lack of properly validated instruments (see e.g., Janiczak *et al.*, 2022; Knapik *et al.*, 2016; Trakman *et al.*, 2016).

The more recent review by Janiczak *et al.* (2022) does note the recent (since 2016) development of validated instruments to assess nutritional knowledge but many of these do not adequately assess patterns of, or motivations for, use of nutritional supplements. The focus of these instruments is assessing athlete knowledge of appropriate nutrition rather than exploring motivations for patterns of use.

One questionnaire that does assess NS use (not included in that review) is described by El Khoury *et al.* (2019). The questionnaire is theoretically grounded in the TPB, and the paper comprehensively describes the validation process for those elements drawn from the TPB (intention, attitudes, injunctive norms, perceived behavioural control and descriptive norms). The questionnaire was employed in a later study exploring determinants of NS use amongst Canadian university students by the same authors (El Khoury *et al.*, 2023). Whilst the TPB elements were clearly validated, the supplement use measure was not. This section was adapted from earlier work (El Khoury & Antoine-Jonville, 2012) which describes the measure as piloted, but without further detail of the validation process. However, they do ask the types (of NS) and frequency of use alongside reasons for use and sources of information. However, the instrument appears to group supplements purely by type (e.g., vitamins/minerals, protein, fatty acids) and includes a category of ‘Meal replacements/Weight gainers’. This last category is problematic; meal replacement and ‘weight gainer’ supplements typically include (at minimum) protein, fat, and carbohydrate sources to provide a balanced source of macronutrients. However, it is entirely possible that they would be used for very different reasons. Meal replacements are common in product ranges aimed at those wishing to lose weight who require accurate calorie intake. Weight gainer products are typically aimed at people wishing to gain muscle. Whilst some may use them interchangeably, it is important to note that differences in motivation for use may reflect a broader difference in approach to supplementation and nutrition that is potentially relevant to later use of banned supplements.

Grouping supplements into categories has benefits from a research perspective as it can facilitate identifying patterns of use, but it should be done with consideration for users' motivations for those patterns. It should also be empirically grounded if it is to have utility across studies. To further understand the relationship between supplement use and doping, it is necessary to explore why athletes choose to use supplements in the first place.

2.5 Supplement Use and Athletes: Prevalence and Motivations for Use

Multiple reasons for using NS have been elaborated, especially around efforts to improve overall nutrition. Athletes use NS in the belief that they offer performance gains and/or address perceived nutritional deficits that may then contribute to improved performance (Maughan *et al.*, 2018a). A high prevalence of NS use is reported in athlete populations with some studies reporting prevalence figures of 60% or more (Knapik *et al.*, 2016; Maughan *et al.*, 2011; Nieper, 2005; Outram & Stewart, 2015). A more recent review Daher *et al.* (2022) shows prevalence figures between 11% and 100% but noted significant diversity in supplement measures. Regardless, evidence shows supplement use is widespread in athlete populations (see e.g., Baylis *et al.*, 2001; Heikkinen *et al.*, 2011; Lun *et al.*, 2012) but with key differences in patterns of use across different groups.

For example; evidence shows greater use of NS at higher competitive levels, as physiological demands increase and performance margins narrow, suggesting that developing/maintaining a competitive edge and optimising performance is a primary driver (Garthe & Maughan, 2018; Knapik *et al.*, 2016) as posited by the IMDB.

More recent evidence suggests age is a significant predictor of NS use, with older athletes using more NS, more frequently, than younger athletes (Graybeal *et al.*, 2023). Some of that use in older athletes appears to be athletes seeking to address perceived physical effects of getting older, whilst younger athletes appeared more likely to see their nutritional intake as sufficient. This was suggested by differences in the *types* of NS taken, with older athletes taking more health and wellbeing supplements (e.g., iron, vitamins etc). Other reasons for age differences included older athletes having more disposable income, but also busier lives (work, families, etc) and thus more able to buy a range of supplements but also possibly less able to find time to prepare balanced meals. Conversely, younger athletes more often reported using various NS because "they were told to" (p612), whereas older athletes tended to report more wide-ranging attempts at sourcing reliable information (e.g., internet, dieticians, coaches etc).

Gender differences are also widely reported, with differences in both types and patterns of use (see e.g., Boardley *et al.*, 2016; Daher *et al.*, 2022; Knapik *et al.*, 2016; Mallick *et al.*, 2023). Typically, males report greater consumption of NS, taking more NS more frequently than females. Conversely, females tend to report more use of health supplements (e.g., vitamins, folic acid, iron) whilst males tend to report more use of protein and ergogenic supplements (e.g., creatine). However, these findings are not universal, with some studies showing greater use in females (e.g., Botelho, 2013; Lauritzen & Gjelstad, 2023; Ziegler *et al.*, 2003).

Differences between sport types have also been reported, with strength and power sports showing the greatest prevalence of NS use (Baltazar-Martins *et al.*, 2019; Lauritzen & Gjelstad, 2023). This should be interpreted cautiously as there are significant differences across studies. For example, Baltazar-Martins *et al.* (2019) report the most prevalent supplement amongst elite Spanish athletes was protein followed by amino acids. The next most prevalent supplements were reported as multivitamins, glutamine, and creatine. Conversely, Braun *et al.* (2009) reported minerals, vitamins, sports beverages, and carbohydrate preparations were most prevalent amongst elite German athletes, whilst protein/amino acids was less prevalent. Both studies had a similar wide representation of sport types, however the study by Baltazar-Martins included bodybuilding and weightlifting, which were not represented in the study by Braun. This may explain the variation in supplement types reported, especially as bodybuilding was the sport with the highest prevalence of supplement use (95%) (Baltazar-Martins *et al.*, 2019).

2.5.1 Nutrition and Supplement Use: Knowledge and Motivations.

Although use is widespread, the evidence base for performance gains from NS is equivocal for all but a handful of supplements (Burke *et al.*, 2006; Schwenk & Costley, 2002) suggesting athletes may not need them if their diet is appropriate to their physical activity (Lazic *et al.*, 2011).

Research clearly shows the importance of optimal nutrition for sports performance (Beck *et al.*, 2015; Bytomski, 2018). Despite this, multiple studies show athlete's nutrition knowledge is often poor (Heaney *et al.*, 2011; Rash *et al.*, 2008; Trakman *et al.*, 2016) and that they frequently fail to meet key macronutrient guidelines (Jenner *et al.*, 2019), or adequately fuel their own dietary needs (Heaney *et al.*, 2011) and that they may use nutritional supplements to overcome these issues (Burke *et al.*, 2006). Guidelines for sport nutrition are complex, but clearly place good quality food as the primary source of nutrition, with supplements to be used sparingly, if at all (American Dietetic Association *et al.*, 2009). Clearly, there is a mismatch between the evidence base on optimal nutrition and athlete's dietary practice.

Why this mismatch exists is difficult to determine with any precision. Systematic reviews on athlete's nutrition knowledge have highlighted issues around variability in research, poor study quality reporting, rendering reliable conclusions challenging. For example, a key issue raised by Trakman *et al.* (2016) was the lack of appropriately validated tools across most studies they reviewed. Those studies that scored well on the validation of the instrument used the "General nutrition knowledge questionnaire". However, as Trakman and colleagues point out, this questionnaire does not assess sports nutrition knowledge and is thus inappropriate for research with athletes. Other measures that did address sport nutrition were not validated and/or contained outdated questions (i.e., not in line with nutritional guidelines at the time). Trakman and colleagues highlight the earlier call by Heaney *et al.* (2011) who reported the same findings, for the development of new, appropriately validated measures to be used. Despite this, no such measures appeared to have been introduced in the five years between reviews, nor since.

Thus, it remains challenging to assess current understanding of sports nutrition knowledge in athletes. However, there is evidence of specific issues in relation to athlete's knowledge of nutrition that hold across studies. In particular, understanding around the relative roles of specific nutrients, especially protein (Jacobson *et al.*, 2001; Trakman *et al.*, 2016), energy density and supplementation (Trakman *et al.*, 2016). These findings somewhat echo those of Jenner *et al.* (2019) in their review of studies examining dietary *intake* in athletes. They reported that most studies showed athletes meeting or exceeding guidelines for protein and fat but falling short on carbohydrate intake.

The association between nutrition knowledge and dietary practice is complex. Research on nutritional education with athletes generally shows a weak, but positive, relationship between knowledge and dietary intake (Boidin *et al.*, 2021). However, it is notable that the literature is again confounded by methodological issues and poor study quality (Sanchez-Diaz *et al.*, 2020). Equally, whilst research tends to show positive changes to dietary habits as a result of education, none of the evaluations examine long-term outcomes, or effects on sport performance (Maughan & Shirreffs, 2012; Sanchez-Diaz *et al.*, 2020). Thus, whilst nutritional knowledge is undeniably important, scant evidence supports improving knowledge alone as sufficient to improve dietary habits.

Beyond knowledge, several other influences on athlete's diet have been noted in the literature. Heaney *et al.* (2008) identified multiple barriers to optimal nutrition cited by athletes, coaches, and dieticians in a qualitative study. Primary reasons cited by all three groups included nutrition knowledge, financial constraints, poor food preparation skills and insufficient time for food preparation. Lesser barriers included concerns about size and weight, perceived as impacting performance by coaches, whereas athletes' concerns were aesthetic. Issues around obtaining optimal nutrition whilst travelling to and from competitions were also raised by coaches and dieticians, but not athletes. Crucially, this review highlights issues around practical skills in applying nutrition knowledge and sporadic adherence to good dietary practice within their cohort. These findings were supported by Bentley *et al.* (2021), who also highlighted issues around practical food skills and aesthetic concerns around body shape, but added the strong influence of athlete's emotions towards food and food preparation as a key influence on dietary practice. For example, emotional responses to their own sport performance could adversely impact motivation. Equally, emotional issues around body image and the monitoring of body composition could act as both a barrier and an enabler to dietary adherence. So again, whilst nutrition knowledge has a clear impact, there are multiple factors that influence an athlete's diet and associated coping mechanisms such as NS use. Research is needed to disentangle these influences and further our understanding of nutritional practices in athletes.

Maughan *et al.* (2018a) cites the following influences on NS use: correcting nutrient deficiencies, convenience, performance benefit – either direct or indirect (e.g., improved recovery from training or injury), financial gain/sponsorship and perceived peer use. Peer groups and other significant people around the athlete (e.g., family, friends, coaches) in particular are highlighted in the literature as a significant influence on supplement use, although the relative influence of each group varies across studies. Denham (2017) reviewed 53 papers examining athlete's information source and reported that a third cited friends and family as a primary source of information on supplements, whilst athlete support personnel (coaches, trainers) were cited equally or more frequently. This echoes other research (Burns *et al.*, 2004; Diehl *et al.*, 2012), although Kristiansen *et al.* (2005) in a study with varsity athletes, cited coaches as the least influential information source.

Research on athlete's knowledge of nutrition and NS is somewhat equivocal due to the same methodological issues elaborated previously (Capling *et al.*, 2017; Knapik *et al.*, 2016; Trakman *et al.*, 2016). However, multiple studies show athlete's knowledge is poor (see e.g., Dunn *et al.*, 2007; Jacobson *et al.*, 2001; Rash *et al.*, 2008; Rosenbloom *et al.*, 2002) and specifically, that athletes often don't understand the roles of specific macro and micronutrients (Jacobson *et al.*, 2001; Jonnalagadda *et al.*, 2001).

Inadequate diets may lead athletes to use nutritional supplements to address perceived nutrient deficiencies (Maughan *et al.*, 2018a) and evidence suggests athletes frequently use supplements without prior consultation with sports nutritionists (Maughan *et al.*, 2007). Athletes often rely on other information sources such as friends, family members and athlete support personnel that may not possess adequate contemporary knowledge (Denham, 2017). Not surprisingly, athlete's understanding of what supplements may be appropriate and how to use them has been shown to be poor (Jovanov *et al.*, 2019), suggesting supplements may sometimes be used unnecessarily.

Athlete's use of supplements therefore appears driven by multiple influences related to their nutrition, physical demands of their sport, lifestyle and significant people and cultures (e.g., sport teams) around them (Maughan *et al.*, 2007).

2.5.2 The Benefits and Risks of Supplement Use

Whilst some sporting bodies allow the use of specific supplements (Maughan *et al.*, 2018a), anti-doping messages tend to stress that supplements should be avoided due to associated health and doping risks (Backhouse, 2023). A 'food-first' approach is most widely recommended, but there is a case for the judicious use of some supplements by athletes in specific circumstances.

Burke *et al.* (2019) report the International Association of Athletics Federations Consensus Statement on Nutrition for Athletics. They are keen to stress that a 'food-first' approach should underpin the athlete's approach to nutrition but recognise several factors that justify NS use. During competitions, athletes may need to eat pre, during and between competitive events, with extremely limited timescales. In such cases it may be impractical to eat food, given (for instance) the time required for digestion. Equally, athletes' may have special dietary considerations such as restrictive diets (e.g. coeliac, vegan) or the environment may create specific challenges to nutrition (e.g., travel, heat, altitude).

Close *et al.* (2022) make a similar case for the use of NS, but extend it with six situations in which a limited range of properly tested supplements may be appropriate; (i) additional intake of specific nutrients that may be difficult to consume in sufficient quantity, especially if limiting intake of other nutrients (e.g. increased protein demand alongside reduced fat intake), (ii) the richest sources of some nutrients may be foods that a specific athlete cannot, or will not, eat, (iii) nutrient content of food generally can be highly variable, this may be especially true when travelling internationally (Beltramo *et al.*, 2023), (iv) nutritional deficiencies, either as a result of general diet or for medical reason, may require more than the usual recommended amount of some nutrients, (v) timing of food intake around training or competition may preclude some foods and (vi) whilst there are legitimate concerns about potential contamination of supplements, the same may also be true of some food stuffs. Consequently, properly tested supplements may in fact offer more food security in specific situations.

Further to these considerations, an evidence base exists for the efficacy and safety of several ergogenic supplements that exist somewhat outside nutrients (e.g. protein) e.g., caffeine, creatine, sodium bicarbonate, beta-alanine. (Burke *et al.*, 2019; Close *et al.*, 2016; Close *et al.*, 2022)

The findings around ergogenic effects are compelling and would clearly be of interest to a high-performance athlete. However, the evidence base is still disparate and should be treated with caution. A comprehensive review on the efficacy of individual supplements is beyond the scope of this review, but it is worth noting issues around that evidence base.

In particular, the focus on individual ingredients and the evidence behind them (e.g., AIS approach) ignores key evidence that may drive use. An International Olympic Committee position statement by Maughan *et al.* (2018a) provides a comprehensive review of the evidence base for various substances and illustrates this point well. When reviewing the evidence for protein supplementation with reference to gaining lean muscle mass, the authors state "Meta-analyses focusing on younger and older participants have shown positive effects enhancing gains in muscle mass, but effects are not large" (p489).

There are two points to consider here; firstly, even small effect sizes may be attractive to an elite athlete when performance margins between competitors are very small. Secondly, whilst gaining lean mass may be a goal for some, for others there may be multiple alternative reasons. For instance, endurance athletes may not want extra mass in competition, but *will* want to meet the increased demand for protein that accompanies endurance training (Martinez *et al.*, 2019; Miller *et al.*, 2022). Equally, elite athletes may require protein intake of up to 2g/kg (bodyweight)/day or more (Jager *et al.*, 2017) but have dietary restrictions (e.g. reducing calorie intake) leading to use of protein supplements as a viable alternative to whole foods. Indeed, some evidence suggests a substantial proportion of athletes can be at risk of nutritional deficiencies due to restrictive dietary practices (Kiertscher & DiMarco, 2013).

Thus, focus on singular outcomes in studies may be misleading, especially when taking a broader view of the evidence. Athletes use supplements for diverse reasons and those reasons may change over time. Evidence for efficacy within narrow contexts may only be part of an athlete’s decision-making. Equally, athletes may be led by aggressive marketing practices that make attractive, but unsubstantiated claims as to the benefits of various supplements (Tiller *et al.*, 2023).

The inherent risks of this are compounded by poor regulatory oversight of the supplement industry generally, and widely varying regulatory frameworks between different countries (Dwyer *et al.*, 2018). Poor oversight of marketing claims and weak enforcement of regulatory frameworks allows manufacturers to ignore robust quality control. This may lead to the inclusion (intentional or otherwise) of harmful ingredients and there is evidence of potential health harms from using supplements (Cohen, 2014; Stickel *et al.*, 2011). The sport supplement industry is, for practical purposes, largely unregulated. Nutritional supplements are deemed by most Western authorities to fall under food legislation and as such, are not required to provide evidence of clinical efficacy. Although manufacturers must avoid making claims of therapeutic benefit, it is incumbent upon the relevant medicines authority to demonstrate if products contain prohibited or unsafe substances (Mathews, 2018).

There is ample evidence of a risk of inadvertent doping via contaminated supplements (Burke, 2000; Martinez-Sanz *et al.*, 2017; Outram & Stewart, 2015). The risk can potentially be mitigated, but not eradicated, through use of supplement brands that subscribe to third-party batch testing programmes such as Informed Sport (de Hon & Coumans, 2007; Garthe & Ramsbottom, 2020). However, Informed Sport stress they cannot test for every banned substance (Informed Sport, 2022), citing the open-ended nature of the prohibited list.

Outside of such programmes, there is ample evidence to show a risk of contamination, with evidence suggesting anywhere from 15% (Outram & Stewart, 2015) to 58% (Martinez-Sanz *et al.*, 2017) of supplements may be contaminated by substances prohibited under the WADA code (WADA, 2020). Multiple studies have reported the presence of anabolic steroids and/or banned prohormones in widely available NS (see e.g., Geyer & Gmeiner, 2015; Geyer *et al.*, 2008; Geyer *et al.*, 2004; Judkins *et al.*, 2010). Determining whether a supplement contains banned substances is clearly challenging. They may list ingredients that athlete's don't realise are banned, or list alternative names for banned substances that athletes don't recognise, or they may contain unlisted banned substances (Burke, 2000; Lauritzen, 2022). Thus, there is a need for tested athletes to exercise caution when using supplements. Article 2.1.1 of the World Anti-Doping Agency Code states "*It is each Athlete's personal duty to ensure that no Prohibited Substance enters his or her body. Athletes are responsible for any Prohibited Substance or its Metabolites or Markers found to be present in their bodily Specimens".* Infractions of this 'strict liability' rule result in an Anti-Doping Rule Violation (ADRV) under Rule 2.1 of the Code, leading to potentially significant sanctions for the athlete (WADA, 2021b). Some provision is made for the possibility of contamination, but it is incumbent on the athlete to take all reasonable steps to ensure any supplement they use is not contaminated (e.g., using tested products) (Lauritzen, 2022).

Given these risks, if we are to understand why athletes continue to use supplements it is imperative that such research should explore this association from the athlete's perspective.

This is particularly relevant to younger athletes developing their athletic career, as evidence shows adolescence to be a critical period for the development of self-regulatory mechanisms relevant to doping, including attitudes, and a period of increased risk-taking (Casey, 2008; Steinberg, 2005a, 2005b) as well as widespread use of supplements (Bell *et al.*, 2004; Jovanov *et al.*, 2019).

2.6 Adolescent Athletes and Risk-Taking Behaviour

Adolescence marks a significant period of development as young people transition to adulthood, a process that may last several years (Arnett, 1994). Adolescence is associated with suboptimal decision making processes and a heightened vulnerability to risk-taking behaviours, including substance use (Casey, 2008; Steinberg, 2005b). Steinberg (2005b) argues this results from a combination of increases in novelty and sensation-seeking and varying rates of development in cognitive and behavioural self-regulatory mechanisms. This is compounded by a transition away from parents as the primary guide for behaviour (Hurrelmann & Richter, 2005). This is especially relevant to behaviour with health risks such as substance use. Such behaviour can have important social functions such as acceptance within a peer group, signifying a break from conventional or parental norms and identification with desired social groups (Hurrelmann & Richter, 2005). Furthermore, adolescents are open to influence from a wide variety of sources, including parents, but especially peer networks and social media, that may lead them to engage in risky or suboptimal behaviour (Dodge & Clarke, 2015; Kucharczuk *et al.*, 2022; Powers *et al.*, 2022).

2.6.1 Influences on Adolescent Nutrition and Doping

Nutrition for adolescent athletes, likely exceeds that of developed adult athletes as it needs to meet the additional demands of physical growth and maturation (Smith *et al.*, 2015). Thus, there is a need for reliable guidance to ensure that at least adequate, if not optimal, nutritional needs are met. However, multiple influences can derail this process, leading the athlete into practices that can impact the athlete's health, including NS use (Steen, 1994).

2.6.1.1 Social Media and Peer-Networks. Kucharczuk *et al.* (2022) reviewed social media influences on adolescent food choices, noting two key findings; firstly that adolescents were "more likely to recall unhealthy food". Specifically, they spent significantly more time looking at unhealthy food advertising than healthy food and were more likely to share such advertising and consume unhealthy food after seeing it, with effects following a dose-response pattern related to time spent on social media. Secondly, that adolescents' preferred celebrity influencers on social media had a significant effect on food choices, regardless of the healthfulness of the foods advertised. These findings echo an earlier review by Chung *et al.* (2021), which also noted the influence of peer-to-peer networks in which advertising by key influencers was shared. Adolescents were more likely to engage with content shared by their peers and to approve of the messages therein. Similar findings have been reported for NS use (Klein *et al.*, 2021), especially with elite professional athletes advertising supplement brands, encouraging younger athletes to use their products (Frison *et al.*, 2013; McDowall, 2007).

2.6.1.2 Parental/Family Influence. Evidence suggests parents (or other family members) are a key influence on adolescent NS use and nutrition in general (Diehl *et al.*, 2012; Mettler *et al.*, 2022). Some evidence suggests parents may be a source for NS (Diehl *et al.*, 2012). Conflicting gender differences are reported, with one study showing female athletes being more likely to cite parental influence as a primary source, and male athletes more likely to cite peers or coach (Froiland *et al.*, 2004), whilst another suggested the reverse (Fralick & Braun-Trocchio, 2019). Regardless, in both studies parents were a primary influence on athlete's use of NS. Denham (2017) also highlights the influence of friends and family, with 11 of the 53 studies reviewed citing them as a primary source of information on NS use and nutrition and eight studies citing parents/family as a source of supply for NS.

2.6.1.3 Athlete Support Personnel (ASP). Denham (2017) further reports the influence of team personnel, with coaches, physicians and dieticians/nutritionists reported as key sources of information. Other studies suggest the coach is the most significant influence on NS use (Diehl *et al.*, 2012; Jovanov *et al.*, 2019). Some research shows NS use as being specifically directed from within the sport; Diehl *et al.* (2012) explored use of NS amongst elite adolescent athletes and noted a small percentage were contractually obliged to use NS.

Some caution is advised when interpreting these findings, as many focus on the *information source*, which may not be the biggest influence on actual behaviour. However, the evidence shows multiple influences and further, that prevalence of NS use in adolescent athletes mirrors, or exceeds, that of adult athletes. Further, evidence suggests worrying levels of doping use and early initiation.

2.6.2 NS and Doping Use in Adolescent Athletes.

Multiple studies examine prevalence of NS use amongst adolescents; figures vary considerably between 14% (Lucidi *et al.*, 2008) and 91% (Diehl *et al.*, 2012) but many studies report figures in excess of 60% (see e.g., Baltazar-Martins *et al.*, 2019; Hoffman *et al.*, 2008; Jovanov *et al.*, 2019; Mettler *et al.*, 2022) showing widespread use, starting at a young age. Reasons for use mirror those of wider research (e.g., improving performance, perceived health benefits, enhanced training recovery) (Hoffman *et al.*, 2008; Mallia *et al.*, 2013; McDowall, 2007; Zelli *et al.*, 2010) but also include associations with body image dissatisfaction (Yager & O'Dea, 2014), a key issue in adolescence (Gualdi-Russo *et al.*, 2022).

With regard to doping, evidence suggests some adolescents, including young athletes, initiate use of banned substances (e.g., AAS) at a young age and that prevalence can be similar to adult populations (Buckley, 1988; Calfee & Fadale, 2006; Stilger & Yesalis, 1999). Equally, evidence shows such use co-occurs with use of ergogenic NS (e.g., creatine) and shows associations with other risky substance use (e.g., alcohol, psychoactive drugs) (Calfee & Fadale, 2006). Other evidence shows a potential gateway effect, with one study showing those reporting use of permitted NS ten times more likely to report use of banned substances in the same time period (Mallia *et al.*, 2013). This is supported by more recent evidence showing significant associations between permitted NS use and use of banned substances amongst adolescents, as well as significant influences from peers (Shah *et al.*, 2019).

Adolescent athletes are clearly open to a range of influences on their nutritional practices and use of performance enhancing substances and therefore vulnerable to potentially harmful misinformation. This may be particularly prevalent in university students, as the difficult transition from adolescence to young adulthood can be compounded by the experience of undertaking a degree (Briggs *et al.*, 2012). Undergraduate students are faced with the need to become self-directed learners, whilst also navigating potential mental health issues caused by social isolation and learning to become independent (Hussey & Smith, 2010). Overcoming such social isolation requires social acceptance by peer groups, thereby lending extra weight to group participation (Cameron & Rideout, 2020; Scanlon *et al.*, 2007).

Sports participation can provide a readily available means to socialise, especially for those students who already participate in sports, but brings with it expectations of conformity to the group (Benson *et al.*, 2016), which could include approaches to nutrition and performance enhancement. Thus, foundations for future behaviour in relation to sports performance may be laid at this stage and as such, it is appropriate to address these issues in research with this group (Backhouse *et al.*, 2009; Backhouse *et al.*, 2012). This is especially relevant here, given the focus within the current study of potential educational interventions to reframe performance enhancement in a manner that avoids the use of doping. As Garthe & Maughan (2018) point out "… indiscriminate use of supplements is a cause for concern and demands educational interventions at an early age for athletes…" (p133).

2.6.3 Educational Initiatives on Nutrition, Supplement Use and Doping

Efforts have been made to address the risks of NS use and doping via educational initiatives, but they are limited in scope and application, and it is difficult to draw conclusions from the literature.

As far as I am aware, whilst there are several examples of educational initiatives in relation to supplement use and nutrition, only two have been widely adopted in their country of origin: 'Athletes Targeting Healthy Exercise and Nutrition Alternatives' (ATHENA) and 'Athletes Training and Learning to Avoid Steroids' (ATLAS), both of which are programmes delivered in scripted sessions across several weeks, aimed at high school children in the USA (Goldberg & Elliot, 2005). Both programmes seek to promote single-gender nutrition and exercise programmes as alternatives to the use of non-prohibited supplements, illicit drugs and doping substances. The programmes primarily seek to reduce incidence, as opposed to preventing initiation of, drug or ergogenic supplement use. The ATHENA programme additionally addresses disordered eating.

Evaluations of the programmes generally show positive effects on reduction of harmful behaviours, drug and NS use and intentions to use anabolic steroids (see e.g. Elliot *et al.*, 2004; Elliot *et al.*, 2008; Ranby *et al.*, 2009; Yager *et al.*, 2019) but are open to criticism. One study examining the ATLAS programme showed significant positive mediating effects of 'peers as an information source', 'team as an information source' and negative effects of 'beliefs in media advertising' on the relationship between the ATLAS programme and nutritional behaviours, post-intervention and at one-year follow-up (MacKinnon *et al.*, 2001). However, the tool used to assess nutrition behaviour is a simplistic 7-item scale featuring items such as "I am aware of the calorie content of the food I eat", "I set goals for my nutrition" and "Over the last few months I have tried to improve my diet". Whilst improvements in these measures could be described as a good thing, they are imprecise and highly subjective and may not, therefore, reflect any meaningful changes in dietary practices. Notably, this same scale is used in other evaluations of the ATLAS project (Goldberg *et al.*, 1996; Goldberg *et al.*, 2000).

Other reviews of these evaluations have noted the effects are extremely small and, in some cases, not statistically significant (Bates *et al.*, 2019; Ntoumanis *et al.*, 2014; Woolf, 2020). Furthermore, Ntoumanis *et al.* (2014) noted the programmes showed a reduction in intentions to use doping, but not doping behaviour. They reasoned the wide content of the programmes may contribute to this, as doping is not specifically targeted. Equally, the programmes sought to reduce intentions and behaviours that were already low pre-intervention (Ntoumanis *et al.*, 2014). It is also noteworthy that these programmes are delivered as scripted lessons by coaches and key students within the team and as such may be open to bias in their delivery and in the reception by students.

Another programme is described by Wardenaar *et al.* (2017) who report prevalence and type of NS use amongst elite and sub-elite athletes who received dietary counselling. They report that athletes who received counselling tended to make 'better informed choices' with regard to the supplements they used (p40). In this context, 'better' refers to supplements that have greater evidence of efficacy. Results varied between groups, with elite athletes using more supplements. This was partly explained by the fact that elite athletes were provided supplements (e.g. energy bars, isotonic sports drinks) by their teams. Dietary counselling appears to have been beneficial, but the evaluation does not address any potential links to doping.

Several systematic reviews examine individual educational interventions designed to improve or assess athlete knowledge around nutrition and supplement use, all of which included College/University athletes. Heaney *et al.* (2011) reviewed 29 studies to determine athlete nutrition knowledge and, where possible, compare it to non-athletes. They further sought to determine the influence of knowledge on nutritional intake. It should be noted here that, whilst there is evidence to suggest positive associations between knowledge and dietary intake, the association is inconsistent and involves other factors (e.g. food preparation skills) besides knowledge (Heaney *et al.*, 2011; Worsley, 2002). Where non-athlete groups were included (*n*=7 studies) athletes generally scored as well (or slightly higher) than comparison groups on nutritional knowledge, except where nutrition students comprised the comparator.

For the remaining 22 studies without comparison groups, athletes generally performed poorly, with mean knowledge scores between 40-50%. Some of these studies assessed sport nutrition knowledge as well as general knowledge, but several did not clarify the questions posed. Worryingly, several studies reported poor knowledge of the role of specific nutrients in relation to athletic performance. For example, athlete's using NS frequently (incorrectly) cited protein and vitamin/mineral supplements as a primary energy source for muscle contraction.

Whilst 19 studies assessed dietary intake, only nine of these examined associations with nutritional knowledge. Heaney *et al.* (2011) report that just five of these show a weak, positive, association (r<.44). Of the remaining four studies, three found no significant correlation and one was unable to confirm the relationship as intake was not assessed in terms of adequacy.

A later review by Tam *et al.* (2019) reported 32 studies that assessed nutrition knowledge (including NS) before and after education interventions, primarily in College/University athletes. They note promising results, with over 85% of studies citing significant improvements in athlete nutrition knowledge post-intervention. However, 28 studies used face-to-face education with group presentations and most (*n*=19) reported less than five hours of actual contact time. These factors limit the wider conclusions that can be drawn as (a) no two studies used the same methodology and (b) evidence suggests effective nutritional interventions should last at least five months (Murimi *et al.*, 2017). Furthermore, only 15% of studies used validated measurement tools, further limiting the wider conclusions that can reliably be drawn. Finally, no assessment was made of actual behaviour in relation to nutrition or NS use in any of the studies and the authors note that "…the level of knowledge increase necessary to promote effective change in dietary behaviours is not well-established" (p1783).

A more recent review by Sanchez-Diaz *et al.* (2020) examined 14 studies to summarise the influence of interventions on nutritional knowledge, eating habits, body composition and performance in team athletes. Relevant to this thesis, ten of these studies examined the influence of interventions on eating habits, nine explored nutritional knowledge and three examined athletic performance. Multiple educational modalities were employed (e.g., sports nutrition lessons, games, workshops, and technological platforms). The authors note that, across the studies athlete's dietary intake was generally improved post-intervention, but some individual studies reported no change. It is difficult to draw conclusions from this as no quantifiable detail is provided. Much the same applies to the assessment of athlete knowledge, with improvements in knowledge reported across the studies but insufficient detail provided to properly assess this change. In particular, for both variables, no indication is provided as to when post-intervention took place. Thus, any positive changes may have been short-lived. Regarding performance, the three studies reviewed showed mixed results, with improvements in some skills relevant to their sport (e.g., 600m running speed, vertical jump height) but not in others.

Finally, two more reviews published in 2021 specifically examined the impact of education interventions on dietary intake (Boidin *et al.*, 2021) and on knowledge, beliefs and practices around use of NS and doping substances (Daher *et al.*, 2021).

Boidin *et al.* (2021) reviewed 22 studies, of which 12 were single-arm studies (no comparison group). Education modalities were face-to-face lectures and individual nutrition counselling with self-report, three-day dietary records the most common dietary assessment. Interventions ranged from two to thirty-nine weeks duration, with just two studies reporting a post-intervention follow-up (6-16 weeks). The number of educational sessions ranged from three to seven over the period of the intervention with total contact time between 1 and 12 hours. Most studies (15/22) assessed dietary intake immediately pre and post intervention, using validated tools. Results across the studies were inconsistent, but generally showed improvement in at least one nutritional parameter (e.g., protein intake) post-intervention. However, where assessed, carbohydrate intake post-intervention frequently failed to meet even basic guidelines. Most studies did not undertake any long-term evaluation, or assess barriers to implementation of the guidelines offered.

Daher *et al.* (2021) reviewed 25 studies, examining the content and effectiveness of interventions specifically aimed at the use of NS and/or doping and primarily conducted with adolescent athletes, nine of these studies addressed NS use. Education modalities included face-to-face, individual counselling, handouts, workshops, although three were conducted entirely online. Studies that examined effects of the intervention on NS use generally reported a reduction in use, however the review lacks detail on both the interventions and (importantly) the evaluations. Furthermore, the review notes significant methodological heterogeneity and poor reporting across many of the studies.

Athlete's knowledge and practices in relation to nutrition have been shown to be poor and may influence their use of non-prohibited supplements (Trakman *et al.*, 2016). The evidence presented above suggests educational programmes may improve athlete's knowledge of nutrition, but the effects on dietary practice are poorly understood, largely due to inconsistent findings (Boidin *et al.*, 2021; Sanchez-Diaz *et al.*, 2020; Tam *et al.*, 2019).

It is clear that use of NS is widespread amongst athletes and more so in higher competitive levels (Knapik *et al.*, 2016). Such use is frequently self-directed and may leave the athlete exposed to unnecessary doping-related risks (Maughan *et al.*, 2007). It seems reasonable therefore, to develop initiatives to leverage athlete's supplement use, address poor dietary knowledge and practices and present appropriate evidence-based use of non-prohibited supplements as an alternative to prohibited substances. However, given methodological issues within the literature, further research is required to determine optimal education modalities, especially in light of the weak relationship between nutritional knowledge and dietary practice. Indeed, most studies are more focused on *knowledge* than *understanding* or whether an athlete is actually able to implement recommendations. This is not to say increasing knowledge has no value per se, there are several different types of 'knowledge' that extend beyond the accumulation of facts (Woolf, 2020). For example, procedural knowledge such as food preparation skills, a known barrier to good nutritional practices (Deslippe *et al.*, 2023). However, for most of the studies reviewed here, 'knowledge' is characterised as just factual knowledge.

The lack of reliable long-term evaluations of these programmes is an issue. If education and assessment focus purely on factual knowledge via information provision, and evaluation is conducted shortly post-intervention, then the evaluation is, in practical terms, little more than a recall test. Memorising and reciting information does not equate to understanding, or to the ability to put that information to practical use (Hanson, 2009). The effectiveness of an educational intervention should lie in its ability to make positive, sustained, changes in behaviour, which requires understanding *and* skill acquisition. Evidence for factors that can influence this can be found outside athlete-centred research.

Murimi *et al.* (2017) reviewed 40 studies in adults over 18, to determine the efficacy of educational interventions in creating behaviour change. Studies that failed to achieve behaviour change were excluded. Educational modalities were more varied than those described previously. The majority (*n*=27) employed a single type of intervention (e.g. home education with registered dieticians), but the remainder employed multiple intervention types (e.g., education, cooking classes, exercise classes etc). Longer duration studies (> 5 months) generally had greater success in achieving dietary change, especially when using multiple modalities. Equally, studies that were very focused (<3 key objectives, e.g., eating more vegetables and lowering saturated fat intake) also tended to achieve greater success than those with multiple objectives. Finally, studies rooted in theory (e.g. TPB) also tended to show greater success. Importantly, several studies had long post-intervention evaluations to determine whether the behaviour change held over time.

The use of multiple modalities, including practical skills, clearly has benefits and may address other barriers (besides nutrition knowledge) to good dietary practice raised in athlete-centred literature (Deslippe *et al.*, 2023; Heaney *et al.*, 2008). However, multiple modalities require multiple facilitators with appropriate expertise and necessarily involve greater time and financial commitment (Murimi *et al.*, 2017). These factors may be prohibitive within the context of organised sport, given the reliance that many federations have on external funding (UK Sport, 2023). However, there appears to be a need for greater investment, both financially and intellectually, to achieve effective results and current educational initiatives largely appear to fall short.

2.6.4 Lessons from Anti-Doping Education

A key feature of the education studies reviewed above is that they are generally developed, and implemented, within the context of academic research. It is worthwhile briefly examining relevant evidence within the context of broader anti-doping education.

In recent years, WADA has increasingly emphasised the need for anti-doping education for both athletes and athletes support personnel. Starting in 2015 with the introduction of Article 18 into the World Anti-Doping Code, that states “All Signatories shall within their means and scope of responsibility and in cooperation with each other, plan, implement, evaluate and monitor information, education, and prevention programmes for doping-free sport.” (WADA, 2014, p96). According to the Code, information programmes should provide basic information on a specific subject list (e.g., prohibited list, doping control procedures), education programmes should focus on (doping) prevention and prevention programmes should be values-based and have “…a particular focus on young people through implementation in school curricula” (p96).

More recently, WADA launched the ‘Anti-Doping Education and Learning Platform’ (ADEL) in 2018, a centralised e-learning platform for athletes and athlete support personnel. Subsequently, in 2019, they launched the International Standard for Education (ISE), a technical document intended to align education across Code signatories (WADA, 2021a).

These efforts have been bolstered by the legal framework provided by the International Convention against Doping in Sport. Introduced by UNESCO in 2005, it commits signatory states to supporting the anti-doping efforts of WADA and Code signatories. Writing prior to the introduction of the ISE, Houlihan (2008) notes that achievements (the Code and UNESCO ratification) underline both the gravity of doping, but also the importance of elite sport. Hosting major sporting events and/or being represented on the world stage by elite athletes is a good way to raise the profile of a country internationally and can also be lucrative, for both governments and businesses within the country (Houlihan, 2008). Clearly, even just allegations of cheating can be detrimental to these causes and can tarnish a country's reputation. A recent example of this is, of course, the Russian doping scandal at the Sochi Olympics in 2014, leading to numerous athletes being banned and, eventually, Russia being banned from sending athletes to the 2018 Winter Olympics. Thus, there is a need for robust anti-doping education for athletes and support personnel, and one would assume that developments in the past decade have progressed substantially to achieve this aim.

However, a common finding across evaluations of anti-doping education, even in recent times, is that athlete's understanding of anti-doping is generally quite poor (Woolf, 2020). The most widely adopted and well evaluated programmes are ATLAS and ATHENA, that show effects across multiple measures, but how meaningful these effects are in real terms is at best questionable. Woolf (2020) notes early evaluation reports used self-assessed knowledge (a scale anchored with items such as "Good knowledge", "Very correct", "Poor knowledge"). A subsequent follow-up study reported significant increased knowledge on the effects of anabolic steroids but, as Woolf points out, in real terms these increases amounted to participants increasing their score from 59.1% to 60% (less than two additional correct answers on an 18-item quiz). Similar findings are reported across other evaluations and other programmes. The threshold for excellence in assessed work at the University of Birmingham is a grade minimum of 70%, the results above would qualify as (barely) crossing the boundary between "Sound" and "Good" grades. From an education perspective this is not resounding support and could arguably be held up as evidence the programme is in need of improvement, either in content or delivery.

Several reviews have considered anti-doping education literature in an attempt to determine specifics of modality design, content and delivery that proved most effective. Conclusions should be treated with some caution, as Backhouse *et al.* (2007) note, programmes frequently report success in changing attitudes or intentions, but where drug use behaviour is measured, it is rarely positively changed in any meaningful or significant way. Equally, there is a dearth of long-term follow-up studies determining whether any changes persist over time. In short, literature on anti-doping education presents the same issues elaborated earlier with nutritional education. Further, little attempt has been made within those studies to elaborate what aspects of the programme were most useful in achieving positive outcomes.

There are, however, lessons to be learned from these reviews, that resonate with findings from the nutrition literature. Backhouse *et al.* (2007) suggests longer educational periods with multiple sessions employing a multi-faceted approach and with a focus on participant ownership/involvement in the programme (e.g., peer-led teaching or homework) are key to a successful programme.

Woolf (2020) highlights the need for theory-driven approaches to education, noting that some programmes (e.g., ATLAS/ATHENA) have been grounded in established theory such as Social Learning Theory (Bandura, 1977), Theory of Planned Behaviour (Ajzen, 1991) or the Health Belief Model (Janz & Becker, 1984). A sound theoretical grounding provides an evidence-based platform for programme design and facilitates logical exploration of the mechanisms by which the programme achieves its goal.

Hauw (2016) notes the need to ensure education is relevant and incorporates the individual's lived experience, echoing earlier work by Hanson (2009). Neither support the simple provision of information, preferring to focus on meaning within the content and contextualisation; making education relevant to the athlete's experience, as educational tools. Hanson suggests a constructivist approach to develop the learner's understanding and engagement with contextual knowledge. He uses examples from ATLAS and ATHENA programmes that feed into this approach, notably the peer-led, small-group work and gender specific nature of each programme.

However, Hanson notes a common criticism of this is the sense of "the blind leading the blind". In other words, being led in discussions about drug use by people with no more lived experience of such use than the students, essentially means being reliant on the facilitator's interpretation of the materials. This is not to say that such programs should be delivered by people with, for example, direct experience of doping. Rather, that the facilitator should ideally have an in-depth understanding of both the content and the lived experience of the students.

This, as Woolf (2020) points out, is a fundamental issue with such programmes; the creator of the programme necessarily cedes control of delivery, leaving content open to interpretation, or delivery in the absence of genuine understanding. Regarding ATLAS and ATHENA programmes, Hanson notes that "…there is no way to know how the interaction pattern unfolds during the programme activities or the extent to which the athletes are supportively pushed to articulate their beliefs and to challenge the espoused beliefs of others. There is a possibility that many of the athletes may simply be learning the right thing to say in the context of a drug education programme" (p402). This is a significant issue considering the self-report nature of evaluation studies. This doesn't mean such modalities are inherently flawed, the issue here is that we currently have no conclusive evidence one way or the other.

It's important to briefly note that there is a place for memorisation of facts. Athletes are expected to know anti-doping rules and procedures, in particular, the list of possible ADRVs, and lists require memorisation. But evidence from reviews clearly shows the need for modalities that extend beyond information provision to address more complex and nuanced elements such as risk factors for doping. Backhouse *et al.* (2009) describes several factors that should be incorporated:

- Targeted at young people and adolescents when attitudes and values are being formed.
- Tailored to fit the target population (e.g., risk factors, developmental).
- Interactive and emphasising active participation (e.g., role-plays, discussions).
- Derived from social influence approaches and focused on developing core life skills (e.g., communication, decision-making, refusal skills) as knowledge dissemination alone is ineffective in changing behaviour.
- Monitored and delivered with high degrees of fidelity, ensuring that programme implementation is as directed.
- Delivered by well-trained individuals.
- Booster sessions delivered over a number of years. This reinforces and builds on intervention messages.

Thus, broader anti-doping education that seeks to both prevent certain behaviours and, where appropriate, foster behaviour change, can offer insight to inform education around nutrition and supplement use.

However, the present review is concerned with associations between athlete nutrition, supplement use and doping. Whilst providing information on managing the risks of nutritional supplements is specifically required within Article 18 of the Code (WADA, 2014), there is no mention of nutritional advice for athletes. Some individual NADOs offer their own approaches, but provision is highly variable. UK Anti-Doping (UKAD) offers resources via their website including downloadable information for educators that include cookery lessons as activities. The obvious issue here of course, is that educators (and possibly athletes) need access to resources to implement these, as well as someone with appropriate competence to deliver them with fidelity. Supplement risks are frequently highlighted but with very little detail beyond generalised warnings about possible contamination and reminders that the athlete is responsible for what is in their body.

By contrast, US Anti-Doping Agency (USADA) offers detailed examination of supplements and ingredients as well as food alternatives (although, this includes use of olive oil as an alternative to a growth hormone boosting supplement, with no evidential basis). They also address issues such as food timing by offering suggestions for meals that can be taken at various points before and after a competitive event. However, the suggestions are just lists of foods that could be combined with cursory information on the calorific value of those foodstuffs and no guidance on preparation.

These are just two examples, but for an athlete with little or no understanding of nutrition and supplements, with limited access to appropriate education, these resources offer little value. Further, the scant (and sometimes incorrect) information provided suggests athlete nutrition is of little importance to anti-doping agencies and that supplement use should just be avoided. The latter may be a safe approach but is clearly not the approach taken by most athletes and as such, it could be argued that anti-doping education is lacking. This is perhaps unsurprising given their focus on doping prevention, but it does suggest a need for development of anti-doping education that recognises the importance of athlete nutrition and how (and why) supplement use may play a role in that.

This latter point is discussed in the qualitative work in Chapter 5, within the framework of athlete's views on nutrition, supplement use and possible gateway effects. Chapter 1 of this thesis provided an overarching view of the methodology for that work and I will now provide a review of relevant literature for the analytical approach.

2.7 Analysing the Data: Reflexive Thematic Analysis

Qualitative data analysis in this thesis employs a reflexive thematic analysis (RTA) approach, as described by Braun & Clarke (2019). As noted by Braun & Clarke (2020), thematic analysis (TA) generally can be described as sitting on a continuum, with the stricter coding reliability approach at one end, RTA at the other and the 'codebook' approach (e.g., template analysis) somewhere in between.

The coding reliability approach has a focus on the 'accuracy' of the coding process, usually via use of a structured codebook, multiple coders and quantitative measurement of inter-rater reliability such as Cohen's Kappa (Guest *et al.*, 2012). By contrast, the reflexive approach of Braun & Clarke takes a more flexible approach to coding. Broadly, they argue that the process of trying to ensure 'accuracy' in coding suggests themes exist in the data prior to coding and that the analytical process serves to evidence these themes (Braun & Clarke, 2021). Essentially, the coding reliability approach seeks to overcome presumed subjectivity on the part of the coder, something that has been presented as a source of bias.

However, as Gough & Madill (2012) eloquently argue, not only is minimising subjectivity challenging, if not impossible, there are cogent arguments for viewing such subjectivity as a resource to enrich research. In particular, and relevant to the present thesis, the reflexive researcher positions their subjectivity both within the analysis and even earlier, within the process of data collection. They understand and value their own experiences relevant to the phenomena under investigation (Braun & Clarke, 2019; Gough & Madill, 2012).

In the present context, I have extensive experience relevant to the subjects explored in the qualitative studies. I have used supplements and explored multiple approaches to nutrition in relation to my own sport-related performance, in previous roles I have trained with numerous athletes and interviewed them about their approaches to exercise, nutrition and use of supplements, including use of banned substances. I have designed and delivered training programmes on the use of anabolic steroids and related substances for healthcare professionals, law enforcement, prison staff and pharmaceutical companies and I have extensive experience acting as an expert witness in legal matters in this field. It seems somewhat redundant, possibly even farcical, to attempt to deny the influence of the many years those experiences represent. My own experiences around nutrition, supplement use and training undoubtedly facilitated conversations with my participants, and it seems nonsensical to suggest those interactions did not influence the conversations in some way.

It is important to note that some are critical of the use of 'reflexivity', suggesting the many diffuse meanings render the term somewhat moot (Lynch, 2000) however, I would argue that such a position can be countered by allowing a different perspective. Pels (2000) addresses the question of "who is reflexive for the reflexivists? (p17)" and highlights the need for distributive reflection; the use of critical friends. I was fortunate to have exactly that in my supervisor.

Thus, the reflexive approach of Braun & Clarke seems ideally suited to the qualitative explorations I undertook in the present thesis. The 'codebook' approach that sit somewhere between RTA and the reliability approach, whilst offering a somewhat structured middle ground, does not seem suited to these enquires for much the same reasons the reliability approach does not. I did not seek to find evidence for extant themes, but rather, to find patterns of shared meaning (Braun & Clarke, 2019) whilst recognising how my own experiences are situated within those patterns.

2.8 Chapter Summary

This chapter explores diverse factors relevant to the association between supplement use and doping to underpin the exploration of the IMDB that is central to this thesis. The IMDB offers a novel refinement of the gateway model that allows for a more nuanced exploration of the drivers behind supplement use and their relationship to doping but is currently untested. Exploring the IMDB requires longitudinal research that also facilitates exploration of a key tenet of the gateway model (sequential effects), commonly highlighted as in need of exploration.

There are, clearly, relationships between supplement use and doping, especially via attitudes to doping and the possibility of contamination with banned substances, although these relationships remain ill-defined. Despite these risks, prevalence of supplement use amongst athletes is high and higher still amongst elite athletes. There are multiple drivers for this, some of which could be argued to be entirely justifiable from the athlete's perspective, especially given the enhanced nutritional demands of elite sport and constraints of training and competitive schedules. Other drivers, such as poor nutrition knowledge, poor understanding of the risks of supplement use, lack of understanding around what supplements may be beneficial and how, or lack of practical food preparation skills, could be addressed via meaningful education interventions that empower the athlete to make informed decisions. However, there are methodological issues with research on this, especially around athlete nutrition. In line with calls to make education relevant and appropriately contextualised, there is a need to explore athlete's use of supplements from the athlete's own perspective and to further explore what they feel would be the best approach to address inherent issues and motivations around supplement use and nutrition.

In sum; this chapter has argued that extant research on the associations between supplement use and doping, whilst compelling, lacks longitudinal research testing the supposed causal effects. Related, doping attitudes have been a bedrock of doping research, but have largely been confined to (and not distinguished between) moral attitudes towards doping behaviour, rather than functional processes of performance enhancement. Finally, evidence has been presented that the use of supplements is widespread in athlete populations, with multiple and sometimes justifiable drivers for such use, especially related to poor athlete nutrition. Education on athlete nutrition is highly variable, despite its importance to performance and health and as such needs refinement, especially in relation to supplement use. Whilst there is evidence to show effective elements of educational modalities, there is little research that explores these issues from the athlete’s own perspective.

Chapter 3: Scale Development

This chapter describes the development of two scales used in Chapter 4. The first scale is the Functional & Moral Doping Attitudes Scale (FMDAS) and measures functional and moral doping attitudes. Early development of this scale was conducted by Professor Andrea Petroczi as part of her PhD (Petroczi, 2002). This chapter reports the further development of that scale. The second scale measures use of nutritional supplements, over-the-counter medications and performance enhancing substances and was developed from work by Boardley *et al.* (2016). Development of the FMDAS scale is presented below in section 3.1 and development of the supplement use measure is presented in section 3.2.

3.1: Functional and Moral Doping Attitude Scale (FMDAS): Scale Development

We sought to develop a scale measuring distinct functional and moral doping attitudes. Development of the scale built on the tenets of the IMDB (Petróczi, 2013a), the dynamics of reasons for and against doing things (e.g., Westaby, 2005) and a hypothesised relationship between functional attitudes towards performance enhancement (as a behaviour), functional attitudes towards performance enhancement (as a goal) and moral attitudes ("internalised social values regarding the expected performance and behaviour" (Petróczi, 2013a: p157)).

3.1.1: Preliminary Item Set

Development and piloting of the initial item set was completed by a Professor with extensive experience in the field of doping research, including the development of perhaps the most widely-used doping attitude scale (PEAS (Petroczi, 2002)).

The preliminary item set included 11 candidate items to measure functional attitudes (FDA) and 9 items to measure moral doping attitudes (MDA) (Petroczi, 2002). For each construct, items were arranged as two sub-scales. The first sub-scale includes statements about the behaviour, rated on a 6-point scale anchored between strong disagreement (-3) and strong agreement (3). The second evaluated the importance, using a 6-point scale anchored between extremely undesirable (1) and extremely desirable (6).

Exemplar items taken from Petroczi (2002) are provided in Table 3.1.

Table 3.1 Examples of Preliminary Item Set for the FMDAS Scale

Functional-focus Doping Attitude (FDA)	
Behaviour: Achieving an athletic goal	**Evaluation of the importance of the outcome**
FDA1(a1) Using doping can make my results better	FDA1(A1) Making my results better is…
FDA2(b1) If I use doping I will remain competitive	FDA2(B1) Remaining competitive for me is…
Morally-framed Doping Attitudes (MDA)	
Behaviour: Breaking the rule/cheating	**Evaluation of the importance of the outcome**
MDA1(a2) Using doping is morally wrong	MDA1(A2) Doing what is morally right for me is…
MDA2(b2) Using doping gives unfair advantage	MDA2(B2) Gaining unfair advantage for me is..

Attitude scores for each sub-scale were first created by multiplying the behaviour score and its importance to the individual. Scores were then added together for each construct independently. [FDA = (a1 x A1) + (b1 x B1)+...(k1 x K1); MDA = (a2 x A2)+(b2 x B2)…(j2 x J2)]

Further development by Petroczi led to the item sets used in the present study, which comprised ten items in the FDA scale and seven items in the MDA scale, each with, as previously, two sub-scales. A full list of the first item set used in the present study is provided in Table 3.2. This table is taken directly from the original work by Petroczi (2002).

Table 3.2 First Item Set for Development

Functional-focus Doping Attitude (FDA)

		Behaviour: Achieving an athletic goal		Evaluation of the expected outcome
FDA1	a1	Using doping can make my results better.	A1	Making my results better is...
FDA2	b1	If I use doping, I will remain competitive.	B1	Remaining competitive for me is…
FDA3	c1	If I use doping, I will not know what I am capable of without drugs.	C1	Knowing what I am capable of for me is...
FDA4	d1	Using doping can help to improve my athletic performance.	D1	Improving my athletic performance is…
FDA5	e1	If I don't use doping, I will not benefit from my hard work and training as much as I want to.	E1	Getting return on my hard work and training for me is...
FDA6	f1	Using doping will not help me train hard. (R)*	F1	Training hard for me is...
FDA7	g1	Using doping after injury will not aid my recovery. (R)*	G1	Recovering fully and quickly after injury for me is ...
FDA8	h1	If I refrain from using performance enhancing drugs, I can see the results of my natural ability. (R)*	H1	Seeing how far my natural talent can take me is...
FDA9	i1	If I use doping, I will be a more competitive athlete.	I1	Being a competitive athlete for me is...
FDA10	k1	If I increase my performance with doping, my income will be higher.	K1	Increasing my income for me is....

Morally-framed Doping Attitude (MDA)

		Behaviour: Breaking the rule/cheating		Evaluation of the expected outcome
MDA1	a2	Using doping is morally wrong.	A2	Doing what morally right for me is...
MDA2	b2	Using doping gives unfair advantage.	B2	Gaining unfair advantage for me is… (R)*
MDA3	c2	If I use doping, I will feel I cheat.	C2	Cheating for me is... (R)*
MDA4	d2	If I use doping, I will not harm others. (R)	D2	Harming others for me is... (R)*
MDA5	e2	Using doping is not against the spirit of sport. (R)	E2	Keeping the sport clean of drugs for me is...
MDA6	f2	Using doping is against fair play.	F2	Fair play for me is...
MDA7	h2	If I use doping, I will violate the anti-doping rules.	H2	Adhering to the anti-doping rules for me is...

*R denotes reverse-scored items

Development of the scale was conducted using the two datasets collected during the present doctoral programme. Exploratory factor analysis (EFA) was used to explore the factor structure of the two sub-scales (FDA and MDA). Some researchers have suggested EFA is only appropriate when the underlying factor structure is not known (Biddle *et al.*, 2001) and that confirmatory factor analysis (CFA) is preferable when testing *a priori* structures (Tabachnick & Fidell, 2007). Unlike EFA, CFA tests *a priori* factor structures defined by the researcher, with items fixed to pre-determined factors based on theoretical factors and (often) the results of EFA analyses. CFA allows assessment of the model fit, based on a number of fit indices and thereby, confirmation of the factorial structure (Hair *et al.*, 2009).

Although the preliminary development work included factor analysis, details of those analyses were not available. Given the aim to develop the scale, we chose to continue to development on the basis that factor structures were not confirmed and to therefore test factorial validity via EFA and CFA. The two-wave dataset was therefore used to test factor structure via EFA and then again to confirm via CFA. The three-wave dataset was then used for further confirmation via CFA. As our goal was to retain the best indicators of the underlying latent variables, each scale was examined individually (Jöreskog, 1993).

3.1.3 Method

Participants

Sample 1: Two Wave study Participants were UK university-athletes (*n* = 180, 73.3% male) competing in cricket (n=28), water polo (n=20), soccer (n=17), swimming (n=17), rugby (n=16), field hockey (n=14), martial arts (n=13), gymnastics (n=12) or other sports (n=43). At baseline 140 athletes (77.8%) were aged between 18-20 years, 39 (21.7%) were aged between 21-23 years and one (0.5%) was aged between 24-26 years. Twenty-nine (16.1%) athletes had been playing their sport for less than one year, 27 (15%) had played it for 1-3 years, 34 (18.9%) had played it for 4-7 years and 90 (50%) had played their sport for more than 7 years.

Sample 2 (Three wave study) Participants were UK university-athletes from the first author's home institution (*n* = 205, Male = 51.2%) who competed in rugby (*n*=75), netball (*n*=40), triathlon (*n*=22), soccer (*n*=18), field hockey (*n*=15), boxing (*n*=11) and other sports (*n*=24). At baseline, 141 athletes (68.8%) were in the 18-20 age group, 56 (27.3%) in the 21-23 age group, four (2%) in the 24-26 age group, three (1.5%) were between 27 and 29 years old and one (0.5%) was between 30 and 32 years old. One-hundred and twenty-two athletes (60%) had played their main sport for over seven years, 35 (17.1%) for between 4-7 years, 36 (17.6%) between 1-3 years and 11 (5.4%) had played for less than one year.

Procedures

Ethical approval was granted by my institution. For Sample 1 (Two-wave), I attended sports clubs' training sessions, with prior approval from coaches, at my home institution to recruit participants. With the aid of local contacts from two other British universities, I also recruited athletes from Years 1 and 2 undergraduate lectures at those institutions. Recruitment at all three universities followed the same protocol. A briefing session was delivered to invite participation and provide opportunity for potential participants to ask questions. Student athletes who expressed an interest were provided with an information sheet and asked to sign a consent form prior to completing a questionnaire (Time Point 1: October/November 2018). I then contacted participants via gatekeepers to complete a follow-up survey

(Time Point 2: March/April 2019). The time lag enabled examination of changes in supplement use and attitudes across a competitive season. Data were collected via paper-based questionnaires. A few participants who were not able to participate at TP2 completed an identical online questionnaire instead. Changes in group formations across different semesters (e.g., modules or teams), especially at the other universities, compromised access to participants. The sample for analysis therefore comprised the 180 athletes who participated at both time points. This represents an attrition rate of 42.9% from the 315 participants at Time Point 1.

Recruitment for Sample 2 (Three-wave) was conducted under the same ethical approval and entirely at my home institution. I contacted team coaches and student team members to act as gatekeepers. Gatekeepers maintained contact with the cohort between data collections, overcoming the access issues seen with Sample 1 and greatly reducing attrition.

Data were collected at three time points (October 2020, January 2021, April 2021) to span a full competitive season. Data collection at Time Point 1 (TP1) used the same paper-based approach used with Sample 1 (Two-wave). However, due to Covid-19 pandemic restrictions, data collections were moved online for TP2 and TP3. Participants were contacted through gatekeepers, via email, to arrange data collection. The questionnaire used at TP1 was transcribed to an online format using LimeSurvey software. I then emailed participants with details of the survey and an access link.

Measures.

The survey instrument included several measures, besides the FMDAS items previously described. A copy of the full questionnaire can be found in the Appendix.

Doping Moral Disengagement (DMDS) The Doping Moral Disengagement Scale (Boardley *et al.*, 2018) was used to assess athlete's moral disengagement. Athletes were presented with 18 items and asked to indicate agreement with each one on a Likert scale anchored between 1(*Strongly disagree*) and 7(*Strongly agree*). Exemplar items include "Risks associated with doping are exaggerated" and "Doping doesn't really harm anyone else". Higher scores indicate greater moral disengagement.

Doping Self-Regulatory Efficacy (DSRES) The six-item Doping Self-Regulatory Efficacy Scale (Boardley *et al.*, 2018) was used to assess athlete's ability to resist doping influences. Participants were presented with items such as "Resist doping if you knew you could get away with it…?" preceded by the stem "*How confident are you in your ability to….*". Participants responded on a Likert scale anchored between 1(*No confidence*) and 7 (*Complete confidence*). Higher scores indicate greater self-regulatory efficacy (SRE).

Performance Enhancement Attitude Scale (PEAS) The PEAS scale (Petróczi & Aidman, 2009) was administered to assess doping attitudes in the second and third wave of the three-wave study. Participants were presented with a series of 17 statements, such as "Doping is necessary to be competitive" and "Doping is not cheating since everyone does it" and asked to indicate agreement on a Likert scale anchored between 1 (*Strongly disagree*) and 6 (*Strongly agree*). Higher scores indicate more positive attitudes towards doping.

3.1.4 Results

Preliminary Analyses

Before assessing factor structure, several steps were undertaken to select items that proved most effective at measuring the underlying constructs. First, in line with the recommendations of Nunnally & Bernstein (1994), items in each sub-scale with corrected item-total correlations <.30 were excluded from analysis. Secondly, exploratory factor analysis (EFA) was conducted on each sub-scale in its raw form and on the computed items previously described.

3.1.4.1 Factorial Validity. Where possible (and conceptually sound), it is preferable to select the most parsimonious solution (Hair *et al.*, 2009; Kline, 2005). I therefore wished to test whether the computed items, incorporating the Evaluation sub-scale, produced a more satisfactory solution than individual subscales. Essentially, this tested whether including these subscales was necessary and added anything meaningful to the scale. These analyses were conducted using principal axis extraction with oblique rotation as the constructs under investigation were assumed to be unidimensional for each sub-scale. Sample size recommendations suggest that between 5-10 participants per scale item is appropriate (Bentler & Chou, 1987), thus the sample size of 180 is acceptable for both the 11-item FDA and the 7-item MDA scales. Extraction was based on eigenvalues > 1 and factor loadings of 0.3 or above (Hair *et al.*, 2009).

Based on these analyses, it was decided to remove the evaluation subscales from scale items. The computed items performed poorly compared to individual subscales and scale items within the evaluation subscales on their own, did not measure the constructs of interest. Analyses continued using just the importance scales for FDA and MDA. Based on these analyses, items with minimum factor loadings of .40 were selected for subsequent analysis. This process resulted in four items for FDA (FDA1, FDA2, FDA4, FDA10) and three for MDA (MDA1, MDA2, MDA3). Factor loadings for these items are shown in Table 3.3.

Table 3.3 EFA Factor Loadings for FDA and MDA

Item Number	Item	Factor Loading
	Functional Doping Attitudes	
FDA1	Using doping can make my results better.	.92
FDA2	If I use doping, I will remain competitive.	.64
FDA4	Using doping can help to improve my athletic performance.	.77
FDA10	If I increase my performance with doping, my income will be higher.	.51
	Moral Doping Attitudes	
MDA1	Using doping is morally wrong	.62
MDA2	Using doping gives unfair advantage.	.87
MDA3	If I use doping, I will feel I cheat.	.81

Confirmatory Factor Analyses

Confirmatory Factor analyses (CFA) were conducted using EQS v6.2, first on Sample 1 data and then Sample 2 to further test and confirm factor structure. Based on guidance in Bentler (2007), we used

Chi-square (χ^2), comparative fit index (CFI), standardised root mean square residual (SRMR), and root mean square error of approximation (RMSEA) to assess model fit.

A small and nonsignificant χ^2 is considered ideal, however chi-square can be sensitive to sample size and as such, small sample sizes may retain a significant chi-square (Kline, 2005). To overcome this, the use of χ^2/degrees of freedom ratio is suggested, with values between 1-3 considered acceptable (Cole, 1987; Kline, 2011). Acceptable values for other indices are CFI $\geq$.90 and RMSEA/SRMR $\leq$ .08 which indicate adequate model fit, whereas CFI $\geq$.95 and RMSEA/SRMR $\leq$ .05 indicate good model fit.

For Sample 1, the model showed an acceptable fit (χ^2 (12) = 15.45, p = ns; CFI = 1.0, RMSEA = .08, SRMR = .04). For Sample 2 the model also showed an acceptable fit (χ^2 (12) = 34.40, χ^2/df = 2.9; CF1 = .98, RMSEA = .08, SRMR = .03). Factor loadings for the two analyses are presented in Table 3.4.

Table 3.4 CFA Factor Loadings for FDA and MDA scales

Scale Item	Factor Loading Two Wave Data (Sample 1)	Factor Loading Three Wave Data (Sample 2)
FDA 1	.96	.93
FDA 2	.59	.78
FDA 4	.79	.88
FDA 10	.51	.47
MDA 1	.58	.93
MDA 2	.95	.98
MDA 3	.82	.89

3.1.4.2 External Validity. To evaluate concurrent, convergent and discriminant validity and stability over time of the novel instrument, a series of existing, validated, instruments were administered alongside the FMDAS scale for comparison. These included measures of moral disengagement, self-regulatory efficacy, and doping attitudes. Only the final three-wave dataset was selected for these comparisons as it offered the opportunity to compare measures at three different time-points with the same participant group to test stability over time.

Data analysis for validity and reliability was completed using SPSS v29. Pearson bivariate correlations were used to provide evidence for validity, following the approach of Boardley *et al.* (2018).

For parsimony we used the mean scores of variables across all three time points to provide evidence for these elements of validity. Results of these analyses and Cronbach's alpha for each scale are presented in Table 3.5.

Concurrent validity was examined by computing correlations between scores for the two FMDAS sub-scales and scores obtained with existing validated measures that assess theoretically associated constructs (Godwin *et al.*, 2013). In the present context, the FDA and MDA scales were correlated with the DMDS and DSRES. Higher scores on the DMDS represent greater moral disengagement (increased doping risk) and as such we would expect the FDA to be positively correlated and the MDA to be inversely correlated. Conversely, as higher scores on the DSRES represent greater resistance to doping, we would expect these correlational relationships to be reversed. Our findings were consistent with these expectations, as reported in Table 3.5. FDA showed a moderate, positive correlation with DMDS and a weak negative correlation with DSRES. Conversely, MDA showed a moderate negative correlation with DMDS and a weak positive correlation with DSRES.

Convergent validity can be examined by correlating scores with a new instrument, with those obtained from and existing validated instrument that measures a similar construct (Godwin *et al.*, 2013). For this, scores from the FDA and MDA sub-scales were correlated against scores from the PEAS, an existing measure of doping attitudes that doesn't distinguish between functional and moral attitudes. Given that higher PEAS scores represent more positive doping attitudes we would expect scores from the FDA to be positively correlated and scores from the MDA to be negatively correlated. Consistent with these expectations, scores from the FDA were moderately positively correlated with PEAS scores, whilst MDA scores were strongly negatively correlated (Table 3.5).

Discriminant validity is examined by looking at whether measurements that are not supposed to be strongly related, are in fact not strongly linked (Hodson, 2021). For this we examined correlations between scores from the FDA and MDA to ensure they were not strongly correlated. We also examined correlations with the PEAS to ensure they were not too strongly correlated (e.g., > .70). Results showed small to moderate correlations with PEAS and a weak, inverse correlation between FDA and MDA.

Table 3.5 Scale Correlations at Time Point 1 (Three-wave data)

Scale	1	2	3	4	5
1. FDA	(.86)				
2. MDA	-.17	(.92)			
3. DMDS	.37**	-.45**	(.92)		
4. DSRES	-.14**	.18*	-.31**	(.93)	
5. PEAS	.37**	-.54**	.70**	-.30**	(.88)

(Cronbach's alpha is reported on the diagonal) * significant at p<.05, ** significant at p<.01

3.1.4.3 Construct Stability. To assess stability over time we examined correlations within each scale (FDA and MDA) at all three time point of study 2 (Tables 3.6 & 3.7). Results showed moderate to good, positive and significant inter-scale correlations for FDA and weak to moderate, positive and significant correlations for MDA.

Table 3.6 FDA Correlations at Three Time Points

	1	2
1. FDA_T1	-	
2. FDA_T2	.55**	-
3. FDA_T3	.56**	.82**

* significant at p<.05, ** significant at p<.01

Table 3.7 MDA Correlations at Three Time Points

	1	2
1. MDA_T1	-	
2. MDA_T2	.17*	-
3. MDA_T3	.28**	.68**

* significant at p<.05, ** significant at p<.01

3.1.5 FMDAS Development Summary

Results from the CFA showed strong support for the final factor structures for both FDA and MDA. Subsequent analyses of validity provided sound evidence for all three measures of external validity. Some of the correlations were weaker than expected, notably those with DSRES (for both FDA and MDA), but they remain significant and in the anticipated directions. Stability of the FDA was good, with moderate to strong correlations between scores across all time points. The MDA scale was less consistent, with weak correlations between scores at T1 and subsequent time points. The correlation between scores at T2 and T3 however, was strong. It is not clear why this is the case, but it is possible that the move from in-person to online data collection between T1 and T2 influenced this. This may also be reflected in the stronger correlation in FDA scores between T2 and T3.

3.2: Supplement Scale Development

To measure supplement use we developed a novel instrument based on the work of Boardley *et al.* (2016). We wanted to capture data that meaningfully represented supplement use. Thus, the instrument allowed us to capture the number and type of supplements used, as well as the frequency of use. Reported here are factor analyses used to determine supplement groupings as part of the development process.

For Sample 1, athletes were given a list of prohibited (*n*=22) and non-prohibited (*n*=17) supplements, medications (*n*=8) and technologies (*n*=4) under four categories including muscle building (protein, BCAA, creatine, pre-workout drinks), well-being (CBD, multivitamins, magnesium, vitamin C, vitamin D, vitamin E, iron), weight loss (fat burners, meal replacements), and medications (aspirin, NSAID, paracetamol). The list was developed by the research team, including three researchers with extensive experience conducting research in supplement use.

We asked participants to indicate whether they had used any of the listed items specifically to enhance sporting performance or recovery within the previous six months, prior to the past six months or ‘never used. If participants had used the product within the past six months, they were further asked to indicate frequency of use (<once per week, weekly, 3-4 times/week, 5+ times/week). Supplement scores were calculated on frequency of use for participants who had used that supplement within the previous six months.

For the Sample 2 collection, we looked to streamline the instrument developed for the Sample 1 collection, as the length of the instrument made completion quite burdensome for participants, especially in a longitudinal design with repeat completions. For example, supplements that had not been reported by any participants in Sample 1 were removed. Further, some supplements were grouped under broader category headings to reduce the number of responses needed. We also determined that some items may benefit from rewording. For example, we originally included NSAIDs (Nonsteroidal anti-inflammatory drugs) as opposed to generic names (e.g., ibuprofen) that participants may have been more familiar with. Finally, we simplified the response options to make completion simpler. Specifically, participants were asked to simply indicate which items they had used in the past month and to indicate frequency of use using a simplified approach (< Once per week, Weekly, >3 times per week) as opposed to the five response categories used with Sample 1.

We grouped supplements according to their patterns of use via exploratory factor analysis. Several supplements were again minimally reported (if at all) and excluded from analysis. We followed the same process described previously, assessing corrected item-total correlations to remove items before conducting EFA. Four factors were identified with eigenvalues >1 and item-loadings >.40 (see Table 3.8).

Table 3.8 EFA Factor Loadings for Supplement Groups

Item	Factor Loading			
	(MB)	(MED)	(WELL)	(WL)
Branch Chain Amino Acids	.58			
Creatine	.76			
Protein	.53			
Pre-Workout	.43			
Aspirin		.44		
Codeine		.40		
Ibuprofen		.75		
Paracetamol		.71		
Multivitamins			.55	
Magnesium			.61	
Vitamin C			.65	
Vitamin D			.73	
Vitamin E			.78	
Iron			.80	
CBD			.66	
Fat Burners				.58
Meal Replacements				.42

Four factors were identified, and we further tested these groupings via CFA. The groups were named Muscle Building (MB), Wellbeing (WB), Medications (MED) and Weight Loss (WL).

We found good model fit for MB ($\chi2$ (2) = 3.03, p = *ns*; CFI = .99; RMSEA = .05; SRMR = .03), and WB ($\chi2$ (14) = 22.11, p ≤ .10; CFI = .99; RMSEA = .05; SRMR = .08) and adequate fit for Med ($\chi2$ (2) = 12.2, p ≤ .05; CFI = .95; RMSEA = .16; SRMR = .09). The model was not identified for WL, this is likely due to having just two NS items loading, both with relatively low reported use. Factor loadings for each model are displayed in Table 3.9 below.

Beyond the factor loadings, we note that the supplements group together in conceptually sound groupings. All the 'MED category are OTC medicines, all of the WB group represent supplements widely used for general health or to address perceived dietary deficiencies and the MB group are the most commonly used (non-banned) supplements for muscle gain.

Table 3.9 Standardised factor loadings for supplement categories

Factor	Item	Loading
MB	1. BCAA	.86
	2. Creatine	.93
	3. Protein	.77
	4. Pre-Workout	.55
WB	5. CBD	.61
	6. Multivitamin	.75
	7. Magnesium	.60
	8. Vitamin C	.76
	9. Vitamin D	.92
	10. Vitamin E	.85
	11: Iron	.77
Med	12. Aspirin	.64
	13. Codeine	.58
	14. Ibuprofen	.90
	15. Paracetamol	.76

Chapter 4: Longitudinally Examining the Influence of Sport Supplement and Medication Use on Doping Attitudes

4.1 Introduction

A growing body of evidence supports the importance of various predictors of doping (e.g., doping attitudes) in athletes that may help guide interventions. In particular, use of nutritional supplements (NS) (Ntoumanis *et al.*, 2014) and over the counter (OTC) medication (Dietz *et al.*, 2016) have been positively linked to such predictors. The use of NS to enhance health and/or sports performance is a widespread and rapidly growing phenomenon in the UK (Ritchie, 2007), with some studies reporting 48% of UK adults using some form of NS (Community Research, 2018).

Perhaps not surprisingly then, a high prevalence of NS use has been reported in athletes with some studies reporting prevalence figures of 60% or more (Knapik *et al.*, 2016; Maughan *et al.*, 2011; Nieper, 2005; Outram & Stewart, 2015).

The use of NS has been linked to more favourable attitudes towards doping and increased risk of doping behaviours (Barkoukis *et al.*, 2020; Hurst *et al.*, 2019; Hurst *et al.*, 2021a; Ntoumanis *et al.*, 2014). Other research shows doping may be more than three-and-a-half times more prevalent amongst competitive athletes using NS (Backhouse *et al.*, 2013; Papadopoulos *et al.*, 2006). Hoffman *et al.* (2008) reported the use of NS and anabolic steroids (AS) amongst adolescents and reported that NS use increased with age and that increased NS use (number of supplements used) positively predicted AS use. This finding was stronger for supplements used to gain muscle mass or strength (e.g. protein drinks) and is echoed in other research (e.g: Hildebrandt *et al.*, 2012).

There is a significant body of research demonstrating positive associations between NS use and doping but causal mechanisms have not yet been tested (Backhouse *et al.*, 2013). Several studies have highlighted the influence of psychosocial factors on any progression from NS to doping. Hurst *et al.* (2021b) note that ego orientation is indirectly related to doping likelihood, with ego-oriented athletes who use NS more likely to dope. Backhouse *et al.* (2013) noted significant differences between NS users and non-users regarding doping attitudes and beliefs, with NS users reporting significantly more favourable attitudes. This finding was replicated by Barkoukis *et al.* (2015) who suggest a "shared mental representation" of NS use for performance enhancement and doping.

As well as NS use, research shows significant prevalence of OTC medication use among athletes (Alaranta *et al.*, 2008; Lazic *et al.*, 2011) , especially analgesics such as nonsteroidal anti-inflammatory drugs (NSAIDs) (Tscholl *et al.*, 2009; Warner *et al.*, 2002). Research in this area is limited but there is evidence show athletes, especially adolescent athletes, use alarmingly high levels of painkillers (Alaranta *et al.*, 2006; Ciocca, 2005; Warner *et al.*, 2002). Further evidence suggests shared patterns of use between OTC painkillers and other medicines or NS (Shehnaz *et al.*, 2014; Tscholl *et al.*, 2010; Tscholl *et al.*, 2008).

Whilst compelling, extant research linking use of NS and OTC medications with doping outcomes is exclusively cross-sectional. Such research can demonstrate associations but cannot elaborate temporal relationships between the use of NS and OTC medications and subsequent changes in predictors of doping. The present study seeks to address that need by examining these relationships longitudinally.

The theoretical basis for this exploration was previously elaborated in Chapter 2. The Incremental Model of Doping Behaviour (IMDB) (Petróczi, 2013a, 2013b) posits a progression from NS use to doping; but unlike gateway hypothesis, proposes that athletes' attitudes around the *functionality* of performance enhancement, and how this meets their athletic goals is key. The IMDB proposes that functional attitudes are integral to 'the doping mindset' (Petróczi, 2013a, 2013b), whereby the decision to use performance enhancing substances is driven by beliefs about various means to achieve performance-related goals, but is also attenuated by moral attitudes towards the behaviour. The IMDB therefore presents another attitudinal dimension, largely unexplored in the literature.

Furthermore, the IMDB extends conceptualisation of performance enhancers beyond a few ergogenic supplements and banned substances, to include any method by which athletes seek to maximise performance goals. This includes OTC medication, but also physical methods such as altitude masks.

Scant research has really tested elements of the IMDB, with only ones study doing so explicitly. Hurst *et al.* (2022) reported an indirect relationship between NS use and doping via beliefs about the functional benefits of NS use, moderated by moral values and moral identity. Thus, stronger beliefs in functional benefits of supplement use coupled with low moral values and identity represented greater risk for doping. This shows support for the basic tenets of the doping mindset proposed by the IMDB (Petróczi, 2013a).

However, longitudinal research that examines links between NS and medication use and both functional and moral attitudes is needed to establish temporal sequences here.

Further, reviews of the literature around supplement use described in chapter 2 highlighted the heterogeneity of measures for NS use and key methodological limitations, especially around the use of definitions and taxonomies that are not empirically grounded (Janiczak *et al.*, 2022; Knapik *et al.*, 2016). There is therefore a need for a new approach to measuring NS use that is conceptually meaningful and empirically supported.

4.2 The Current Research

Research to date has largely used crude approaches to the assessment of NS use, often conceptualising NS use as a dichotomous (i.e., yes/no) variable or simple lists that vary between studies (Knapik *et al.*, 2016). If we are to better understand the impact of NS use on doping constructs, there is a need to identify whether different *categories* of NS, based upon their proposed function (e.g., muscle gain, fat loss), present different levels of doping risk. There is also a need to examine possible associations between performance enhancing technologies and doping, given no studies have really examined this to date.

In line with the proposals of the IMDB, the current research aimed to examine longitudinal effects of using NS, OTC medications and performance enhancing technologies on functional and moral attitudes in student athletes. In addressing this overarching aim, we sought to answer the following research questions: a) What nutritional supplements, medications and prohibited and non-prohibited performance-enhancing substances and technologies are commonly used by student athletes? b) What are the temporal relationships between use of NS and OTC medications and explicit functional and moral attitudes? Based upon the IMDB and the empirical studies reviewed previously, we sought to test the following a priori hypotheses: a) use of protein supplements, creatine, vitamin preparations and OTC analgesics would be high in this population and b) the use of NS, OTC medications and performance enhancing technologies would lead to positive changes in functional, but not moral, doping attitudes over time.

We further sought to test a novel method for measuring supplement use, as described in Chapter 2.

4.3 Methods

4.3.1 Participants

Participants were previously described in detail in Chapter 3. Briefly, in study one they were UK university-athletes (*n* = 180, 73.3% male) competing in cricket (n=28), water polo (n=20), soccer (n=17), swimming (n=17), rugby (n=16), field hockey (n=14), martial arts (n=13), gymnastics (n=12) or other sports (n=43). The sample for analysis comprised the 180 athletes who participated at both time points. This represents an attrition rate of 42.9% from the 315 participants at Time Point 1.

In study two they were UK university-athletes from the author's home institution (*n* = 205, Male = 51.2%) who competed in rugby (*n*=75), netball (*n*=40), triathlon (*n*=22), soccer (*n*=18), field hockey (*n*=15), boxing (*n*=11) and other sports (*n*=24). This sample represents 205 people who participated at all three time points of the 288 who took part at TP1. This represents an attrition rate of 28.8%.

4.3.2 Measures

The measures used in both studies were the FMDAS scales and the supplement use scales described in Chapter 3. In brief, these scales are:

FMDAS (Functional Moral Doping Attitudes Scale)

For functional attitudes (FDA), we assessed the extent to which the athlete believes in doping-related performance enhancement (4 items; e.g., "*Using doping can make my results better*" using a six-point scale ranging from -3 (Strongly disagree) to 3 (Strongly Agree). For moral attitudes (MDA), we used the same response scale to assess athlete's moral beliefs on doping (3 items; e.g., "*Using doping is morally wrong*").

Supplement, Medication and Performance Enhancing Technology Use

Scale items were altered between studies as described in Chapter 3. For study one, athletes were given a list of prohibited (*n*=22) and non-prohibited (*n*=17) supplements, medications (*n*=8) and technologies (*n*=4) under four categories including muscle building (protein, BCAA, creatine, pre-workout drinks), well-being (CBD, multivitamins, magnesium, vitamin C, vitamin D, vitamin E, iron), weight loss (fat burners, meal replacements), and medications (aspirin, NSAID, paracetamol). They were asked to indicate whether they had used any of the listed items to enhance sporting performance or recovery within the previous six months, and if so, to also indicate frequency of use (<once per week, 3-4 times/week, 5+ times/week). For study two, some items were dropped or renamed and the timescale of use was shortened to one month (see Chapter 3 for a full explanation).

Procedures

Study procedure for the two-wave study is described in detail in Chapter 3.

Data Analysis

Preliminary analyses were performed in IBM SPSS Version 26. Descriptive statistics were generated for demographic variables and focal study variables (supplement/medication use, FMDAS) at each time points and correlations between study variables were analysed.

Main analyses were conducted with Mplus Version 8.4. To examine causal effects between NS/medication use and functional/moral doping attitudes, two-wave cross lagged panel (CLP) analyses were employed (Kearney, 2017). Performance enhancing technologies (e.g., altitude masks) were excluded from analysis due to very low reported use.

In both studies, we tested five competing models (see Boardley *et al.*, 2020; Madigan *et al.*, 2015; Zacher & de Lange, 2011) to examine the causal effects between use of NS/medications and functional/moral doping attitudes across two time points spanning a competitive season. The first model

(M1) included synchronous and autoregressive paths but no cross-lagged effects. This was the baseline model to determine whether specifying cross-lagged effects explained greater variance and fit better to the data. Models 2 and 3 (M2 and M3) added cross-lagged effects of functional/moral attitudes on supplement/medication use, and vice versa, respectively. This was to determine which direction of cross-lagged effect better explained the data. Models 4 and 5 (M4 and M5) contained cross-lagged effects in both directions, Model 4 had equal effect constraint on both cross-lagged paths, whilst Model 5 did not. Robust maximum likelihood was used to handling missing data (Newman, 2014). This allowed us to determine the equality of reciprocal cross-lagged effects. Based on guidance in Bentler (2007), we used Chi-square (χ^2), comparative fit index (CFI), standardised root mean square residual (SRMR), and root mean square error of approximation (RMSEA) to assess and compare model fit. A CFI $\geq$.90 and RMSEA/SRMR $\leq$ .08 indicate adequate model fit, and CFI $\geq$.95 and RMSEA/SRMR $\leq$ .05 indicate good model fit. The best-fit model was selected for further interpretation. For parsimony, only the best-fit models supporting cross-lagged effects between supplement/medication use and FDA/MDA are reported with diagrams and effect sizes are only provided for significant paths. Details on model comparisons for models not supporting cross-lagged effects are presented in the Appendix.

4.4 Results

4.4.1 Preliminary analyses: Study One

Table 4.1 details descriptive statistics for use and frequency of use for supplement, medication and performance enhancing technology at TP1. Equivalent data for Time Point 2 can be found in Appendices.

Table 4.1 ***Time Point 1 Descriptive Statistics on Use and Frequency of Use***

Substance/Method	Use			Frequency				
	Never	Prior to Past 6 months	During Past 6 months	<1/ week	weekly	3-4 times/ week	5+ times/ week	Not reported
Nutritional Supplements								
BCAA	153	6	21	4	2	11	4	0
Creatine	147	9	24	3	3	8	8	2
Protein	98	14	68	7	11	26	21	3
Caffeine	138	7	35	10	20	1	4	0
Taurine	171	1	8	7	1	0	0	0
Other Fat Burners	176	3	1	1	0	0	0	0
Laxatives	176	3	1	1	0	0	0	0
Meal Replacements	161	9	10	1	3	5	1	0
Pre-Workout	133	15	32	9	7	11	1	4
Multivitamin no Minerals	124	17	39	8	7	10	13	1
Multivitamin plus minerals	115	16	49	8	10	14	14	3
Magnesium	170	2	8	1	1	3	2	1
ZMA	176	3	1	0	1	0	0	0
Vitamin C	129	9	42	5	11	6	19	1
Vitamin D	146	12	22	3	3	4	11	1
Vitamin E	164	4	12	1	5	1	4	1
Selenium	177	0	2	0	1	0	1	0
Iron	156	6	17	0	6	0	9	2
Performance Enhancing Technologies								
Altitude Tent	180	0	0					
Altitude Mask	173	2	5	4	0	0	0	1
Compression Garment	164	5	11	5	5	1	0	0
Environmental Chamber	178	0	2	1	1	0	0	0
Medications								
Aspirin	146	12	22	14	4	1	0	3
CBD	180	0	0					
Narcotic Analgesics	173	2	5	4	0	0	0	0
NSAIDS	117	8	55	39	11	3	1	1
Paracetamol	67	14	99	64	24	6	1	4
Anticholinergic	180	0	0					
Benylin	177	1	2	2	0	0	0	0
Beta 2 Agonist	180	0	0					
Prohibited Substances / Methods								
Anabolic Steroids	180	0	0					
Growth Hormone	180	0	0					
Insulin	180	0	0					
Peptide Hormones	178	1	1	1	0	0	0	0
Prohormones	180	0	0					

Testosterone Boosters	179	0	1					
Amphetamines	176	0	3	1	0	0	1	0
Cocaine	161	7	12	10	1	1	0	0
DMAA	180	0	0					
Ephedrine	180	0	0					
Modafinil	168	3	9	1	7	1	0	0
Adderall	179	1	0					
Ritalin	179	1	0					
Clenbuterol	179	1	0					
DNP	180	0	0					
Sibutramine	180	0	0					
Triiodothyronine (T3)	180	0	0					
Corticosteroids	179	0	1	0	0	1	0	0
Beta Blockers	179	0	1	0	0	1	0	0
Meldonium	180	0	0					
SARMs	180	0	0					
Blood Doping	180	0	0					

Table 4.1 shows relatively common (i.e., *n* = >20) use of several non-prohibited substances; BCAA's, creatine, protein, caffeine, pre-workout drinks, multivitamins, vitamins C & D and medications (aspirin, NSAIDs, paracetamol) at TP1. Reported use of prohibited substances/methods was negligible, except for cocaine (*n* = 12) and modafinil (*n* = 9). Use of performance enhancing technologies was also negligible. The substances used most frequently (i.e., use during past six months > *n* = 20, with at least 50% of those using 3+ times per week) were BCAAs, creatine, protein, pre-workout drinks, multivitamins, vitamins C & D and OTC painkillers. Table 4.1 (see Appendix) shows a similar pattern of common (i.e., *n* = >20) use of BCAA's, creatine, protein, caffeine, pre-workout, multivitamins, vitamins C & D, NSAIDs, paracetamol at Time Point 2 (TP2). Reported use of prohibited substances/methods was negligible except again for cocaine (*n*=11) and modafinil (*n*=12). Use of performance-enhancing technologies was again negligible. The substances most frequently used (i.e., use during past six months *n* = > 20, with at least 50% of those using 3+ times per week) were BCAA's, creatine, protein, pre-workout, multivitamins, and vitamins C & D.

Tables 4.2 & 4.3 detail descriptive analyses for the attitude scales for TP1 and TP2 respectively. Alpha coefficients show acceptable levels of internal consistency for each scale. On average functional doping attitudes were marginally above the mid-point, indicating weak positive functional attitudes towards performance enhancement. Moral doping attitudes were strong and positive, indicating stronger moral objection to doping.

Table 4.2 ***Time Point 1 Descriptive Analyses***

	M	*SD*	Minimum	Maximum	α
A. Functional Doping Attitudes	.81	1.32	-3	3	.78
B. Moral Doping Attitudes	2.23	1.04	-3	3	.83

Table 4.3 ***Time Point 2 Descriptive Analyses***

	M	*SD*	Minimum	Maximum	α
A. Functional Doping Attitudes	.79	1.2	-3	3	.69
B. Moral Doping Attitudes	2.16	1.06	-3	3	.84

4.4.2 Two Wave Cross Lagged Panel Analyses: Study One

Muscle-Building Supplements (MB)

For MB supplements and functional attitudes (FDA), no other model improved fit over M2, so we accepted this model (χ^2 (1) = .04, p = ns; CFI = 1.0; RMSEA = .00; SRMR = .01). Autoregressive paths showed strong positive effects for both FDA (β = .68, p = .00, 95% CI[.48, .71]) and MB (β = .71, p = .00, 95% CI[.53, 1.16]). Synchronous correlations were not significant at either time point and showed weak, positive associations. The cross lagged path from FDA to MB was weak and positive, but not significant.

For MB supplements and moral attitudes (MDA), no other model improved fit over model M3, so we accepted this model. (χ^2 (1) = .93, p = ns; CFI = 1.0; RMSEA = .00; SRMR = .01). Autoregressive paths were strong and positive for both FDA (β = .68, p = .00, 95% CI[.59, .87]) and MB (β = .73, p = .00, 95% CI[.54, 1.21]). Synchronous correlations were weak and positive at both time points, but not significant. The cross-lagged path from MB to MDA was weak, negative and not significant.

Weight-Loss Supplements (WL)

Examining the relationship between WL and functional attitudes, no other model improved fit over M3, so we accepted this model (χ^2 (1) = .00, p = ns; CFI = 1.0; RMSEA = .00; SRMR = .00) (see Figure 2). Autoregressive paths showed strong positive effects for both FDA (β = .66, p = .00, 95% CI[.44, .74]) and

WL (β = .55, p = .00, 95% CI[.33, 1.52]). Synchronous correlations were weak and positive, but not significant at either time point. The cross-lagged path from WL to FDA revealed that increased WL at TP1 manifested a weak positive effect on functional attitudes at TP2 (β = .26, p = .01, 95% CI[.01, .46]) (see Figure 4.1).

No model improved fit over M2 between WL and MDA and we therefore accepted this model, (χ^2 (1) = .70, p = ns; CFI = 1.0; RMSEA = .00; SRMR = .04). The autoregressive path for FDA was strong and positive (β = .68, p = .00, 95% CI[.60, .87]), whilst the path for WL was moderate, positive and non-significant. Synchronous correlations were weak and positive but non-significant. The cross-lagged path from MDA to WL was weak, positive and non-significant.

Well-Being Supplements (WB)

No model improved fit over M2 for WB and functional attitudes so we accepted this model (χ^2 (1) = 1.20, p = ns; CFI = 1.0; RMSEA = .03; SRMR = .03). Autoregressive paths were strong, positive and significant for both FDA (β = .68, p = .00, 95% CI[.48, .71]) and WB (β = .90, p = .00, 95% CI[.69, 1.03]). Synchronous correlations were non-significant and inconsistent; at TP1 it was weak and negative and at TP2 it was weak and positive. The cross-lagged path from FDA to WB was weak, positive and significant (β = .15, p = .01, 95% CI[.12, .82]) (see Figure 4.2).

For moral attitudes and wellbeing, the baseline model (M1) with no cross lagged effects offered the best fit and we therefore interpreted that model (χ^2 (2) = .18, p = ns; CFI = 1.0; RMSEA = .00; SRMR = .01). Autoregressive paths were strong, positive and significant for FDA (β = .68, p = .00, 95% CI[.60, .87]) and WB (β = .89, p = .00, 95% CI[.66, 1.03]). Synchronous correlations were weak, negative and non-significant at both time points. No cross-lagged paths are defined in the baseline model.

Medications (MED)

For medications and functional attitudes, model M4 offered the best fit and was therefore accepted and interpreted (χ^2 (1) = .02, p = ns; CFI = 1.0; RMSEA = .00; SRMR = .00).

Autoregressive paths were strong, positive and significant for both FDA (β = .68, *p* = .00, 95% CI[.50, .71]) and MED (β = .67, *p* = .00, 95% CI[.47, .94]). Synchronous correlations were weak, negative, and non-significant at both time points. Both cross-lagged paths were weak, positive, and non-significant.

For medications and moral attitudes, model M4 again offered the best fit and was therefore interpreted (χ^2 (1) = 3.62, *p* = ns; CFI = .97; RMSEA = .09; SRMR = .03). Autoregressive paths were strong, positive and significant for both MDA (β = .67, *p* = .00, 95% CI[.60, .85]) and MED (β = .67, *p* = .00, 95% CI[.48, .85]). Synchronous correlations were weak, positive and non-significant. Cross-lagged paths were weak, positive and significant for both MDA-MED (β = .02, *p* < .05, 95% CI[.01, .11]) and MED-MDA (β = .16, *p* < .05, 95% CI[.01, .11]) (see Figure 4.3).

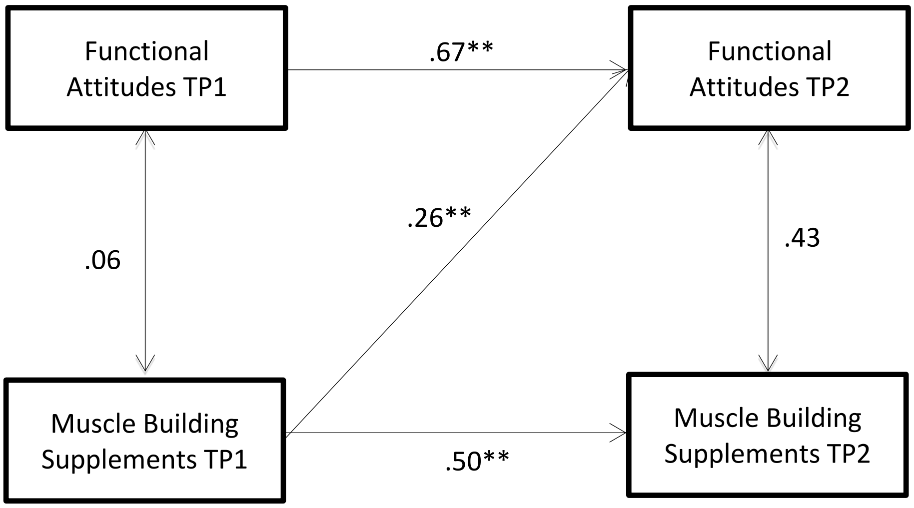

Figure 4.1 Two-wave cross-lagged panel model linking weight loss supplement use and functional attitudes across time (M3). TP1 = Time Point 1; TP2 = Time Point 2. ***p* < .01 (Banana for scale 🍌)

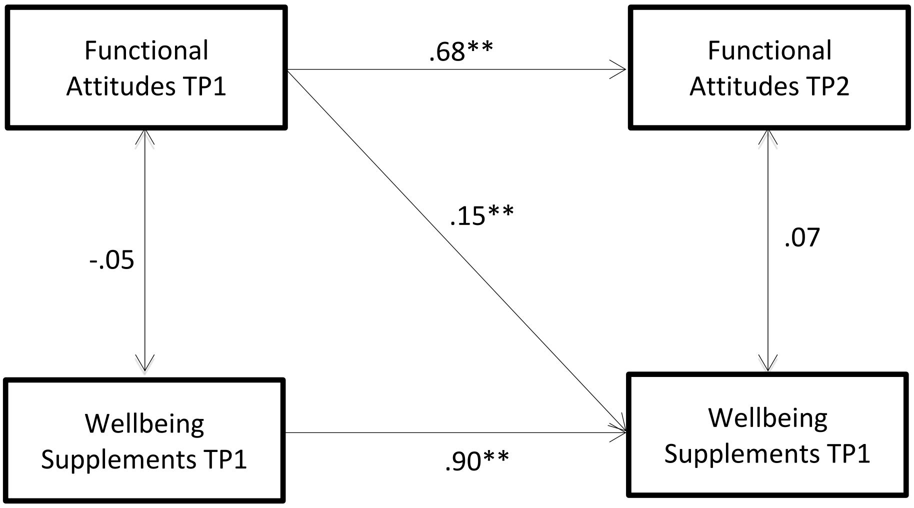

Figure 4.2 Two-wave lagged panel model linking wellbeing supplement use and functional doping attitudes across time (M3). TP1 = Time Point 1; TP2 = Time Point 2. **$p < .01$

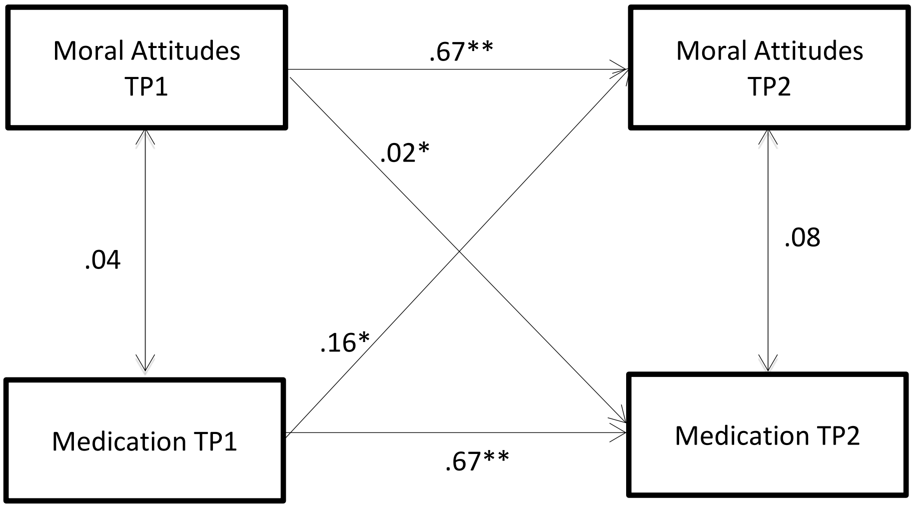

Figure 4.3 Two-wave cross-lagged panel model linking medication use and moral attitudes across time (M4). TP1 = Time Point 1; TP2 = Time Point 2. *<.05 **$p < .01$

4.5 Study Two

Whilst there were encouraging results within the first study, we noted some issues. In particular, the use of just two time points in Study 1 was a limitation of the study. Whilst it is possible to perform CLP across two time points, it is preferable to use three or more in order to replicate effects and properly test key assumptions (Kearney, 2017; Kenny, 1979). We therefore collected data across three time points for this second study.

We employed an identical approach to Study 1 for preliminary analyses. For the CLPM, we applied the same five-model approach to examine temporal effects of supplement/medication use on functional/moral attitude towards doping. We again excluded performance enhancing technologies due to low reported use. The same model fit criteria as Study 1 were used for model comparisons and model selection.

Finally, for CLP analyses we included all study participants from TP1 (n = 288) to maximise statistical power, employing a full information maximum likelihood approach for estimation to handle missing data (Hirose *et al.*, 2015).

4.5.1 Preliminary analyses: Study Two

Data were collected on use and frequency of use of substances and performance-enhancing technologies. Tables 4.4, 4.5 and 4.6, respectively, detail descriptive statistics at each time point.

Table 4.4 Time 1 Descriptive Statistics on Reported Use and Frequency

Substance/Method	Use		Frequency		
	Never	Used during the past month	<1/week	weekly	3+ times/week
BCAA	191	14	1	9	4
Creatine	169	36	8	5	23
Protein Powder	118	87	12	16	59
Caffeine	194	11	5	4	2
Taurine	194	11	5	4	2
Fat Burners	203	2	0	1	1
Laxatives	205	0			
Weight Loss Meal Replacements	203	2	0	1	1
Pre-Workout	159	46	20	16	10
Magnesium	197	8	1	3	4
ZMA	203	2	0	1	1
Multivitamins	126	79	12	19	48
Vitamin C	152	53	6	15	32
Vitamin D	167	38	5	10	23
Vitamin E	199	6	0	1	5
Selenium	205	0			
Iron	187	18	2	5	11
Performance Enhancing Technologies					
Altitude Mask	204	1	1	0	0
Compression Garment	164	41	8	18	15
Medications					
Aspirin	195	10	7	1	2
Codeine	200	5	4	0	1
CBD	200	5	2	2	1

Ibuprofen	137	68	53	9	6
Paracetamol	116	89	73	11	5
Prohibited Substances / Methods					
Anabolic Steroids	205	0			
Human Growth Hormone	205	0			
Insulin	205	0			
Testosterone Boosters	205	0			
Amphetamines	205	0			
Cocaine	205	0			
Modafinil	205	0			
Adderall	205	0			
Clenbuterol	205	0			
Thyroid Drugs	205	0			
Beta Blockers	205	0			
SARMs	205	0			

Table 4.5. Time 2 Descriptive Statistics on Reported Use and Frequency

Substance/Method	Use		Frequency		
	Never	Used during the past month	<1/week	weekly	3+ times/week
BCAA	193	12	2	3	7
Creatine	172	33	2	6	25
Protein Powder	115	90	23	14	53
Caffeine	194	11	7	2	2
Taurine	201	4	2	1	1
Fat Burners	203	2	1	0	1
Laxatives	203	2	2	0	0
Weight Loss Meal Replacements	197	8	3	4	1
Pre-Workout	168	37	18	10	9
Magnesium	192	13	2	6	5
ZMA	203	2	0	0	2
Multivitamins	115	90	14	12	64
Vitamin C	152	53	7	14	32
Vitamin D	153	52	6	14	32
Vitamin E	194	11	1	2	8
Selenium	205	0			
Iron	179	26	3	6	17
Performance Enhancing Technologies					
Altitude Mask	205	0			
Compression Garment	153	52	16	23	13
Medications					
Aspirin	200	5	1	2	2
Codeine	204	1	1	0	0
CBD	200	5	1	2	2
Ibuprofen	157	48	33	11	4
Paracetamol	141	64	44	15	5
Prohibited Substances / Methods					
Anabolic Steroids	205	0			
Human Growth Hormone	205	0			
Insulin	205	0			
Testosterone Boosters	205	0			

Amphetamines	205	0			
Cocaine	205	0			
Modafinil	204	1	1	0	0
Adderall	205	0			
Clenbuterol	205	0			
Thyroid Drugs	205	0			
Beta Blockers	205	0			
SARMs	205	0			

Table 4.6 Time 3 Descriptive Statistics on Reported Use and Frequency

Substance/Method	Use		Frequency		
	Never	Used during the past month	<1/week	weekly	3+ times/week
BCAA	188	17	4	6	7
Creatine	171	34	3	5	26
Protein Powder	106	99	23	23	53
Caffeine	197	8	2	2	4
Taurine	198	7	4	3	0
Fat Burners	203	2	0	0	2
Laxatives	205	0			
Weight Loss Meal Replacements	200	5	1	2	2
Pre-Workout	163	42	15	17	10
Magnesium	192	13	2	2	9
ZMA	203	2	0	0	2
Multivitamins	123	82	5	16	61
Vitamin C	168	37	5	7	25
Vitamin D	155	50	8	8	34
Vitamin E	200	5	1	1	3
Selenium	205	0			
Iron	186	19	3	2	14
Performance Enhancing Technologies					
Altitude Mask	205	0			
Compression Garment	159	46	11	19	16
Medications					
Aspirin	196	9	5	2	2
Codeine	204	1	1	0	0
CBD	196	9	3	4	2
Ibuprofen	155	50	35	10	5
Paracetamol	144	61	42	10	9
Prohibited Substances / Methods					
Anabolic Steroids	205	0			
Human Growth Hormone	205	0			
Insulin	205	0			
Testosterone Boosters	205	0			
Amphetamines	205	0			
Cocaine	205	0			
Modafinil	204	1	1	0	0
Adderall	205	0			
Clenbuterol	205	0			
Thyroid Drugs	205	0			
Beta Blockers	205	0			
SARMs	205	0			

Tables 4.4, 4.5 and 4.6 show relatively common ($n > 20$) use of several non-prohibited substances; Creatine, Protein powder, Pre-Workout drinks, Multivitamins, Vitamins C & D, and medications (Ibuprofen and Paracetamol) at all three time points and relatively common use of Iron at TP2 and TP3. Reported use of prohibited substances/methods was almost non-existent, with just one report of modafinil use at TP2 and TP3. The most frequently used supplements ($n > 20$, 3+ times per week) were Creatine, Protein powder, Multivitamins, Vitamins C & D at all time points. Regarding performance-enhancing technologies, only use of compression clothing was reported, with approximately 20% of the sample reporting regular use.

Tables 4.7, 4.8 and 4.9 detail descriptive analyses for TP1, TP2 and TP3 respectively. Alpha coefficients showed good to excellent internal reliability for each scale.

Table 4.7 Time Point 1 Descriptive Analyses

	M	*SD*	Minimum	Maximum	α
A. Functional Doping Attitudes	.42	1.64	-3	3	.85
B. Moral Doping Attitudes	2.1	1.5	-2.3	3	.95

Table 4.8 Time Point 2 Descriptive and Correlational Analyses

	M	*SD*	Minimum	Maximum	α
A. Functional Doping Attitudes	.75	1.25	-3	3	.78
B. Moral Doping Attitudes	2.5	.67	-1	3	.84

Table 4.9 Time Point 3 Descriptive and Correlational Analyses

	M	*SD*	Minimum	Maximum	α
A. Functional Doping Attitudes	.66	1.30	-3	3	.77
B. Moral Doping Attitudes	2.54	.62	.33	3	.84

4.4.5 Cross-Lagged Panel Analyses: Study Two

Fit indices and parameter estimates for accepted models with cross-lagged effects are presented below. As previously, only models with cross-lagged effects are reported with diagrams and only significant paths are reported in detail. Model fit comparisons can be found in the Appendix.

Muscle-Building (MB) Supplements

For models examining MB and functional attitudes, Model 2 (cross-lagged effects between FDA and MB) provided the best fit provided the best combination of fit and parsimony, ($\chi 2(6) = 13.18$, $p > .05$; CFI = .99; RMSEA = .06; SRMR = .03) and was therefore accepted and interpreted (Figure 4.4). Autoregressive paths showed moderate to strong positive effects for FDA (TP1 – TP2: $\beta = .55$, $p = .00$, 95% CI[.33,.56], TP2 – TP3: $\beta = .75$, $p = .00$, 95% CI[.81, .96]) and MB (TP1 – TP2: $\beta = .54$, $p = .00$, 95% CI[.37,.69], TP2 – TP3: $\beta = .83$, $p = .00$, 95% CI[.65, .92]). Synchronous correlations were inconsistent; they were significant, but weak and positive at TP2 ($\beta = .15$, $p = .02$, 95% CI[.10, .71]), but non-significant at TP1 and TP3.

The cross-lagged path from TP1 to TP2 was weak, positive, and significant (TP1 to TP2: $\beta = .12$, $p = .01$, 95% CI[.07, .40]), whilst the path from TP2 to TP3 was weak and positive, but not significant (TP2 to TP3: $\beta = .10$, $p = .82$, 95% CI[-.13, .25].

For models examining MB and moral attitudes, the model with reciprocal cross-lagged effects from MB to moral attitudes (M5) was accepted (Figure 4.5); ($\chi 2$ (4) = 2.99, $p = .02$; CFI = .98; RMSEA = .08; SRMR = .04). Autoregressive paths were strong and positive for MB (TP1 – TP2: $\beta = .51$, $p = .00$, 95% CI[.37, .71], TP2 – TP3: $\beta = .79$, $p = .13$, 95% CI[.71, .94]) and MDA (TP1 – TP2: $\beta = .13$, $p = .02$, 95% CI[.01, .13], TP2 – TP3: $\beta = .67$, $p = .00$, 95% CI[.52, .77]). Synchronous correlations were inconsistent, with weak ($\beta = -.16$, $p = .01$, 95% CI[-1.12, 0.00]) and moderate-to-strong negative ($\beta = -.13$, $p = .05$, 95% CI[-.62, -.17]) associations at T1 and T3, respectively and a non-significant association at TP2. Cross-lagged paths were inconsistent; only the paths from T1MB to T2MDA and T2MDA to T3MB were significant. The path from T1MB to T2MDA was weak and negative ($\beta = -.27$, $p = .00$, 95% CI[-.09, -.01]) whilst the path from T2MDA to T3MB was weak and positive ($\beta = -.13$, $p = .01$, 95% CI[.19, 1.01]).

Weight Loss (WL) Supplements

For models examining WL and functional attitudes, Model 2 (cross-lagged effects between FDA and WL) showed the best fit and we therefore accepted and interpreted that ($\chi 2$ (6) = 16.7, $p = .01$; CFI = .97; RMSEA = .08; SRMR = .04). Autoregressive paths were significant for both variables, across all time points.

For FDA the paths were moderate to strong and positive (TP1 – TP2: β = .55, *p* = .00, 95% CI[.33, .56], TP2 – TP3: β = .83, *p* = .00, 95% CI[.81, .96]). For WL paths were also moderate to strong and positive (TP1 – TP2: β = .61, *p* = .00, 95% CI[.43, .85], TP2 – TP3: β = .53, *p* = .00, 95% CI[.27, 1.2]). Synchronous correlations were weak and positive at T1 and T3, weak and negative at T2 and none were significant. Cross-lagged paths at T1-T2 were weak, inverse and not significant. Cross-lagged paths at T2-T3 were weak, positive and not significant.

For models examining WL and moral attitudes, the cross-lagged model from WL to MDA (M3) had the best fit ($\chi 2$ (5) = 12.11, *p* = .01; CFI = .97; RMSEA = .08; SRMR = .04) and we therefore accepted and interpreted this model. Autoregressive paths were again significant for both WL and MDA. For WL the paths were moderate to strong and positive (TP1 – TP2: β = .61, *p* = .00, 95% CI[.43, .85], TP2 – TP3: β = .53, *p* = .00, 95% CI[.27, 1.2]). For MDA the paths were weak to moderate and positive (TP1 – TP2: β = .19, *p* = .00, 95% CI[.03, .15], TP2 – TP3: β = .69, *p* = .00, 95% CI[.52, .77])

Synchronous correlations were inconsistent; they were weak, negative, and non-significant at TP1 and TP2 and weak, positive, and non-significant at T3. Cross-lagged paths between WB and MDA were also inconsistent; the path from T1-T2 was negative, weak, and non-significant whilst the path from T2-T3 was weak, positive and non-significant.

Well-being (WB) Supplements

For models examining WB and functional attitudes, no cross-lagged model (M2-M5) showed improved fit over the baseline model (M1), so we accepted and interpreted Model 1, ($\chi 2$ (8) = 19.98, *p* = .01; CFI = .97; RMSEA = .07; SRMR = .04). Autoregressive effects for both WB and functional attitudes were significant across all time points. For FDA the paths were moderate to strong and positive (TP1 – TP2: β = .55, *p* = .00, 95% CI[.33, .56], TP2 – TP3: β = .83, *p* = .00, 95% CI[.81, .97]). For WB the paths were weak to moderate and positive (TP1 – TP2: β = .43, *p* = .00, 95% CI[.23, .66], TP2 – TP3: β = .62, *p* = .00, 95% CI[.45, .73]). Synchronous correlations were weak and positive effect, but only significant at T2 (β = .12, *p* = .01, 95% CI[.12, .84]).

For models examining WB and moral attitudes, no cross-lagged model showed better fit than the baseline model without cross-lagged effects (M1) and as such, we accepted and interpreted this model (*χ2* (8) = 26.40, *p* = .00; CFI = .92; RMSEA = .09; SRMR = .05). Autoregressive paths were again significant for both variables. For MDA the paths were weak to strong and positive (TP1 – TP2: β = .19, *p* = .00, 95% CI[.03, .17], TP2 – TP3: β = .69, *p* = .00, 95% CI[.53, .79]). For WB the paths were moderate to strong and positive (TP1 – TP2: β = .42, *p* = .00, 95% CI[.23, .65], TP2 – TP3: β = .61, *p* = .00, 95% CI[.45, .73]).

Synchronous correlations were inconsistent; they were weak and positive at T1 and T3 and weak and negative at T2, none were significant.

Medications (MED)

For models examining medications and functional attitudes, the reciprocal cross-lagged model with equal constraints between Med and FDA (M4) showed the best fit (*χ2* (6) = 10.12 *p* = ns; CFI = .99; RMSEA = .05; SRMR = .03) so we accepted and interpreted this model (Figure 4.6). Autoregressive paths were significant for both variables across all time points. For FDA the paths were moderate to strong and positive (TP1 – TP2: β = .55, *p* = .00, 95% CI[.33, .55], TP2 – TP3: β = .82, *p* = .00, 95% CI[.79, .96]). For MED the paths were weak to moderate and positive (TP1 – TP2: β = .32, *p* = .00, 95% CI[.16, .46], TP2 – TP3: β = .63, *p* = .00, 95% CI[.49, .94]). Synchronous correlations were non-significant except at TP3, which was weak, positive, and significant (β = .15, *p* = .01, 95% CI[.03, .26]). Cross-lagged paths from FDA to MED were weak and positive, but non-significant. Cross lagged paths from MED to FDA were weak, negative and marginally significant (TP1 – TP2: β = -.08, *p* = .03, 95% CI[-.12, -.01], TP2 – TP3: β = -.06, *p* = .03, 95% CI[-.12, -.01]).

For models examining MED and moral attitudes, the reciprocal equal cross-lagged effects model (M4) again showed the best fit (*χ2* (6) = 15.50, *p* = ns; CFI = .96; RMSEA = .07; SRMR = .05), we therefore accepted and interpreted this model (Figure 4.8). All autoregressive paths were again significant. For MDA the paths were weak to moderate and positive (TP1 – TP2: β = .20, *p* = .00, 95% CI[.02, .15], TP2 – TP3: β = .68, *p* = .00, 95% CI[.50, .76]). For MED the paths were also weak to moderate and positive (TP1 – TP2: β = .31, *p* = .00, 95% CI[.13, .41], TP2 – TP3: β = .62, *p* = .00, 95% CI[.45, .88]).

Synchronous correlations were again inconsistent and non-significant; effect sizes were weak and positive at T1 and weak and negative at T2 & T3. Cross-lagged effects from MED to MDA were weak and negative across both time lags, whereas reciprocal effects were weak and positive. No cross-lagged paths were significant.

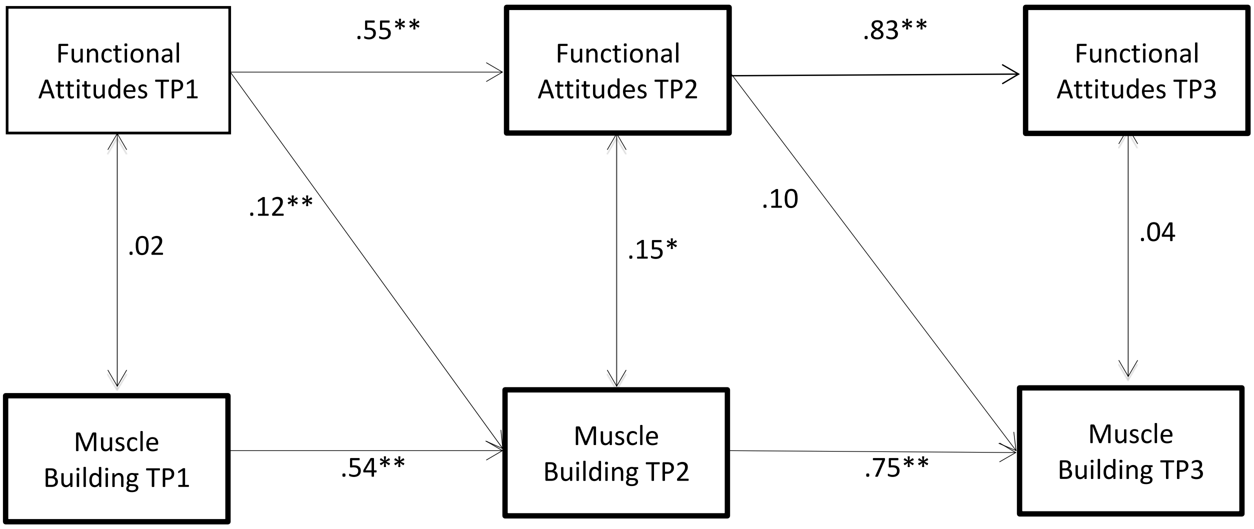

Figure 4.4 Three-wave cross-lagged panel model linking muscle building supplement use with functional doping attitudes across time (M2). TP1 = Time Point 1; TP2 = Time Point 2; TP3 = Time Point 3. *$p < .05$, **$p < .01$

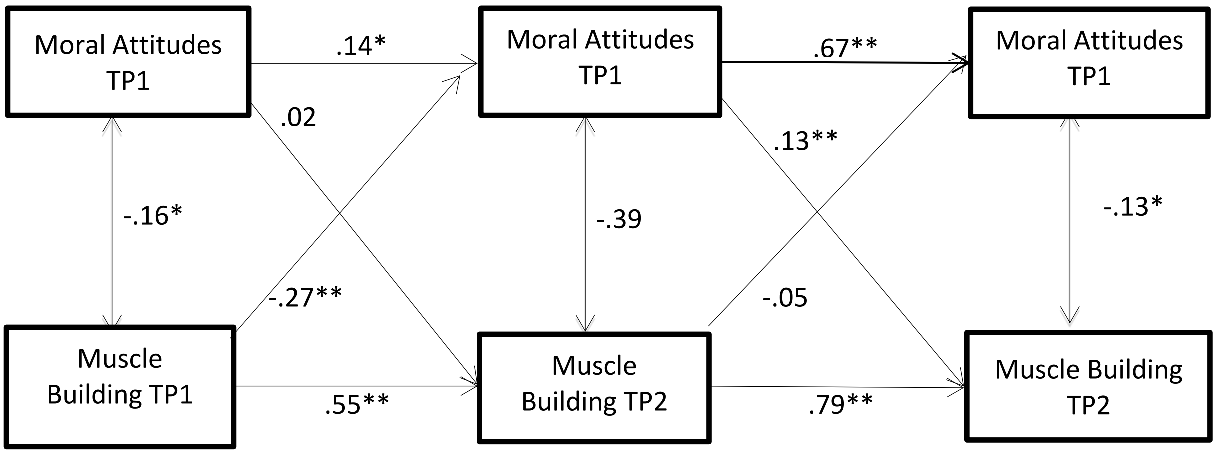

Figure 4.5 Three-wave cross-lagged panel model linking muscle building supplement use with moral doping attitudes across time (M5). TP1 = Time Point 1; TP2 = Time Point 2; TP3 = Time Point 3. *$p < .05$, **$p < .01$

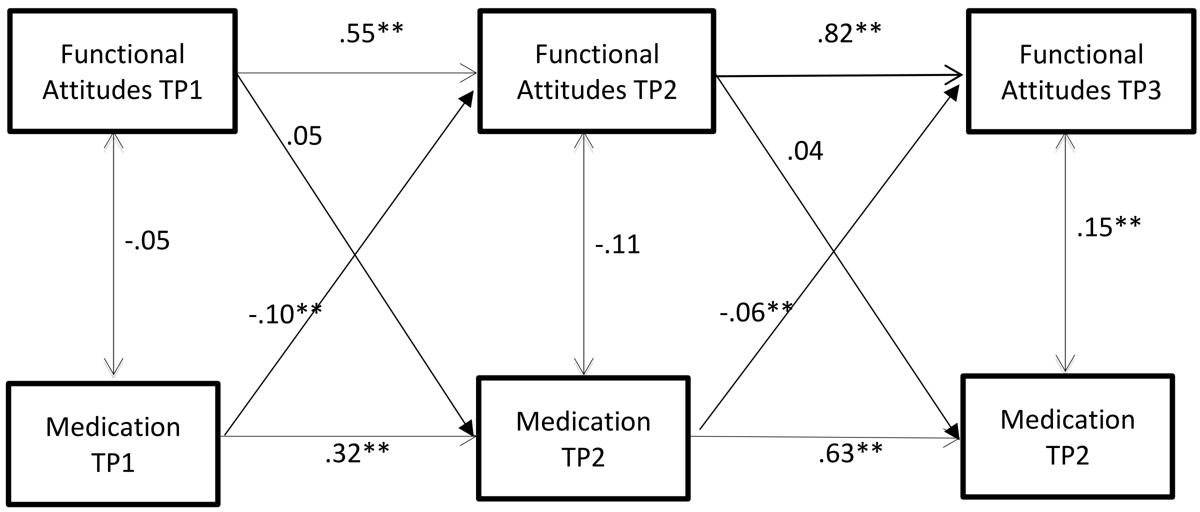

Figure 4.6 Three-wave panel model examining medication use with functional doping attitudes across time (M4). TP1 = Time Point 1; TP2 = Time Point 2; TP3 = Time Point 3. *p < .05, **p < .01

4.6 Discussion

We sought to test the following hypotheses: (a) the use of protein supplements, creatine, vitamin preparations and OTC analgesics would be high in this population and (b) the use of NS, OTC medications and performance enhancing technologies would lead to positive changes in functional, but not moral, doping attitudes over time. Our findings supported our first hypothesis and partially supported our second. We also report testing for the FMDAS scale and a novel approach to measuring supplement use.

4.6.1 Supplement Use

The first hypothesis is supported, with protein, creatine, vitamins and OTC painkillers among the most commonly used supplements/medications, both in terms of number using and frequency of use, across all time points. These findings were consistent with extant literature (Nieper, 2005; Petroczi *et al.*, 2008b), although the literature tends to report higher prevalence of vitamin use compared to protein. It is not clear why reported protein use appears slightly higher than vitamin use in our studies, but it may be that wellbeing is less of a concern for this age group.

Recent use of analgesics, specifically NSAIDs (ibuprofen) and paracetamol was also consistent with the extant literature (see e.g., Brennan *et al.*, 2021; Lazic *et al.*, 2011; Tscholl *et al.*, 2010) and reveal a concerning pattern of frequent sport-related analgesic use amongst student-athletes in both studies. Whilst there is some evidence to suggest possible prophylactic benefits of analgesics, the evidence is equivocal (Holgado *et al.*, 2018). There is however, substantial evidence for adverse side-effects of heavy and/or long-term analgesic use, especially ibuprofen (Ong *et al.*, 2007) and as such, this finding is of concern and suggests educational initiatives for athletes should include advice on appropriate analgesic use.

Recent use of weight loss supplements was relatively low compared to extant literature on athletes, but consistent with data from the general population, however this finding is not unexpected. Relton *et al.* (2014) reported a population based cross-sectional study of weight management strategies amongst adults in the UK and noted 3.4% had used meal replacement, whilst 3.2% had used weight loss medication. Amongst athletes however, research shows weight loss behaviours vary considerably. Evidence suggests weight loss practices are more prevalent in leanness sports (Werner *et al.*, 2013), whilst other research shows weight control linked to competitive schedules (Artioli *et al.*, 2010). None of the athletes in the studies above participated in leanness sports and there was no competitive schedule at the time of study. It is noteworthy that use of fat burners was largely reported by male athletes in study one (66% at TP1), but exclusively reported by female athletes in study two. This may suggest that use of fat burners in these athletes was perhaps driven by aesthetic, rather than performance or competitive, reasons.

Use of prohibited substances was very low in both studies, with single reports of anabolic agents (e.g., peptide hormones or anabolic steroids) and single figure reports of stimulant use, both psychoactive (cocaine) and cognitive enhancers (modafinil). Use of cognitive enhancers by students is not unusual (Heyes & Boardley, 2019) and likewise use of recreational psychoactive drugs such as cocaine (Patton, 2018). The prevalence of these drugs in our studies is however, markedly lower than would be expected in a student population, based on extant literature. A national survey of UK student drug use undertaken by National Union of Students and Release indicated approximately half the sample (n = 2,801) reported use of cocaine, with just under 40% of those reporting current use and approximately 20% reporting modafinil use, with approximately 10% reporting current use (NUS & Release, 2018).

Our results with respect to recreational drugs may be explained by our participants being competitive athletes and therefore perhaps more health focused than other students. However, we asked participants to only indicate use for sports performance purposes. Cocaine, being a stimulant, may be perceived as having physical enhancement properties.

It is of course, possible that respondents simply misunderstood the instructions and reported use of substances, regardless of their intended purpose. Such possibilities are an inherent limitation of self-report measures (Richter & Johnson, 2001). If, however, students are using recreational psychoactive drugs for performance enhancing purposes, then this a matter of concern. Cocaine has well-evidenced potential for adverse effects, especially regarding cardiovascular function (Havakuk *et al.*, 2017; Kim & Park, 2019).

With regard to reported use of anabolic steroids and peptide hormones, although minimal, it is a concern that any students are using doping substances given the potential for adverse side-effects (Kutscher *et al.*, 2002). However, extant literature on doping use amongst student-athletes generally suggests prevalence rates significantly higher than that found in our sample (see e.g., Green *et al.*, 2001; Wanjek *et al.*, 2007; Williamson, 1993).

Use of performance enhancing technologies (altitude tents/masks, compression clothing, environmental chambers) was negligible across both samples. The predominant technology reported was compression clothing across both studies and all time points (6% at TP1 in study one, 20% at TP1 in study two), with minimal use of altitude masks too. It would appear then that such technologies were not a significant performance enhancing method within our samples.

4.6.2 Cross-Lagged Models

Regarding the hypothesis that greater use of NS and OTC medications would lead to positive changes in functional, but not moral, doping attitudes; cross-lagged analyses provided partial support and unexpected findings.

In Study 1, consistently strong autoregressive paths were found for both attitude measures in all models and all supplement measures (except WL with MDA), demonstrating stability of the constructs over time. Synchronous correlations were mostly weak and positive, which was unexpected. Theoretically, MDA and FDA should be consistently negatively associated with each other. This finding suggests that, at least in these data, the two constructs were not distinct.

Regarding the temporal analyses, positive cross-lagged effects were found from muscle building supplements to functional attitudes, demonstrating that increased use of MB influenced later functional attitudes. A cross-lagged effect was also found for functional attitudes on wellbeing, with stronger functional attitudes at time one predicting greater use of wellbeing supplements at time two. Finally, equal reciprocal cross-lagged effects were found between moral attitudes and medication use. Equal reciprocal effects cannot be interpreted as causal as the relationship is somewhat circular (X influences Y which influences X). These effects should be therefore interpreted as the two variables being equally influenced by a third (and unknown) variable (Tyagi & Singh, 2014). Thus, we found some interesting effects, especially in regard to the stability of the constructs over time. The cross-lagged effects however, were largely absent, although it is possible this was due to the use of just two time-points.

This limitation was addressed in Study 2, however cross-lagged effects in Study 2 were inconsistent. Muscle building supplements again showed significant positive effects on functional attitudes between Time 1 and Time 2 and moral attitudes between Time 2 and Time 3, but negative effects on moral attitudes between Time 1 and Time 2. Medications showed significant negative effects on functional attitudes across both time lags, but not on moral attitudes. No other significant cross-lagged effects were found. These findings partially support the second hypothesis, but due to the inconsistencies they should be interpreted with caution.

The results do show some support for the distinction between functional and moral attitudes as proposed in the IMDB (Petróczi, 2013a), although there are caveats. Strong autoregressive paths across all models show clear support for the stability of these constructs over time, but we would expect the synchronous paths to be equally consistent and significant. Most of the synchronous paths were negative, as expected, but the fact that some are positive and that few are significant, suggests the scale needs further work. Given the pattern of results across each time lag, it may be that the change from in-person to online data collection at T2 affected the findings. We initially set out to capture data across a competitive season, however, not only was there no competitive season, but people were not allowed to undertake any organised exercise due to pandemic restrictions. Regardless, the results suggest promising directions for future research to determine whether the attitudes function as hypothesised.

The findings also show some support for distinctions between different supplement categories and differential effects on doping-related constructs previously reported in the literature (Hildebrandt *et al.*, 2010; Hurst *et al.*, 2021a). Further, they add the cross-lagged effects of medication on functional attitudes. However, the negative association shows greater medication use weakens functional attitudes which is again, unexpected. This may reflect greater reliance on the self, rather than supplements, to achieve performance goals, but also perhaps greater trust in medicines (vs NS) to overcome performance issues (e.g., injury). However, this is speculation based on intriguing, but unexpected, results. Whether this is actually the case requires further research. Regardless, there is a clear need to recognise and further study, the potential impact of over-the-counter medication use on doping-related constructs.

4.6.3 Supplement Scale

We grouped substances into conceptually meaningful categories and supported this categorisation with CFA (Chapter 3). Results of these analyses suggest the use of such substances may be driven by common function or intended purposes. To our knowledge this is the first empirical evidence of such categorisation and is consistent with the IMDB's proposition regarding functionality of supplement use.

A key feature of the extant literature is the heterogeneity of data collection methods for NS use (Garthe & Maughan, 2018; Knapik *et al.*, 2016). This variability poses a significant challenge when attempting to draw broad conclusions on NS use by athletes. Whilst there have been attempts to provide taxonomies of NS previously (e.g., Garthe & Maughan, 2018; Hildebrandt *et al.*, 2012), none have provided empirical support for their categorisations. The taxonomy presented in this thesis therefore represents an important first step towards an evidence-based method of data collection for NS use that may help to resolve methodological issues in the literature.

4.7 Conclusion

The present study then, adds novel empirical evidence on distinctions between supplement types. Furthermore, it shows intriguing results that suggest future directions for research to further our understanding of the causal relationships between NS and doping attitudes.

It is important to note that, whilst the present study and work by Hurst and colleagues support some tenets of the IMDB, the IMDB does not distinguish between different types of supplement. Within their paper reporting development of the SSBS, Hurst and colleagues note some athletes suggested that the type of supplement they used influenced their beliefs about its performance effects (Hurst *et al.*, 2017; p92). Thus, our empirical findings that different supplements may exert different effects may require adjustment in the IMDB. Related, the present study suggests use of weight-loss or wellbeing supplements (e.g., fat burners, meal replacements, vitamins) are not related to doping attitudes and as such, future research may be best served focusing on performance related supplements (e.g., muscle-building) and OTC medications.

Importantly however, whilst there is evidence here of cross-lagged effects, suggesting influences over time, it is not yet evidence of causal effects. The methodological issues around the development of the FMDAS scale, described in chapter 3, alongside the findings in this chapter, suggest much more development work is needed on the scale. Whilst the constructs have been shown to be stable over time, there are issues around the distinction between them that need to be resolved.

Chapter 5: A Qualitative Exploration of Athlete's Dietary and Nutritional Supplement Use; Can Supplements be Presented as an Alternative to Doping?

5.1 Introduction

Research suggests athletes may not properly understand the intended use of specific supplements, which may lead to inappropriate use (Jovanov *et al.*, 2019). Whether athletes properly understand the role of supplements or not, use is prevalent across all sports and competitive levels. Some research suggests the prevalence could be as high as 70%, although this varies across sports and what is defined as a supplement (Garthe & Ramsbottom, 2020). Extant research also suggests higher prevalence in elite athletes than in lower competitive levels (Knapik *et al.*, 2016).

Only a small proportion of supplements have strong evidence to support their use (Schwenk & Costley, 2002) and some argue that an appropriate diet negates the need for NS (Lazic *et al.*, 2011). Others have suggested demands of high-performance sport, alongside practicalities such as food availability or nutrient deficiency, support measured use of supplements (Close *et al.*, 2022; Garthe & Ramsbottom, 2020).

Diverse reasons for NS use have been elaborated in the literature, e.g., maintaining a competitive edge, combatting the effects of aging, specific macro/micro nutrient goals, lack of food skills (see e.g., Braun *et al.*, 2009; Close *et al.*, 2022; Graybeal *et al.*, 2023; Knapik *et al.*, 2016). One possible reason may be found in research showing athlete's poor knowledge and practical skills in relation to healthy eating (Bentley *et al.*, 2019; Bentley *et al.*, 2021).

Furthermore, given the prevalence of NS use (Daher *et al.*, 2022) and the associated perceived risk in progression to doping (Backhouse *et al.*, 2013; Barkoukis *et al.*, 2020) it would seem prudent to provide appropriate athlete education to address these risks. Extant research here is limited and evaluations of existing programmes suggest that more should be done (Bates *et al.*, 2019; Ntoumanis *et al.*, 2014).

There is a need for qualitative research exploring these issues from the athlete's perspective, to elaborate their perspectives in more detail and to understand the complex relationships between nutrition, NS use and performance goals. Related, extant educational research explores the impact of interventions created for, rather than by, or with, athletes. Qualitative research is needed to explore what educational modalities athletes see as most effective.

5.1.1 Research Aims

The current study has two primary aims; firstly, to explore athlete's knowledge and practices around nutrition and the use of non-prohibited nutritional supplements (NS) and athlete's views on links between NS use and doping. Secondly, to explore athlete's views on effective and appropriate educational interventions.

I sought to contribute to the literature by examining the following research questions; (a) How do student athletes approach their own nutrition? (b) What knowledge and practices do student-athletes have in relation to non-prohibited supplements? (c) What knowledge and practices do student-athletes have in relation to prohibited performance enhancing substances? (d) What links, if any, do student-athletes perceive between the use of non-prohibited supplements and prohibited substances? (e) Could educational initiatives position NS as a viable alternative to doping and if so, how?

5.2 Methodology

5.2.1 Participants

A purposive sample of athletes studying at universities in the UK, engaged in competitive sport at British University and College Sport (BUCS) level or higher were recruited. I employed purposive sampling to gather a range of viewpoints across different sports and competitive levels.

For the individual interviews (Study 3), ten student athletes (five female) were recruited. Athletes competed in rugby (n=5), netball (n=2), basketball (n=1), triathlon (n=1) and distance running (n=1) at the following competitive levels: BUCS (n=2), county (n=3), regional (n=2), national (n=2) and international (n=1) and had participated in sport for between three and 17 years.

For the focus groups (Study 4), 18 student-athletes (nine female) were recruited. Athletes participated in one of five focus groups, with 3-4 athletes per group. They competed in a range of sports;

rugby (*n*=6), distance running (*n*=5), triathlon (*n*=4) and netball (*n*=3) and at the following competitive levels; BUCS (*n*=6), county (*n*=2), regional (*n*=3), national (*n*=4) and international (*n*=3).

5.2.2 The Interviewer

As discussed in the introduction and chapter 2, the interviewer is integral to the development of the stories that emerge from interviews and focus groups. In particular, their own experiences, beliefs and opinions can shape those stories, and ability to facilitate a conversational space, all help to shape the dynamics of both the interactions and subsequent analyses (Bryman & Cassell, 2006; Pezalla *et al.*, 2012; Roulston *et al.*, 2008).

At the time of data collection, I was immersed in other research as a staff member with groups of student-athletes from which my initial pool of participants was drawn. Thus, I was aware my participants may have preconceptions about me and their role in the interview. Although I sought to clarify I was simply interested in their own experiences and opinions as they saw them, I recognise that, with some participants at least, it would take time to establish the conversational space. Furthermore, my position as researcher, staff member and my own experience with the discussion topics were integral to the data collected.

I drew on substantial experience interviewing people around sensitive subjects, especially related to the use of image and performance enhancing drugs as well as my experience delivering training and education to diverse groups. I am comfortable talking to new people in situations where I need to have open discussion and trust my ability to facilitate those conversations, although I note the caveats expressed earlier in this thesis (Chapter 1: The reflexive researcher).

5.2.3 Procedure

Ethical clearance was granted by my institution. For individual interviews I recruited participants from students taking part in a related study and via snowball sampling. For focus groups, I recruited some participants from those who had taken part in individual interviews. These participants then acted as gatekeepers to recruit teammates or friends involved in sport. Other participants were found via personal contacts (e.g., colleagues, friends and family acting as contact points).

All participants were provided with an information sheet detailing study procedures and participant's rights. Participation consent was provided by email and suitable dates arranged for interviews. I recorded all interviews remotely via zoom due to Covid-19 pandemic restrictions. Individual interviews were conducted between June and August 2020 and lasted between 22 and 69 minutes (M = 37 minutes). Focus groups were recorded April-June 2021 and lasted between 38-51 minutes (M=43).

5.2.3.1 Interview structure. Interviews and focus groups were semi-structured, using a pre-determined schedule, but allowing for exploration of salient issues not explicitly targeted within the schedule.

The schedule comprised a series of open-ended questions grouped within broad topics; demographics (e.g.: *What sport do you participate in?*), nutrition and sport (e.g.: *How do you approach your own nutrition?*), supplement use in sport (e.g.: *What are the key influences on your use of supplements?*), knowledge and understanding of non-prohibited forms of performance-enhancement (e.g.: *When you think of non-prohibited forms of performance-enhancement, what are the first things that come to mind?*), knowledge and understanding of illicit/banned forms of performance enhancement (e.g.: *Can you give me any examples of illicit performance-enhancers in sport?*) and links between non-prohibited and illicit forms of performance-enhancement in sport (e.g.: *Do you see any links between using non-prohibited forms of performance-enhance and doping in sport?*).

Following on from the individual interviews, focus groups first explored some of the same topics, partly to gain the input of new participants, but also to see what grew out of group discussions. Additional topics were inspired by the findings of individual interviews. Key topics were; demographics and sport (e.g. *What sports do you all participate in*?), nutrition and sport (e.g., *How do you approach your own nutrition?*), supplement use in sport (e.g. *What are the key influences on your use of supplements*?), knowledge and understanding of prohibited and non-prohibited forms of performance-enhancement (e.g.

When you think of non-prohibited forms of performance enhancement in sport what are the first things that come to mind?), nutritional education including supplement use (e.g., *Have you had any education around nutrition or use of supplements?*) and suggestions for future education initiatives (e.g., *What sort of education would you like to receive around nutrition and supplement use?*).

Major topics of the schedules provided my overall framework, but I wanted discussions to be guided by things that seemed meaningful to participants at the time. That process inevitably led to tangential discussions and on occasion necessitated bringing the discussion back to the framework, so as not to accumulate data outside the remit of my study. This flexible approach has been described as trying to stay “on target”, whilst preserving a rich exploration of the participant’s story (Braun & Clarke, 2022). I sought to cover all key topic areas in every interview/focus group, but not every question was asked in every session.

5.2.4 Data Analysis: Theoretical Approach.

Braun & Clarke (2023) emphasise the importance of a theoretical position, noting that RTA “cannot be conducted in a theoretical vacuum” (p4). For my analyses, I adopted the approach of Byrne (2021), as his worked example resonated with my own goals. Given the earlier discussion of my implicit role in shaping the conversations, I take an experientially oriented constructionist approach.

A key criterion for the development of themes is recurring patterns across the data, but it’s important to note that something being repeated is not necessarily meaningful in and of itself. Meaningfulness is conceptualised, and constructed, both by the researcher, within the framework of the research questions but also by the subjective meaning participants ascribe to the topic of enquiry (Byrne, 2021). I sought to determine what the athlete’s themselves saw as meaningful within the topics, but at the same time, my research questions looked towards practical future initiatives and my own experiences were implicit in the conversations and analyses. I thus aimed to guide discussions, but let athletes tell me what they thought was important.

5.2.5 Data Analysis Procedure.

Data were initially coded using a deductive codebook approach, based on the themes of each schedule, to help familiarise myself with the data. Further coding inductively explored patterns of shared meaning to develop themes. The use of both approaches provides criteria by which to determine whether information is relevant to the research questions (deductive), but also allows for 'open coding' (inductive) to capture the meaning communicated and perhaps, meaningful themes not previously been considered (Braun & Clarke, 2021).

Analysis followed the six steps outlined by Byrne (2021) and Braun & Clarke (2021). First, I listened to audio recordings several times to familiarise myself with the content. I then manually transcribed them, taking brief notes on recurring points. My supervisor also read the transcribed texts several times to familiarise himself with the data to act as a critical friend in the analyses. Second, data were coded in NVivo 12 software to broadly cluster data within the six themes of the schedule. There are mixed feelings about the use of such software in RTA (Braun & Clarke, 2021), but I found it helped organise the large body of data and my associated thoughts in a coherent and accessible way.

Discussions frequently addressed multiple topics simultaneously (e.g., discussing supplement use both as part of athlete's own nutrition and broader discussions on their knowledge and understanding of NS). Such responses were coded across multiple themes where appropriate. Further coding using an inductive approach provided more nuanced distinction of coded text and subsequent development of new themes.

For the third stage, I developed new overarching themes and sub-themes. These themes were again informed by the original schedule but refined according to topics raised by participants during discussion, leading to the development of new sub-themes not previously defined.

For the fourth stage, I discussed the coding with my supervisor, reflecting on the development of themes and sub-themes from the codes. My supervisor acted as a critical friend, providing an alternative perspective on my analyses, which in turn required more reflection on my part as the analytical process continued. In the fifth stage, we discussed and agreed a final summary of the developed themes and sub-themes. The final stage was the production of this manuscript.

Whilst the stages above are described as sequential, it is important to note that analysis moved back and forth through the six stages to reach the final stage. Furthermore, whilst the analysis of individual interviews could stand alone, they are presented here more as a pilot stage. This is because of the way they fed into the focus group interview schedule. Some topics went in previously unexpected directions, and I wanted to explore these more in group discussions to gain a richer understanding of them.

5.2.6 Judging the Quality of the Research

Determining the quality of qualitative research generates considerable debate in the literature, with little consensus on best practice (Tracy, 2010). It is incumbent on the researcher to determine what approach is best suited to their own work. I therefore seek to illustrate the trustworthiness of my qualitative studies from a realist perspective (Sparkes & Smith, 2009), drawing on subsets of appropriate criteria discussed by Tracy (2010) and Stenfors *et al.* (2020). The worthiness of the study is illustrated in the introduction (and chapter 2) where associations between athlete nutrition, supplement use and doping are highlighted as relevant and significant. I ensured rigour and dependability through the application of transparent and replicable data collection and recruitment of appropriate samples to address the research questions. I sought to ensure confirmability and credibility through detailed descriptions of the data, exemplar quotes and explanations of tacit knowledge. Braun & Clarke (2020) note that themes do not 'emerge' in RTA, but rather are constructed by the researcher drawing on the rich stories they seek to interpret. My supervisor acted as a critical friend throughout this process, discussing themes in an iterative process. I also sought to embed my position as a reflexive researcher throughout the data analyses and discussions presented in this chapter. Finally, the corrections to this thesis provided the opportunity for further reflection on my theoretical position and my contributions to the themes I describe here.

5.3 Data Analysis: Individual Interviews

Three overarching themes were developed that reflected the most frequent and meaningful discussions with participants, within the framework of the research questions; 1. Nutrition: knowledge, behaviour and education, 2. Prohibited substances and nutritional supplement use: Knowledge and influencing factors 3. Gateway effects of supplement use.

5.3.1 Nutrition: Knowledge, Practice and Education

Athletes possessed poor knowledge around nutrition in relation to sports performance. Responses to questions about their diet were vague and although they frequently spoke of trying to achieve a 'balanced' approach to nutrition, most couldn't elaborate on that in detail. This was not wholly surprising in and of itself; the literature clearly shows this to be a common pattern (Heaney *et al.*, 2011; Trakman *et al.*, 2016). However, this group were all university students, with access to extensive resources and training in critical analysis and research.

Some athletes with specific dietary approaches or dietary conditions (e.g., food intolerances, diabetes, vegan) spoke of specific measures (e.g., protein sources, monitoring carbohydrate intake) to address their diet within those constraints, but almost none discussed nutrition in relation to sport performance. The only exceptions to this were rugby players who sporadically monitored macronutrient intake, with broad targets for protein and fat intake, and an international level distance runner who adjusted diet according to the competition timetable. Further, none of the athletes had received education they perceived as meaningful on nutrition, especially as it related to sport performance. Rather, their approach to nutrition was influenced by a range of other psychosocial factors, described in sub-themes below.

5.3.1.1 Personal approach to nutrition. I asked athletes to describe their approach to nutrition in any way they wished, but most were extremely vague. This was exemplified by a national level netball player:

You know, I get fruits and veg and quite a bit of protein where possible, obviously I've got some bad days as well.

Only two athletes noted any attempt to track macronutrients within a broad plan; both were rugby players, one of whom played at county level. The former also mentioned occasional use of software to track nutrition, whilst the latter said:

I take well, roughly about 4000 calories a day. I try and get my protein grams…if I hit between 180g and 200g of protein a day…and keep my fat under 100g I'm happy. And obviously, a lot of carbs…because I'm training.

Whilst they did generally recognise the need for balanced nutrition, or at least pay lip-service to the idea, they saw a student lifestyle as being a barrier. A national netball player said:

… the Uni lifestyle doesn't always lend itself that well to a balanced diet and so it definitely hit me a little bit hard in first year, at the beginning…

Some athletes did reference broad structure around nutrition in relation to their sport. Examples of this are the rugby player quoted above and this international distance runner: *So, during a competitive season I am flexible but relatively controlled I'd say. And the reason behind that is, your competitive season you're little bit tighter on what you take in because at that point, you'd be trying to sort of make sure you're restricting your way to a race weight. So, controlled in the sense that I'd be quite structured in sort of in the morning, something after, a porridge after a run in the morning and a light lunch and then probably slightly bigger dinner in the evening, and then some snacks in between. But staying away from probably some of the fattier stuff I eat during the winter.*

It was apparent then that, although the athletes recognised the importance of a healthy balanced diet, at least in some abstract sense, they lacked the skills, resources, and knowledge to implement it. This was not a theme I expected to find prior to the interviews. I had assumed that, given the importance of proper nutrition and their access to evidence-based approaches, they would have afforded it greater importance. I was surprised to find this consistently across the interviews and sought to explore it more in the focus groups.

5.3.1.2 Education and other influences on nutrition. That athlete's lacked structure in their approach to nutrition was perhaps explained by this next sub-theme. Across the sample, they reported a lack of structured nutritional education, whether targeted to sport or otherwise and regardless of sport or competitive level. For example, a former NCAA Division 1 basketball player:

> *…my sports, my S&C coach, she tells us a bit about nutrition from time to time and stuff like that. So yeah, no, I haven't had any sort of nutrition classes. I've never really looked into nutrition; I'm vegan so I think about it a bit more now, but I've never been taught anything about it properly*.

Equally, this UK international distance runner noted that:

> *I did have a few conversations with a nutritionist and sat down, sort of said this is what I eat …and they sort of said, make a few changes make sure you've always got protein with a meal. But that's the extent of my sort of knowledge around nutrition or workshops on nutrition...*

Those athletes who did note some nutritional knowledge were sport science students who had completed basic nutrition modules or undertaken self-directed research. However, modules appeared to lack specific focus regarding performance, or athletes did not recall such specificity, suggesting it was not a meaningful aspect of the module. Equally, whilst these athletes had research skills and resources via their degree, they frequently referenced social media, although some noted a measure of scepticism about these sources. For example, a county rugby player said:

> *And I guess a lot of it does, would, come from social media and TV and stuff like that. So, but I tend to…I mean as someone who's kind of research minded, if I read or if I hear about something that I find interesting, I'll probably look for an actual article on it and not like just listen to what they say on Facebook.*

Similarly, this county level rugby player stated:

> *I've had like, obviously my A-level PE. We went through it then, and there's been like some modules have touched on it for sure enough, I've never had just specific nutrition training. I'm just going off*

like what I watch. A lot of fitness videos on YouTube and stuff…I thought it was pretty self-explanatory.

When asked how he chose which videos to watch, he responded:

> *There's a lot of a lot of rubbish out there. So normally, I go with, I don't watch a YouTube video specifically for nutrition. Like, I'll watch like a bodybuilder put like every meal he'll eat throughout the day and like, why he's eating it and I listen or watch the ones that are kind of* [unclear] *and don't lie about taking steroids. I don't mind if they're taking the steroids or not, if they admit to it, but a lot of them say their natural when they're clearly not. So, them ones I kind of just scrap off…. And you can kind of tell when they're talking nonsense and who's, who knows what they're all about. So, kind of filters through naturally.*

It was apparent that social media was significant, with mention of key 'influencers' and reference to Instagram and YouTube as primary information sources, which resonates with extant literature (Frison *et al.*, 2013; Klein *et al.*, 2021).

I was less surprised by the meaning they assigned to social media than the lack of formal training around nutrition. The extant literature clearly how pervasive social media is (Alruwaily *et al.*, 2020; Bourke *et al.*, 2019), but also, I recognised my own immersion in social media, especially during pandemic restrictions when these interviews took place. I was however, surprised by how little clarity most athletes had around critically analysing social media, especially around the use of supplements explored within the next theme.

5.3.2 Prohibited substances and nutritional supplement (NS) use: Knowledge and influencing factors

Athletes' knowledge around banned[5] substances was extremely poor. They generally opposed their use in competitive sport but offered interesting insights into possible reasons for progressing to doping. Regarding non-prohibited NS, they all had better factual knowledge, perhaps because use of dietary supplements such as whey protein, vitamins etc was widespread. Whilst many knew of more

[5] Substances on the WADA Prohibited List 2020

specialised NS such as creatine or pre-workout drinks, only those involved in power sports such as rugby, or those regularly doing gym-based resistance training, mentioned using them. Most athletes felt NS were not *necessary*, except within the context of high-performance sport.

5.3.2.1 Lifestyle Factors*.* Several athletes noted poor understanding of food preparation amongst their peers. This, coupled with financial constraints, was seen as contributing to the use of supplements by students generally, including student-athletes. Interestingly, this highlights that student-athletes, often used as research populations, are not 'a breed apart', they are students who also take part in sport. Thus, they find themselves treading a balance between conforming to the student lifestyle, whilst also trying to conform to the demands of a sportsperson. Related, some noted the convenience of supplements as another influence. For example, this BUCS level triathlete said:

> *Lots of people I know didn't know how to cook when they got here and some still don't, so they'll buy protein bars, drinks and stuff because it's easier and then that's just part of their normal diet, it's not like, it's not a supplement thing anymore, it's just what they eat.*

And this BUCS level rugby player said:

> *I'm a student, I work. Well, I worked a little bit part-time alongside, I can't afford to eat and eat and eat, whereas actually, just taking a quick protein shake makes a lot of difference when I don't have to have another meal or another snack alongside*.

These quotes illustrate a key point; that some athletes may not view supplementation as it is nominally intended to be used (an addition to a healthy diet), but rather, just a form of convenience food that supplies good quality macronutrients. Whilst convenience is noted in the literature, this suggests such use may go beyond occasional use, but actually become integral to daily diet.

Related to this, some athletes noted supplements were used to address perceived deficiencies in their diet. For instance, this regional level rugby player, when asked about her teammate's use of supplements, noted: "*I mean, people use vitamin supplements and stuff like that as well, to try and balance out diets…*"

The same athlete also noted the influence of time constraints, especially for students:

I feel like I don't have the time to fix my diet properly to get that protein… It's the time thing, isn't it? So, like when I was unemployed, it was fine. Now that I'm not I feel stressed all the time.

The issue of food cost was frequently mentioned, sometimes alongside the constraints of alternative dietary choices. This county level rugby player noted:

…And then a lot of them, it's the veggie and vegan thing as well I think is, is changing the nature of supplements among the, kind of, I mean I class myself as a millennial but some of the girls that I play with now, or those, you know, Gen-z coming in and half of them are vegetarian.

The use of supplements to address other aspects of student lifestyle was also raised. This county level rugby player stated:

I have a few boys in my house who play hockey and actually…they have a red bull before their training sessions. But normally… that's because it's a Thursday evening and they're still tired from sports night [a social event]*. So, they're trying to wake themselves up rather than enhance the training performance.*

In this instance then, potent stimulants are used simply to overcome consequences of aspects of the student lifestyle that impact their ability to perform.

5.3.2.2 Sport influences: Competitive level and sport requirements. Some athletes noted that competitive level was potentially an influencing factor. At lower levels, or where an athlete was not planning to progress in a competitive sporting career, supplements were not generally seen as necessary. This, BUCS level netball player eloquently explained that:

The thing is, I'm here to do a degree, not to be a professional athlete. So that's the more important thing for me over extra performance in sport.

Equally, this triathlete also expressed no desire to go beyond amateur competition, and stated:

I've also just never felt like I needed to [use supplements]*. But one of my friends I go to the gym with, he's tried creatine and he's like for him, he wants to be a professional football player and that*

> *was like his whole thing. So, he was like anything that I can do to boost my performance, even if it's like mentally like I'm going to do it.*

At higher competitive levels, NS use was perceived to offer marginal, but important, performance gains, as demonstrated in the previous quote and this from a BUCS rugby player:

> *…if you kind of need to take it* [supplements] *to make it to that next level to in order to maybe start earning, then maybe yeah.*

This same athlete noted that, within his own sport, NS use was sometimes driven by expectations around physical mass. He remarked that players were not necessarily selected on ability, but often on the fact they were large and muscular, suggesting influence from coaches, "…*there's so much emphasized on size now and we will teach you the skills later*."

Peer influences were also evident; some athletes reported common NS strategies amongst teammates and the influence on their own behaviour. This BUCS level, rugby player said:

> *A lot of people in my circle starting to take protein and stuff and being like, "yeah, I'm taking protein and like" …and I actually did the same.*

Some athletes spoke of targeted NS use for performance-enhancement relevant to their sport, such as rugby players meeting macronutrient goals to maintain size and energy. This international level, distance runner said:

> *…so yeah,* [the most commonly used supplement] *in distance running or athletics, it's protein powder, but on race day, it's definitely caffeine, because every person is either popping* [caffeine] *pills, drinking coffee, or drinking red bull.*

Caffeine use to enhance competition performance was echoed throughout the sample and provides a clear example of targeted NS use. Related to this, the same athlete spoke about athletes relying on specific supplements:

> *…panic on someone if they haven't got a beetroot shot before* [a race] *because they suddenly attached the fact that* [they] *are running well because I'm taking a beetroot shot.*

This approach was noted even when the benefits were perceived to be psychological. This BUCS level, rugby player spoke about her own experience and that of her teammates:

> *…the girls always have Lucozade when their playing kind of thing, so for the sugar. It is far more psychological… I do sometimes take pre-workout or like drink a sugar free Red Bull or something before a game. But again, I'm fully aware that I think that is psychological for me.*

5.3.2.3: Prohibited substances: Knowledge and opinions. When asked about their knowledge of prohibited substances, all but one athlete struggled to name any beyond anabolic steroids and EPO. Knowledge was poor, as evidenced by several athletes naming testosterone and anabolic steroids (AAS) as separate substances (AAS are derivatives of testosterone). All athletes expressed moral opposition to use of prohibited substances in sport, but some commented on how the demands of sports could lead someone to use them. For example, this county level rugby player:

> *Rugby hurts less and is easier if you are bigger and stronger and there's no, like, two ways about that…so if you can do that in an easier way then, if you could get away with it if you need to get away with it then, yeah, you probably would find it super useful.*

This same athlete went on to say:

> *When you're young…like people feel indestructible right? They never think it's* [side effects of steroid use] *going to happen and it's a short-term boost or advantage that if you're, like my goal has never been to play elite level rugby. I don't want to play for England…but if that is your goal, I could totally see why people would be willing to sacrifice or risk the potential future even if they know about future implications, you know, to get that opportunity.*

Several athletes said they could see the value within elite sport, where performance margins. However, there was also agreement that anyone using them should have a clear understanding of how to use them. This regional level netball player said:

> *I think they* [prohibited substances] *are effective, I think obviously at elite level. It's not shaving masses off of your time and things like that. It's not making big differences, but just a couple*

milliseconds here that does make a big difference in that kind of environment. And from what I know, I do think they are effective and again when used correctly and things like that, but I'm sure people who use them at that level know what they're doing.

I asked whether they thought such substances were necessary to achieve elite level sporting performance. Whilst they all said that performance could be achieved without them, they also noted the demands of elite level sport could make such use *appear* necessary. This BUCS level triathlete summed this somewhat incongruent position up:

> *I don't think they're necessary no, but I think in certain environments like in the cycling like industry, like if you don't use them, you don't have a, like a chance in competing, then I think people see them as necessary. So, otherwise, you're not going to reach the level you want to be able to reach, but I don't think they're necessary to reach top performance and maintain performance.*

Unfortunately, we didn't explore this dichotomy further in the interview; that something could be 'unnecessary' and yet, without it you stand no chance of progressing. The conversation here turned to influences from different sport types, with cycling perceived as a doping-rich environment.

Other athletes noted such substances would allow someone to train harder and recover faster which, in a competitive environment, especially when competitions are close together, was a valuable benefit. However, they recognised this carried risks of adverse effects, as well as career-ending sanctions if caught. The potential for such outcomes was often quoted as sufficient to prevent these athletes from doping. Equally, moral considerations around the use of banned substances played a strong role in influencing such decisions for some. For example, when asked if he would use doping, this international distance runner responded:

> *You might have to sacrifice a few of your morals, because you need to perform up here. And whereas I would love to perform 'here', I'm not willing to make those sacrifices in terms of, I'm not willing to take a substance that will allow me to get to that level.*

Thus, athletes recognised potential benefits and possible drivers for banned substance use, but identified several factors that would prevent them personally from using them.

This topic in particular resonated with me. I have interviewed over 150 people about their use and opinions of such drugs over the past 20 years. I found myself having to stay quiet when asking people to name banned substances, especially when they made obvious (to me) mistakes. My role was primarily to listen, certainly not to teach, but I noted that I very much wanted to in some interviews and was at pains to move away from too much self-disclosure on my background and experience. However, reflecting on the interviews with that experience in mind, I saw clustering in participant responses, broadly producing three groups; (a) those with absolutely no interest in doping substances or developing an athletic career, (b) those who, to me, seemed very interested in doping from a cost-benefit perspective, some of whom toyed with the idea of an athletic career but felt they should have progressed further by this point to achieve that (and thus considered doping due to timeframes), or alternatively wanted quicker, more effective, aesthetic results from their exercise and (c) those who were actively involved (or had been) in competitive sport at national or international level for whom doping was an absolute "no" and supplement use was viewed with caution at best, deep mistrust at worst.

The reader may be asking, where in the data do the codes and themes for these groups lie? The answer lies more in the nature of the interactions; the non-verbal communications, or rather 'not what they said, but the way they said it'. Those in group A spoke about doping as an abstract thing, there was no interest in their voice, their responses; doping was an odd thing that other people did, that they had barely considered. Conversely, the other two groups spoke with passion; they had thought about it, their voices here were not new, they seemed to be expressing considered thoughts and feelings. For me, it was that passion that characterised the groups and emotions can be awkward to code. The only real difference between groups B and C was context; how positively (or not) they viewed doping. Certainly, both groups expressed understanding of why people would do it.

I reflect on this here as part of the corrections to my thesis as, whilst I did revisit the recordings, I noted the complexity of trying to code nuance, purely to evidence a perceived grouping that is highly dynamic, with blurred boundaries between groups. The nuance here is the interface between emotion and context that distinguished the groups for me. Thus, this is more a reflection of thought processes and perhaps my own feelings, that contributed to my analytical lens.

***5.3.3 Gateway effects of supplement use*.**

This theme explored athlete's thoughts about possible gateway effects of NS. Generally, athletes felt they could act as a gateway but importantly, noted moral opposition and concerns about side-effects could (or should) prevent such effects. This BUCS level rugby player commented:

> *I think it* [supplement use] *steps you on that like escalation ladder… if you see that something is working… the advantage you get from the legal ones or the ones that are allowed… to the ones that are not… if you start going up that ladder… I'm getting bigger, I'm getting better, I'm getting noticed, you want to keep improving… the more you start doing these things.*

This response was interesting, because (as she mentioned) it was borne out of her postgraduate work in the sociology of nuclear weapon escalation and reflected the parallels she drew to create the narrative.

Some athletes identified 'grey areas', where use of non-prohibited substances was taken to limits that were morally or ethically questionable. This blurring of distinction between prohibited and non-prohibited use was seen as exacerbating any gateway effects. This international distance runner remarked; "*Eventually it comes a point where they see the world not as black and white, but as sort of shades of grey*" and explained this by saying:

> *There's a bizarre amount of asthmatic distance runners at the highest level now… supplementing salbutamol… you find a lot of people taking a few puffs of their inhaler prior to a 1500 meter or 5k*.

He further explained potential gateway effects by remarking:

So, from a functional aspect. I'm taking a substance that is improving my performance… it's improved my performance, brilliant… and then move to the next list of substances.

This recognition of a 'grey area' prompted this athlete to purposefully avoid such behaviour; "…*my psychology of approaching the grey area, stay as far away from that as possible*".

A similar outlook was expressed by this this BUCS rugby player. He talks about using NS to gain results he perhaps wouldn't achieve otherwise, but drew a line at using banned substances:

I think when I first started using supplements, I was quite naïve thinking this is just going to be the miracle and I'm going to get really big and really strong and really fast… but at no point have I ever thought, 'Oh, I'm going to go take steroids'.

Athletes talked about moral opposition to doping having a greater effect than any fear of testing positive (although only one athlete had ever been tested). They also perceived the demands of higher-level competitive sport as being influential, given a particular mindset. In essence, both functional and moral doping attitudes were seen as highly influential, with high functional and low moral doping attitudes potentially representing a risk profile for doping when using non-prohibited supplements for performance.

5.4 Data Analysis: Focus Groups

Building on the outcomes of the individual interviews, four overarching themes were developed in the group discussions: 1. Education and knowledge on diet, 2. Factors influencing supplement use, 3. Gateway effects of non-prohibited supplements and 4. Educational interventions; what is needed? These themes and their sub-themes are described below.

5.4.1. Education and Knowledge on Diet

I wanted to explore issues raised in individual interviews around poor understanding and implementation of good dietary practices further with the focus groups. Groups discussed input from dieticians or nutritionists via their teams, but that input was largely dismissed as rudimentary, and several athletes were surprised that others had any nutrition education at all provided. Mostly they felt left to their own devices. This national level rugby player commented:

We had a sports nutritionist when I played for [County team] *but that was basically just pointing out vegetables aren't bad and explaining the pros and cons of different supplements and eating some foods before training, but it wasn't in much detail, so I mostly just worked it out myself.*

Equally, this BUCS level rugby player said:

We had someone do a talk which was kind of interesting, but it was very general healthy eating, kind of a like, don't eat too many takeaways and make sure you get a balance of macros, but it didn't really tell me anything I felt I needed to know.

His experience then, was that whilst some advice was provided, it wasn't particularly relevant.

Groups often spoke of information shared between players as being more interesting and relevant than any formal advice offered via their team. Formal advice was often described in a dismissive manner. This international level distance runner said:

When we were part of team [team name] *we'd sort of have a little bit of information, but it's not like, it wasn't structured. It was sort of, here's a document taken off the internet or from another professional team, about sort of fuelling before a run or fuelling for the week. So, we've been given sort of a very like, I don't know, an infographic almost, about what might be useful to look at.*

Experiences of nutrition education then, especially as it related to their sport performance were characterised as sporadic and cursory, regardless of competitive level.

Where participants did discuss dietary structure, it was more about timing of food intake relative to training, foods to avoid or broad targets, rather than attempts to support performance. For instance, this national level rugby player reported said:

If I have a really crappy meal, like the night before and the morning before I play, I feel horrific, like really sluggish, really slow".

Similarly, this county level triathlon athlete noted:

If I don't eat right or eat the right things like certain times you feel so different and you know you think you're fine, then you start running and you've eaten too soon, or like not enough, and then 'oh actually I feel awful'.

Notably, these approaches were largely formed as the result of prior experiences, rather than any evidence-based approach to sports nutrition or expert advice. Participants discussed these issues at length, sharing accounts of poorly planned food intake. They all mentioned a lack of input from coaching staff around even something as basic as food timing. The general feeling seemed to be that coaches didn't see nutrition advice as important and therefore, neither did athletes. As one rugby player noted:

"*Bottom line is, your coach is really just there to train you how to play.*."

The only exception was an international level distance runner who reported dietician input provided by her team. However, this was in response to an identified eating disorder, rather than an educational programme. Interestingly, all but one member of that focus group (all endurance athletes) reported having had eating disorders, but only the female athlete received support from the federation.

Discussions here reflect the individual interviews but extend them through the detail around poor team (or federation) input. Discussions were rooted in athlete's perception that they were essentially 'on their own' regarding nutrition. Reflecting on this, I wonder how much the premise of strict liability may contribute here (WADA, 2021b). If athletes are held solely responsible for what goes in their body, does this create distance with athlete support personnel who may want to avoid being involved? Whilst this question could not be resolved in these groups, it is worth considering for future research.

5.4.2 Factors Influencing Supplement Use

I also sought to further explore influences on NS identified in the individual interviews. Key influences, including peer influence, coaches and trainers, social media, and the sporting environment were all discussed. This theme suggests a complex interplay of both external and internal influences on athlete's decisions around supplement use. These influences are explored through several sub-themes.

5.4.2.1 Peer influences. Supplement use by friends and teammates was frequently cited as a key influence. This regional level netball player said:

I think, obviously I don't take protein supplementation, but I am contemplating starting. I think a big influencing factor is like people around me. Like, most of my housemates take it.

And this national level rugby player:

…you're more likely to do it if you know some friends have tried it….and like I don't know, if increasing their protein use is working for them, then you're probably more likely to give it a go yourself.

Student-athletes at university commonly live in shared accommodation, and this was the case for our athletes. Often, their housemates also took part in sport and/or exercise, creating a shared culture that influenced nutritional and training behaviours, perhaps exacerbating the effects of peer influence. This regional level netball player said:

I feel like as a university student, like literally living with other athletes, other students who are all taking supplements, like many of them, like friends with lots of people who play sport as well, I feel that definitely does increase your exposure to like talk about nutrition supplements, which would probably increase my own like thinking about that compared to if I wasn't at university.

5.4.2.2 Coaches and Trainers. Team coaches were described as influential in decisions to use supplements. This regional level rugby player suggested:

Probably peers and then almost like peers and significant others, so if your coach is saying, "I think you should be like… maybe start supplementing protein, you're more likely to do it…".

The influence of coaches was pervasive. In particular, the relationship that is built up between athletes and coaches over time and their position of authority were seen as highly influential. An example of this was provided by this regional level triathlete:

I feel like we as athletes look up to our coaches and are quite influenced by what they say, because they are coaching us all the time and they're the ones telling us what to do so, like if they said take this, take this, you probably would listen to them, because they know you.

Personal trainers were also described as influences on athletes' supplement use. For instance, this BUCS level triathlete said:

…every like, personal trainer or person that works in the gym they're all like, most of the time they use it and if I asked them, "I'm like struggling to put on weight, I want to put a bit of muscle mass on" then that's what they normally say, to take a protein supplement as well as doing this gym program.

5.4.2.3 Social Media and Influencers. Social media was frequently highlighted as a significant influence on supplement use, generally via key influencers promoting particular dietary approaches or supplements. Sponsored influencers raised awareness of specific brands/products and their supposed benefits. This county level rugby player explained his view:

There's influence from like social media seeing, like all the advertising that whoever it is, is sponsored by [brand] that does influence you to go to that brand, or just to use protein in general, or it's the new beta-alanines or whatever that player is going on about, it's influence from people who have succeeded.

This viewpoint was echoed by other athletes, such as this regional level netball player:

Most of my housemates take it [protein supplementation]*, and then my influencers from Instagram are often promoting it or like associated with like My Protein or like Women's Best or things like that, and so yeah definitely these things have influenced me..*

And also, this national level netball player:

I follow influencers on social media that promote them and so that's how I found out about like different products like different protein bars and stuff like that, so I think that's quite big influence.

Whilst most athletes followed influencers from their own sports, some mentioned the influence of athletes from other sports. This highlighted that motivations for exercise and supplement use may not just be driven by the athlete's own sport. For example, this BUCS level triathlete:

> *…I'm sort of like…watching Eddie Hall a lot, you know the strong man … And he's sponsored by My Protein, and he gives you like a great discount and he's always saying "Oh, this is good".*

5.4.2.4: Influences from the Sport Environment. Athletes noted strong influences from their sporting environment such as the impact of training and the prevalent culture within their sport and competitive level. For example, several rugby players noted the propensity for 'size before skill' within their sport, with newer players encouraged to gain mass quickly to be able to progress. When asked about this, one international level rugby player commented:

> *Yeah absolutely. Players that I've played with in the past, have not been skilful at all, but they packed on so much size and they're just snapped up straight away,*

For rugby players then, there was a drive to gain physical mass as a prerequisite to advancing their career. Other athletes noted that progression through competitive levels brought with it more focus on the use of supplements. This county level netball player said:

> *When I played at school, like that wasn't very competitive, so there was literally no talk about it* [supplement use] *ever. And then, as when I'd say, when I hit like county level, people started to talk about it.*

This was echoed by this BUCS level triathlete:

> *Yeah, I think when you get at a more competitive level like from say from school to university, it becomes like everyone's talking about like supplements or working out, or nutrition, all of that sort of stuff.*

In addition to these influences, training volume related to the competitive season was suggested as a driver for supplement use. For example, this county level rugby player noted that:

…like in the last year, with Covid, I haven't really been taking any supplements just haven't thought I really needed it. But when we're in season and we're training a lot and trying to keep the weight on, I'll be taking protein shakes.

5.4.2.5 Disincentives to supplement use. Whilst the discussions focused on drivers for supplement use, we also explored reasons for *not* using them. The potential for inadvertent doping because of contaminated supplements was particularly highlighted. As explained by an international level distance runner:

I don't really want to have to worry about any of that [supplements] *being contaminated, even though you'd go down that route of batch testing and making sure you do your due diligence on that. I just don't see the point, if it's not anywhere near me, then I don't really have to worry about it.*

Other reasons for not using, or discontinuing use, reflected some of the previously mentioned drivers *for* use such as cost or dietary restrictions, highlighting the importance of context for enablers and barriers. For example, this international rugby player noted his dietary restrictions created cost issues when purchasing supplements:

So like protein, for example, because I'm lactose intolerant, it's very difficult to find protein that mixes well and gives you the protein output that whey protein would and that taste nice. The alternative ones that I'd have to take out, the vegan ones are very, very, expensive and I'd much rather just, eat more chicken or more eggs or have a couple of cans of tuna or something, which kind of is a lot cheaper than buying like £30 bag of protein.

A BUCS level rugby player noted the influence of cost, but also described his sense that supplements were in some way 'unnatural' and as such, less desirable:

When I've got a little bit more expendable income I've invested in some supplements, but I try and get most of the stuff through whole foods if I can. I think the other thing is with some of the other stuff …It's probably just a personal feeling, like a lot of it just feels very unnatural and processed and

I'm just not a huge fan of that sometimes. I can't imagine the chemical processes some of them go through to get to what they are and yeah just probably becoming a bit more sceptical on whether they're actually needed or not.

However, the same athlete also noted that his scepticism only applied to some supplements:

…. obviously, a lot of them are incredibly helpful or can be, if used correctly and but yeah that probably the two main reasons for me [for not using] *expense and unnatural sort of things.*

Whether a supplement was useful was also raised by other athletes. Most athletes did not speak of critically analysing supplement benefits; just one BUCS level triathlete noted that:

I did a lot of research side like sift through papers and actually like read what was like beneficial and what wasn't and then obviously like the Informed Sport [a batch tested supplement brand] *so whether it's actually accredited and like sort of supported by researchers and science, before taking it. But it would take me like a good couple of weeks of reading information before thinking I'm actually going to take it.*

Athletes therefore identified multiple influences on their decisions to use supplements. Some of these influences related to their own nutrition and feelings about supplements vs whole foods, whilst others reveal a complex interplay from their social and sporting environment. Importantly, few athletes noted the benefit of having reliable information about supplements in their decision-making.

5.4.3 Links between non-prohibited and prohibited performance enhancement.

The third overarching theme explores connections between use of non-prohibited supplements and doping. Athletes generally saw a link, but noted its dependence on a particular mindset. They also identified reasons why this progression may not happen.

5.4.3.1 Gateway effects of non-prohibited supplement use. Several athletes believed the use of non-prohibited supplements increased the likelihood of using prohibited substances. This international level distance runner was quite definite about this:

You're more likely to dope if you take supplements, because you're more likely to do everything you can to get the best out of yourself. You're looking at all different things, you can use because you have that mindset.

Thus, this athlete perceived a particular mindset of specifically seeking performance enhancement by any means available. This international level distance runner echoed this sentiment, but framed within a broader context of environment and experience:

I suppose say if you're a naïve person in sport, probably more like a weightlifter or something like that and you're asking questions…your first question is not going to be 'Where do I get gear?' [anabolic steroids] *It's going to be along the lines of 'What supplements, do you use?' When you're asking older, more experienced athletes, you might be saying 'Well what should I be taking?' and they're probably not going to open a cabinet and say, well, here we go. But as you get more immersed in the sport and those doors are open, or your eyes are opened, then maybe that might be a route into using if you were that way inclined, but yeah, it's interesting to think of it as like an age and experience point of view.*

He further explained that:

As you just become more exposed to something, more knowledgeable about something, you realize there's more frontiers that you can approach.

So, this athlete then, sees the progression as linked to contextual influences such as sporting environment and the incremental progression of knowledge and experience.

This link was further elaborated by this county level rugby player:

I think that definitely might be a link because the people who are more willing to explore permitted stuff, even when it gets to the more extreme end of the stuff, they're probably more likely to be the people who are going to be really trying to get the most from supplements and stuff. So maybe they think they've been doing all of this stuff already maybe, why not just take the jump...

This BUCS level rugby player also noted the idea of incremental progression, tied to ever decreasing performance gains from non-prohibited supplements:

> *Yes, definitely soon as you start taking protein or whatever, then you move on to the next, and it starts getting closer and closer and your opinion of supplements may start getting more and more blurred and you just, as the gains get smaller and smaller when you're on 20 supplements a day or whatever the gains get smaller, it's more likely to have that big jump and then it's obviously going outside legal realms.*

Interestingly, this view reflects those previously found amongst bodybuilders in a study by Boardley & Grix (2013) where progression followed an incremental path as gains from supplements diminished.

Another perspective suggested supplement use, including doping, could be seen as just another tool to use. This BUCS level triathlete explained:

> *To an extent there's using what's available to you as well, like if there's new technology and trainers and new bikes that are lighter and things like that, and you can buy those to race on and they give you that advantage, it's kind of like why wouldn't you? So, if there are things that going to aid your nutrition and help you in training and it's also just another thing that's a bit like, it's a benefit to you.*

Our athletes framed gateway effects in terms of mindset (e.g., "…inclined that way" "…using everything you can" "..people trying to get the best from supplements") *and* environments rich in experiential opportunity and guidance towards more 'risky' NS use prior to doping. Essentially, they described someone vulnerable to influence, keen to experiment and looking outside of themselves for 'solutions' to performance goals.

This shared narrative existed across competitive levels and sport types, but it wasn't clear where the narrative was derived. Nobody spoke of people they knew who matched this characterisation, rather, conversations related to some abstract 'other'. This suggests shared meaning (and detail) in the conceptualisation of a doping athlete that perhaps exists within a broader social context. Participants in these groups came from diverse backgrounds, geographically, culturally and in terms of sport involvement so the shared narrative is not necessarily derived from directly shared experience. It is relevant to consider this in light of the impact such conceptualisations may have on narratives constructed around gateway effects.

5.4.3.2 Barriers Preventing Progression to Doping. We also discussed potential barriers to gateway effects. A BUCS level rugby player explained how other influences would stop him from progressing to prohibited substances use. In particular, he highlights lack of desire to progress in the sport:

> *I mean I if I was playing at a higher level, say, professional and it was like, 'ah dude, oh you're not going to make it', then maybe I'd think about crossing the line. But just playing university and not going further, no. Because I'm starting a career or whatever, yeah, I think I'd have no desire to* [use doping].

A county level rugby player echoed this and explained how his opinion changed over time, highlighting a key stage when he could have been influenced to try doping:

> *I think it's also like a time thing as well, I think. Now I'm at uni I wouldn't even think about it, but if I was offered it say in year 12 at school or something like that, I would be more susceptible to it.*

When asked why he would have been more susceptible, the athlete said:

> *Less educated and probably more ambitious like that, I could have gone further in a rugby career or whatever. Whereas now, I pretty much know that's not gonna happen, I don't really want to, and I know more about the harmful effects of using steroids incorrectly.*

Other athletes noted how their moral code would likely be a barrier. A BUCS level triathlete said her environment may sway her, but ultimately, her own morals would probably stop her:

> *I think if I was in an environment where everyone was taking them and I was, I was competing all the time, it was my everything, racing was like what I wanted to do, I think I definitely could be swayed to try it, but I just, I am very morally against it in general, so I didn't think I would.*

Something that struck me in these conversations, was the lack of discussion around "winning". Athletes spoke of NS and doping use in terms of performance gains, either as a means for career progression, to maintain a competitive edge or simply to achieve personal goals. Some did speak of moral issues around cheating when we discussed doping more generally, usually around not wishing to compromise their own moral codes. But even for these athletes, how one may progress to doping behaviour was characterised as an incremental and (almost) understandable journey to reach specific goals, rather than a 'win at any cost' attitude. Thus, it seems they recognised doping as cheating, but when pressed for detail, didn't *conceptualise* cheating to win as a primary goal.

5.4.4. Educational Interventions; What is Needed and How Do We Do It?

The final theme examines what kind of education initiatives could prevent progression from NS use to doping, and whether it could be framed to present NS as an alternative. Athletes generally felt sports nutrition interventions promoting appropriate non-prohibited NS use could be effective. However, they were keen to point out it should be delivered by experts (i.e., dieticians, sports nutritionists), rather than, for instance, team coaches. There was mixed debate around when such education should be delivered, with some suggesting that it should happen as athletes began their career and others suggesting even earlier. All athletes agreed such interventions were best framed within the wider context of how food and supplementation can positively influence performance, rather than from a prohibitive, moral-based perspective.

This national level rugby player said:

> *I think yeah, definitely as a base to kind of educate people, because someone might be like 'Oh well, I'm using it, so why am I not seeing improvements' … so you take a look at someone's diet and you go, "oh because your diet's crap", or "the training is off"… [if] you say like upskill people, they know more, and then they're aware that it's* [improving performance] *not an overnight thing. I think they're less likely to then dope.*

This national level netball player elaborated:

> *…it's basically moving away from saying like, how bad doping was and how it's morally wrong and prohibited you shouldn't do it. Rather than tell them what not to do, tell them what to do and say*

you should be able to get most of what you need from really good, healthy, balanced diet and consulting with a specialist nutrition coach and S&C coach. It's more about the training and overall nutrition, rather than just saying 'don't'.

Regarding when such education should be delivered, some suggested athletes should be targeted as they move from playing at school or local clubs and start to show more commitment. This county level rugby player explained:

I think, around 15-16 is probably where most people will start really getting into the gym stuff and so maybe quite competitive, so I think if you can get in early around the early to mid-teens like 14, 15, 16, that's probably a good time, so educating people before they start down the wrong path.

This was echoed by his teammates, with this national level player adding:

But if you wait until [they're]20 then you've got a few years of doing things wrong.

A BUCS level rugby player elaborated on this:

I think especially from the concept of rugby around 15 is probably the best timing. It's when everyone starts getting into the academies, getting ready for if they're going to try and go pro, they're going to need 16 to 18 to be their best years.

Some athletes suggested even earlier could be more beneficial. For example, these BUCS level triathletes said:

Athlete 1: I would say education in schools is probably my main thing yeah and educate people younger, even if they're not athletes, because then they might become athletes and it's still relevant.

Athlete 2: Yeah, I'd say the same, I think, although it's important to have that education from a young age, I think, to a certain extent, it is already done in schools it's just not done to a level that's... like kind of like you get taught general nutrition in like science courses, but obviously it's not specific to training in sport.

This latter comment highlights a further issue raised, that of specificity to the sport. Most athletes felt such education should be targeted towards the demands of their own sport, making the education more relevant and accessible. For instance, this county level triathlete:

> *I feel like, I would be more interested in learning about nutrition for my performance if I knew how it could help me in my own sport. Like I don't need to know what a weightlifter does or like, a rugby player. I need to know what's going to help me run and cycle and swim and recover from that. If it was too general, I'd be like, how do I use this?*

Targeting education to the demands of specific sports and improving performance was also highlighted to divert athletes from progressing to doping. This BUCS level triathlete commented that:

> *Yeah, I think if people understood like if that if their nutrition and supplementation was like tailored and suited to them and it was really fine-tuned and they understood all the benefits, I think they'd be less likely to feel the need to try stuff that's banned because they would be experiencing such good benefits from that, but if you do tailor it, so you do experience really good benefits that they wouldn't really feel the need, so I do think it would definitely decrease that.*

Regarding whom should deliver such education, there was universal agreement it should be people with recognised expertise in the area. Coaches were seen as lacking the necessary education and credibility regarding nutrition. For example, this national level netball player felt quite strongly that coaches were not appropriate:

> *Unless they were like specialists in nutrition, or they had a background* [in nutrition] *like, I'm a coach and I don't have to have any nutritional background or qualifications… I wouldn't then trust what they were saying or listen to them, you'd almost want that professional advice to actually know that that's what is right.*

This was echoed by this international level rugby player:

> *…coaches are there to train you aren't they, they're not necessarily there to teach you stuff other than rugby and, if they start then talking about nutrition, my first response would be where's your*

qualification. Like you're just a coach, like you're not a nutritionist you haven't got any background in it…

Thus, athletes were supportive of the idea that early, sport-focused education, built around nutrition and appropriate supplement use could be beneficial in preventing progression to doping. Some athletes noted that interventions already existed, built around a ‘food first’ approach. However, they also highlighted the lack of impetus driving such interventions. These two international level distance athletes commented on this:

Athlete 1: *In terms of teaching people to get their fuelling from food not supplements, or further down the line steroids…sort of a food first, food before everything…I think that the principle's great, but I just don't think there's…there's no structured approach from the national governing bodies or from* [redacted NADO] *and no one's pushing it.*

Athlete 2: *I've been working as the* [NGB] *anti-doping program officer, so our whole approach with rugby is to try and explain to the young academy kids that they can reach their goals in terms of mass and size and strength through food rather than through supplements … that ties into the anti-doping message quite strongly and gives people practical advice if your coach is saying you need to be 90kg by the time you're 18; teaching them how to do that, using food…and actually don't just say don't take drugs, like provide a viable means, allowing them to meet the targets* [that] *are being set… It's not come from* [NADO]*, it's coming from the* [NGB].

5.5 Discussion

The research questions guided development of the themes and the findings in these studies reflect the extant literature that informed those questions. Enablers and barriers to appropriate nutrition discussed in these studies largely mirrored those reported in the literature. However, these studies add more detail to those discussions, reflecting the complex interplay of influences on dietary practice and NS use.

For example, two key findings were the lack of structured approach to nutrition and widespread supplement use with relatively little understanding. Extant research shows athlete knowledge around nutrition and NS use is generally weak (Heaney *et al.*, 2011; Rash *et al.*, 2008; Trakman *et al.*, 2016) so these findings are not surprising per se, but exploring reasons behind them revealed a complex interplay of social, cultural and personal (including emotional) influences. Some of the barriers to good nutrition discussed by the participants have been previously elaborated in the literature (e.g., finances, resources, skill sets) (see e.g. Bentley *et al.*, 2021; Heaney *et al.*, 2008), but a key factor here appeared to be the lack of any structured education around nutrition and NS use across all sports and competitive levels.

For me, a striking aspect of this last point was less that teams didn't provide adequate guidance, but rather that the athletes appeared to just accept this as the 'way things are'. They spoke of a desire for guidance but turned to each other and social media rather than support personnel. Bentley *et al.* (2019), in their qualitative study of sports nutritionists, discuss a "dependence mindset" (p2079) whereby athletes, especially those who have been engaged in the "sport system" for many years, devolve responsibility for their actions to support personnel. Thus, nutritionists struggled to implement effective interventions with athletes, especially those involving personal action (e.g. food shopping and preparation). These nutritionists spoke of other barriers that resonate with the discussions in the present study. Coaches were cited as disseminating misconceptions around food that contradicted nutritionists' advice and, in some cases, radically altered athletes' relationship with nutrition. Rugby players in the present study spoke of coach-driven impetus for 'size over skill'. Importantly, nutritionists spoke of frustrations in dealing with these issues due to a lack of opportunity and power dynamics within the team, especially given the dominant position of coaches.

Whilst the findings are relevant to the present study, the study by Bentley *et al.* (2019) explored issues with nutritionists working in Olympic/Paralympic and/or professional sport. The present sample did include a small number of international level athletes, but none were Olympic or full-time professional athletes. Thus, the parallels in findings suggest the issues identified by Bentley *et al*. may be rooted in earlier and perhaps, wider experiences beyond the 'sports system' identified by Bentley *et al.* (2019).

In the present sample, coaches were cited as highly influential in decisions to use NS, but were, paradoxically, not considered a reliable source for nutrition education. The need for input from sports nutritionists was clearly expressed, strongly defined in terms of relevance to each sport, as opposed to more general nutritional guidance. This was somewhat reflected in Bentley *et al.* (2019) when nutritionists spoke of frustration that athletes were most easily motivated in the competitive period, when nutrition was seen as directly relevant. Outside of the competitive calendar, it was much harder to implement meaningful changes to athlete behaviour. Sports nutritionists also highlighted opportunity as a barrier in their work, with limited time to work with athletes.

Athletes in the present sample suggested a need to implement education earlier, before 'bad habits' became entrenched. Working with young athletes, early in their career and making good nutritional practice a priority, could overcome issues of opportunity and embed better habits. There may be issues of resource here, however food technology is already an integral part of the UK school curriculum (PHE, 2015) so there exists a framework on which to build more specialised education relevant to sport performance. However, many athletes in the present sample spoke of peers' (or their own) poor food preparation skills, perhaps reflecting insufficiencies in the current curriculum. That is perhaps an argument in favour of investing more in such a basic life skill at an early age.

These studies also highlighted the influence of social media, a key factor that is likely to become more significant as its presence grows, especially in relation to nutrition advice (Russo & Simeone, 2017). Whilst some evidence suggests consumers of social media may be better informed on nutrition compared to mass media consumers (Russo & Simeone, 2017), other evidence highlights issues around the accuracy of information and the credibility of sources (Rutsaert *et al.*, 2013). Further evidence shows strong positive associations between SM use and use of NS and doping substances (Hilkens *et al.*, 2021).

In a review of the literature, Kucharczuk *et al.* (2022) noted 90% of adolescents in developed countries have social media accounts and, worryingly, that adolescents were more likely to recall unhealthy food and follow celebrity influencers. They further noted that use of influencers to promote unhealthy dietary practices was increasingly commonplace. In the present sample, athletes frequently spoke of social media influence as pervasive and, with few exceptions, did not reference any meaningful attempts to critically analyse the information. Many of the comments essentially referenced a 'gut feeling' response to information from social media in terms of whether to accept it. Bearing in mind that this group had, or were developing, skills and resources around critical analysis, this is concerning.

Evidence around the impact of social media (SM) on nutritional choices and practices is mixed. A mixed methods review of the impact on young adults by Rounsefell *et al.* (2020) showed greater SM use was associated with body dissatisfaction, restrictive dieting, and overeating, but also healthy food choices. Use of SM was also highlighted as encouraging body comparisons, thereby heightening dissatisfaction. Whilst young adults were aware of the impact on body image, they nonetheless pursued external validation via SM. These findings were reflected in other work, even amongst diet and nutrition students (Law & Jevons, 2023).

The impact of SM and influencers noted in the present studies reflects the extant literature, but it was less clear why influencers did not appear to be held to any evidential standard for their claims, even amongst students who recognised their brand loyalty/promotion. Rogers *et al.* (2022) note several features of SM influencers that contribute to their success in communication, e.g., multiple modes of delivery (images, video, blogs etc), physical attractiveness and features of language use to make messages feel personal to the consumer. More successful influencers can thus engage with huge audiences simultaneously, which also facilitates debate amongst followers, further cementing the messages. Evidence shows athletes engage with SM when it's easily accessible, well presented, information rich (regardless of accuracy) and they can connect to it personally (Bourke *et al.*, 2019).

There is perhaps a need for nutritionists to leverage SM to help address issues raised here, but there are potential pitfalls that need to be addressed. Whilst people are open to health interventions, especially around nutrition and supplement use via SM, evidence suggests they are reluctant to properly engage in open (vs private) SM channels (Klassen *et al.*, 2018). Further, the Academy of Nutrition and Dietetics published guidance for nutritionists noting that, whilst they strongly recommend making use of the opportunities of SM, caution must be exercised to avoid professional and ethical pitfalls of providing advice (Helm & Jones, 2016).

Reflecting on this last point, influencers are likely not bound by such professional constraints, a primary goal for many is to disseminate information that is popular and therefore garners more subscribers. Certainly, there is evidence to show that influencer endorsers of products are more effective than celebrity endorsers, largely because people are more likely to identify with them (Schouten *et al.*, 2019). In the present sample, athletes spoke of following successful sportspeople from their own sport, but also people from other arenas who represented ideals (often aesthetic) they aspired to. Of concern here is evidence that such influences can start as young as three years old and further, that the use of very young "kid influencers" to promote unhealthy eating is a growing trend (Alruwaily *et al.*, 2020), lending weight to the idea that evidenced interventions should start early.

There is a clear need for further research here, along three major strands; firstly the mechanisms of engagement with SM, how and why do people respond to some messages (and messengers) more than others? Secondly, how can that be used to ensure appropriate and accurate information is disseminated in a crowded field of information? Third, simple information delivery alone is insufficient (Hauw, 2016) and several barriers identified relate to practical skills, so how can SM best support food skill development?

When considering the development of appropriate athlete education, it seems SM could very much be part of the multi-faceted approach suggested by Backhouse *et al.* (2007). At the very least, it is critical to recognise the influence of the internet and the need for better critical skills amongst consumers

(Backhouse, 2015). Equally, the calls from the present sample for relevance in such education echo those of Hauw (2016) and Hanson (2009).

Finally, athletes in the present sample discussed factors relevant to the primary theory under investigation in this thesis, the IMDB. Specifically; Petróczi (2013a) argues for a distinction between functional and moral doping attitudes the extant literature does not really consider, and further, that the use of performance enhancers is not driven by a desire to 'win by cheating', but rather a desire to maximise performance. Whether an athlete chooses to progress to actual doping from non-banned performance enhancement methods depends on the doping mindset, of which moral objection is a key component. Athletes in the present sample recognised inherent moral issues in the use of doping and many felt that would prevent them from crossing that line, but also recognised why it may be desirable, given a specific mindset. Furthermore, their lived experiences and indeed, the hypothetical narratives they created around progression to doping focused almost entirely on maximising performance as described by the IMDB.

Importantly, for me, these conversations were not prompted by any prior discussion of the IMDB. Whilst I recognised these factors in the discussions, I actively avoided talking about specific theoretical models to try and prevent leading the discussion. I knew some participants were aware of the gateway model, but the majority were unaware of any extant literature in the field. Thus, this finding shows some support for the conceptualisation of the model.

5.6 Conclusion

This chapter draws together related research from diverse fields relevant to the research questions. Barriers and enablers to athlete nutrition and supplement use are elaborated in the extant literature but to date, scant research explores possible solutions from an athlete's perspective. Further, there is a dearth of literature on the influence of social media on the nutritional habits of athletes, especially adolescent athletes. Further research is required to bring together the disparate strands elaborated here, into effective, relevant and practical educational interventions.

Chapter 6: Discussion

I sought to answer three overarching research questions: 1. What are the effects over time of using nutritional supplements, medications and performance enhancing technology on explicit functional and moral doping attitudes and automatic doping preferences in student athletes? 2. What permitted forms of performance enhancement are commonly used by student athletes and why? 3. How can permitted forms of performance enhancement be presented most effectively to portray them as alternatives to, rather than precursors for, doping?

I addressed the first question by collecting longitudinal data on what supplements were used by student-athletes and how frequently and data on their functional and moral doping attitudes, using a novel scale (Study 1 & 2). The second question was partly explored by analyses in Study 1, but also through qualitative interviews with student-athletes (Study 3 & 4). The third question was explored via focus groups and built on the findings of the first qualitative study (Study 4).

6.1 Quantitative Studies

6.1.1 Supplement Use

Findings regarding substances and technologies supported the first hypothesis on which substances would be most widely used. Furthermore, empirical support was shown for a novel approach to measuring supplement use.

A key issue identified within the literature is the heterogeneity of methods used to record supplement use (Knapik *et al.*, 2016; Maughan *et al.*, 2018a). This limits robust conclusions as to what supplements are used by athletes and how frequently. Equally, denoting sample groups as 'supplement users' or not, as in some studies, fails to capture important details about supplement use. An example of this may be grouping athletes using multiple ergogenic supplements daily, in the same category as athletes using vitamins weekly. There are important differences here, but extant literature does not explore them.

Importantly, despite a wealth of research, no empirically supported taxonomy currently exists. For example, Garthe & Maughan (2018) group items such as iron and vitamin D as ‘Medical supplements’, defined as “Used to treat clinical issues, including diagnosed nutrient deficiencies” (p127). Literature suggests these substances may be used to address *perceived* nutritional deficiencies (Close *et al.*, 2022; Maughan *et al.*, 2018a), but they are unlikely to be diagnosed. It also raises the question of where to place medications, given similar associations with doping (Dietz *et al.*, 2016).

Whilst the findings regarding categorisation of supplements in Studies 1 & 2 clearly need refinement (see Chapter 3 and 4), they provide empirical support for grouping supplements. Importantly, this novel approach to categorisation was conducted post-hoc, reflecting patterns of use in the samples. Athletes self-select supplements to use together based on multiple influences and may not follow any recognised guidelines to do so. This approach facilitates understanding of how athletes group supplements, which may reflect reasons for using them. For example, athletes using vitamins and minerals only are likely attempting to address perceived nutritional deficiency, whilst those using multiple muscle gain/ergogenic supplements may be looking for performance gains. This is a key point as evidence shows the number and frequency of supplements use is positively associated with doping use in adolescents (Hoffman *et al.*, 2008).

Further work is required to develop this approach into meaningful measures that can be used to standardise measurement of supplement use, thereby overcoming a key issue in the literature. However, the findings presented here show strong support for this method, especially as the categories derived are conceptually sound, in that the substances in each group share common functions and use (e.g. protein & creatine, OTC medications, vitamins & minerals).

6.1.2 Longitudinal Effects on Doping Attitudes

Regarding the effects of supplements on attitudes, there were interesting, but inconsistent findings. Longitudinal data was collected to overcome issues with cross-sectional research and to explore temporal associations between use of NS, medications and performance enhancing technologies and subsequent changes in functional and moral doping attitudes. It was hypothesised that use of these substances and technologies would result in positive changes in functional attitudes, but not moral attitudes.

Across the two studies (1 & 2) (ignoring equal reciprocal effects for medications in Study 1), eight meaningful cross-lagged effects were found but with no consistent pattern. As predicted, Muscle-building supplements mostly had positive effects on functional attitudes and negative effects on moral attitudes but only in Study 2. Medications had negative effects on functional attitudes in Study 2. Significant effects were noted for weight loss and wellbeing supplements on functional attitudes in Study 1, but not Study 2. Effect sizes were generally small, but this is to be expected in cross-lagged analyses (Orth *et al.*, 2022).

There are three key points for discussion here; first, the discovery of cross-lagged effects shows partial support for the hypothesis. However, the fact that some of the cross-lagged effects, especially in relation to moral attitudes, were not in the predicted direction shows further work is required. The FMDAS scale is still in development and has changed since the first iteration of this thesis. The autoregressive paths across both studies suggest the attitudes measures are stable and appear to be distinct constructs, but further work is required to determine their relationship to each other and whether they do in fact measure the dimensions of interest. A key point here is that the MDA is now reduced to just three items and as such may be limited in its ability to test the dimension. Whilst there are no fixed rules on the optimal number, a generally agreed rule-of-thumb is that three items should be the absolute minimum for a validated scale (Robinson, 2017). Future development of this scale should explore other possible items for inclusion.

Second, differential effects were noted between supplement groups, lending further support for the categorisation of supplements. In particular, four of the eight cross-lagged effects relate to muscle building supplements. Previous research has highlighted ergogenic supplements as a key risk factor, but no previous research has demonstrated these effects over time (Hildebrandt *et al.*, 2012; Hoffman *et al.*, 2008; Hurst *et al.*, 2021a). These findings then, warrant further research and will be taken forward as a continuation of the studies presented here.

Finally, sample size and potential issues with the CLPM. In both studies sample sizes were relatively small for CLPM. Sample size is noted as a potential issue, with a minimum sample size of *n* = 200 suggested for two-wave studies and more for additional waves (Hamaker *et al.*, 2015). Smaller sample sizes increase the risk of spurious effects (Lucas, 2023), whilst some evidence suggests quite large sample sizes are required to overcome these effects (Hamaker *et al.*, 2015; Lucas, 2023; Orth *et al.*, 2021). Much debate exists around the application of the CLPM, with some researchers suggesting the more recent Random Intercept Cross-Lagged Panel Model (RI-CLPM) may overcome potential issues around controlling for unobserved confounders in CLPM (Lucas, 2023; Orth *et al.*, 2021).There remains debate as to whether that is the case (Lüdtke & Robitzsch, 2021), but the inconsistencies in the present findings and the discovery of equal reciprocal effects for medications, would suggest there may be time-invariant confounders that were not controlled for in the present study. It is possible to do that in CLPM, but evidence suggests the RI-CLPM offers a more robust approach. Further exploration of the current data are warranted, but ideally, future research should employ larger sample sizes and alternative cross-lagged models in order to test this. Possible confounders could be other dimensions as yet unexplored in the literature (e.g., health harms, legality).

6.2 Qualitative Studies

The qualitative studies explored athletes' views on nutrition and supplement use, including possible links to doping. They further explored what they saw as optimal education approaches to address issues raised.

Whilst knowledge and practices in relation to nutrition and supplement use were in line with findings in extant research, the discussions highlighted influential factors that have not previously been connected in the literature. Notably, despite evidence to show poor dietary habits develop can early (Braun *et al.*, 2009; Rounsefell *et al.*, 2020) there seems little impetus to address these issues in young developing athletes. Athletes in our sample perceived nutritional interventions they received as unhelpful and further, that optimal nutrition was not seen as a priority. It seems likely that these beliefs would carry through to higher competitive levels and may underpin the issues noted by sports nutritionists by Bentley *et al.* (2019). Without direction from teams or federations, athletes were left to find their own path and turned to other sources of information such as social media.

Social media is ubiquitous and highly influential, especially in relation to nutrition and supplement use, but the accuracy of information provided is at best debatable (Chung *et al.*, 2021; Kucharczuk *et al.*, 2022). Thus, young athletes are potentially exposed to substantial misinformation, potentially exacerbating poor dietary practices.

Furthermore, whilst the use of supplements as convenience food have previously been highlighted, the reasons for this have not been explored. The qualitative work here suggested poor food preparation skills may influence that practice. More importantly, the finding that many students use supplements just as part of their normal diet is a matter of concern. Peer influence is frequently cited and if your peers all use supplements instead of preparing food, you are more likely to follow suit.

Addressing such issues then, requires educational interventions that seek to (a) improve factual knowledge, (b) improve practical skills and, ideally (c) highlight the importance of critically analysing information sources such as social media. Athletes felt such interventions should be delivered at a young age, before bad habits become entrenched, but also, that they should be targeted and relevant to the athlete's sport. There was strong feeling that education in this area should be delivered from the perspective of appropriately optimising health and performance, rather than "what not to do" (e.g. use supplements).

Such education clearly needs to take a multi-faceted approach as suggested by Backhouse *et al.* (2007). As discussed in Chapter 4, this is not without challenges, but incorporating both knowledge *and* skill acquisition, as well as leveraging the influence of social media could address the key issues and perhaps result in less impetus to try doping. If athletes don't understand the performance enhancing benefits of optimal nutrition, it is no wonder some turn to use of supplements or doping. Equally, knowledge that cannot be practically applied is of limited use.

6.3 Integrative Discussion: The Incremental Model of Doping Behaviour (IMDB)

The IMDB (Petróczi, 2013a) forms the theoretical underpinning for much of the work undertaken in the present thesis. The findings presented here offer some support for that model, but also offer suggestions for its advancement. Briefly, the IMDB posits that doping results from an incremental journey through differing methods of performance enhancement, all with the common goal of maximising performance, as opposed to cheating to win. It distinguishes between functional attitudes towards performance enhancement and moral attitudes towards associated behaviours and frames these within a 'doping mindset', the interplay of which determines whether an athlete chooses to dope.

The quantitative findings in this thesis demonstrate that functional attitudes are a distinct construct largely unexplored in the literature and worthy of further investigation. Further, whilst the cross-lagged effects should be cautiously interpreted, findings in relation to ergogenic supplements suggest performance goals may be a driver for supplement use. This is supported by the qualitative work in which participants conceptualised doping in terms of maximising performance or recovery, rather than winning competitions. Related, athletes spoke of the need for a particular 'mindset' to progress from supplement use to doping and highlighted the influence of moral attitudes in this.

The present work also suggests possible adjustment to the IMDB. The model does not account for nuance in influences across different types of performance enhancement but seeks to extend the concept beyond just supplements or doping. The present work suggests the conceptualisation of performance enhancers can be refined, especially in relation to supplements and further, that the relative influence of different methods should be explicitly considered within the model.

6.4 Limitations and Future Research

There are several limitations within the studies presented here that warrant highlighting, in the hope they inform, where appropriate, future research.

6.4.1 Quantitative Limitations

Time frames for both studies were relatively short; given the temporal nature of the study, future research should examine whether longer time periods and/or more time points, influence effect sizes.

The results presented here only show evidence of limited associations between supplementation and changes in attitudes. Future research should examine these constructs in relation to actual behaviour.

Data collection for the Study 1 was hampered by a lack of consistent access to participants, resulting in significant attrition and a smaller dataset than planned, across just two time points. This was inadequate for cross-lagged panel analyses. Participant retention was improved in Study 2, allowing data collection across three time points and a marginally appropriate sample size, however the findings may reflect prevalent culture within the single institution from which participants were recruited. Future research should recruit from groups across multiple institutions.

Related, data collection was severely disrupted by pandemic restrictions due to the Covid-19 outbreak. This caused a marked and sudden shift in data collection from in-person to online and prevented any sport competitions. The change in data collection likely impacted the data and it’s possible some of the inconsistencies in CLPM findings are due to this. Equally, research was planned to capture possible changes in supplement use and attitudes across the competitive season. Future research should therefore employ consistent data collection within an active competitive season.

Both instruments require further validation and as such, findings from them should be treated with caution. Furthermore, these are both self-report measures and as such, open to bias and errors of recall (Kirby *et al.*, 2016).

Finally, samples used in this study were entirely drawn from student-athletes in the UK and were limited in terms of higher competitive levels which limits generalisability of results. There is thus a need for longitudinal research in other athlete groups and cultures.

6.4.2 Qualitative Limitations

Across both studies higher competitive levels were minimally represented. Equally, the range of sport types was limited. Data were not analysed with regard to sport type, but some differences emerged with rugby versus other sports. Future research should include higher competitive levels and a wider range of sport types to determine whether these factors influence results. Related, several of the national and international athletes were involved in doping-related projects or had experience of working with anti-doping organisations and as such, may not represent most athletes at that level.

Almost all participants were based at one of two Birmingham universities. It is again possible that the conversations may simply reflect shared culture based on immersion in the same educational institutions.

Additionally, I have extensive experience conducting interviews, but these conversations took place online, with no prior personal contact and this may have impacted the openness of the exchange and potentially, the generalisability of the findings. Related, these conversations took place during stay-at-home restrictions caused by the Covid-19 pandemic that left many people feeling isolated. For some people this was a new way of communicating and certainly a new way of meeting people for the first time. Furthermore, evidence shows people can find video conferencing physically and emotionally challenging due to the effort involved in maintaining nonverbal communication cues (Fauville *et al.*, 2023). These factors could also impact the dynamics of discussions.

6.5 Implications of the Research

Alongside the iterative nature of empirical research, where knowledge is progressively built upon and refined, academic research can, and should, inform policy and practice. The measures described throughout this thesis cannot be used as diagnostic tools (Petroczi, 2016), but they do contribute to our understanding of phenomena.

Whilst there is still work to be done, the present research advances our understanding of temporal relationships between supplement use and doping attitudes. In particular, it may serve to focus future research efforts more productively. Related, the novel approach to supplement measurement represents a first step in standardising measures to overcome identified methodological constraints of the literature.

Finally, the qualitative work connects disparate strands of research that can collectively inform development of appropriate and effective educational interventions with athletes.

6.6 Conclusion

Extant research, including that presented here, reveals the complexity of influences and decision-making processes that surround use of supplements (prohibited or not). This thesis highlights and draws together key influences regarding nutrition and the association with supplement use that are currently under-studied and disparate in the literature. I argue that sport, especially at higher levels, requires significant nutritional resources (Bytomski, 2018; Purcell & Canadian Paediatric Society, 2013) and if athletes are ill-equipped, or unable, to meet these needs via their diet they will be more likely to use supplements. Current research suggests this exposes them to two significant risks; firstly, contaminated supplements (Martinez-Sanz *et al.*, 2017) and secondly, possible gateway effects (Backhouse *et al.*, 2013; Hildebrandt *et al.*, 2012).

I argue this leaves the athlete in a difficult position. They are advised to steer clear of supplements due to the risks, but resources to help understand and meet dietary needs are lacking. Sub-optimal nutrition will result in sub-optimal performance (Bytomski, 2018) and athletes seeking to maximise their performance will, understandably, do everything they feel comfortable with to overcome that.

Current educational initiatives have limited and equivocal evidence of positive effect (Boidin *et al.*, 2021; Trakman *et al.*, 2016) and there is a need for better provision. This thesis explores key features of possible education initiatives that may better meet athlete's needs. Two conceptual frameworks for improving education have been proposed in the literature. Both apply approaches based in behaviour change theory, recognising the need for empathy and empowerment. Lee & Lim (2019) highlight the need for adaptation to meet the specific needs of the target group, Bentley *et al.* (2020) note the need for guidelines for nutritionists, based in behavioural science and further, the application of wider behavioural change techniques in nutrition education. I would extend these with two further suggestions; firstly, a paradigm shift in athlete education towards promoting safe, accessible means to optimise performance, including nutrition and appropriate supplement use. Secondly, that such education requires a holistic approach, incorporating dieticians, coaches and crucially a focus on engagement via multiple channels.

I argue that the current framework of performance enhancement in sport is hampered by anti-doping efforts. Doping-related risks associated with supplement use render recommendations on supplement use almost taboo. Certainly, there are risks, but arguably, this demands greater investment in regulated and reliable supplement provision and better education (Maughan *et al.*, 2018b).

6.7 Personal Reflection

My views on the use of performance enhancers are grounded in the harm reduction movement. Outside of a sport environment I have no issue with people self-medicating, as long as they are properly informed and have access to uncontaminated products (although the latter is the obvious sticking point here). Within a sport context, I believe people should play by the rules they sign up to.

However, my work in harm reduction taught me that that, in the absence of appropriate support people will often self-direct to resources they perceive as beneficial, trusting personally relevant sources (e.g., friends, peers, people they aspire to) more than ‘official sources’. If it’s desirable to steer them away from harmful behaviours, then it is equally necessary to provide support for appropriate alternatives. Furthermore, it is crucial to empower them to make best use of those. The current framework of advising athletes to avoid supplement use bears, for me, similarities to anti-drug campaigns such as “just say no” that seek to minimise use by telling people not to do it and attempting to scare them with dire (and often unlikely) consequences. My experience observing such approaches is, they don’t work for the people who may need to hear them.

I began my career and PhD study in doping research, aware this was a young field compared to psychoactive drugs. However, I was surprised to read policy documents and research that seemed to echo anti-drug efforts from decades ago. For me, gateway theory was an outdated and simplistic concept, used by policy makers to justify archaic drug legislation with little or no understanding of the realities of drug use. However, gateway theory is a broad church and viewed through the lens of multiple psychosocial influences now makes much more sense. Thus, my PhD journey has led me to reflect on both my future and past career and perhaps adjust my understanding of some basic concepts within harm reduction. For the harm reductionist, drug prohibition is a barrier to effective intervention, creating many more problems than it solves. For athletes however, I would argue prohibiting doping *is* harm reduction.

The use of psychoactive drugs is generally self-directed, but as seen in several global scandals, athlete doping is often led from above. My experience in the drugs world suggests to me that, given significant potential for financial gain from athletes' efforts, allowing doping, (as espoused by Aron D'Souza and the 'Enhanced Games') would lead to increasing exploitation of the athlete and therefore increasing harms. Whilst there are convincing arguments that the current shackles of anti-doping need urgent revision to be properly fit for purpose, they do at least act as a form of brake and perhaps, a sanity check for those contemplating performance enhancement via substances.

Finally, the PhD journey is challenging on multiple levels, but it is also rewarding. The current thesis is a very different piece of work to the original and I am grateful for that. Whilst the process of corrections brought significant challenges, they have led to greater reflection on and appreciation of, the mechanisms and nature of my research and greater understanding of the methodologies I employed.

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APPENDIX

Supplementary Materials

APPENDIX: Contents

Section 1: CLPM Model Fit Indices for Two Wave Model (Study 1)

This section presents all model fit indices for the two-wave CLP models conducted in Study 1. Shaded rows represent the model finally accepted and interpreted.

Medication

FDA

	Chi^2 (*df*)	Chi^2/df	*p*	CFI	RMSEA	SRMR
M1	.44 (2)	.22	.80	1.0	.00	.02
M2	.27 (1)	.27	.60	1.0	.00	.01
M3	.11 (1)	.11	.75	1.0	.00	.01
M4	.02 (1)	.02	.89	1.0	.00	.00
M5	.00 (0)	-	.00	1.0	.00	.00

MDA

	Chi^2 (*df*)	Chi^2/df	*p*	CFI	RMSEA	SRMR
M1	18.12 (2)	9.06	.00	.84	.16	.07
M2	17.60 (1)	17.60	.00	.83	.23	.05
M3	5.22 (1)	5.22	.02	.96	.12	.04
M4	3.62 (1)	3.62	.06	.97	.09	.03
M5	.00 (0)	-	.00	1.0	.00	.00

Muscle Building

FDA

	Chi^2 (*df*)	Chi^2/df	*p*	CFI	RMSEA	SRMR
M1	.91 (2)	.46	.64	1.0	.00	.03
M2	.04 (1)	.04	.83	1.0	.00	.01
M3	1.51 (1)	1.51	.22	.99	.04	.03
M4	1.31 (1)	1.31	.25	.99	.03	.03
M5	.00 (0)	-	.00	1.0	.00	.00

MDA

	Chi^2 (*df*)	Chi^2/df	*p*	CFI	RMSEA	SRMR
M1	1.83 (2)	.92	.40	1.0	.00	.03
M2	.91 (1)	.91	.34	1.0	.00	.03
M3	.93 (1)	.93	.33	1.0	.00	.01
M4	1.53 (1)	1.53	.22	.99	.04	.02
M5	.00 (0)	-	.00	1.0	.00	.00

Weight Loss

FDA

	Chi^2 (*df*)	Chi^2/df	p	CFI	RMSEA	SRMR
M1	3.71 (2)	1.86	.16	.98	.05	.08
M2	4.07 (1)	4.07	.04	.97	.10	.08
M3	.00 (1)	.00	.95	1.0	.00	.00
M4	.36 (1)	.36	.55	1.0	.00	.03
M5	.00 (0)	-	.00	1.0	.00	.00

MDA

	Chi^2 (*df*)	Chi^2/*df*	p	CFI	RMSEA	SRMR
M1	3.87 (2)	1.94	.14	.98	.05	.10
M2	.70 (1)	.70	.40	1.0	.00	.04
M3	4.05 (1)	4.05	.04	.97	.10	.09
M4	3.14 (1)	3.14	.08	.98	.08	.10
M5	.00 (0)	-	.00	1.0	.00	.00

WellBeing

FDA

	Chi^2 (*df*)	Chi^2/*df*	p	CFI	RMSEA	SRMR
M1	8.41 (2)	4.21	.02	.97	.10	.05
M2	1.20 (1)	1.2	.31	1.0	.03	.03
M3	21.50 (1)	21.50	.00	.91	.25	.04
M4	16.60 (1)	16.60	.00	.93	.22	.04
M5	.00 (0)	-	.00	1.0	.00	.00

MDA

	Chi^2 (*df*)	Chi^2/*df*	p	CFI	RMSEA	SRMR
M1	.18 (2)	.09	.91	1.0	.00	.01
M2	.11 (1)	.11	.74	1.0	.00	.01
M3	.02 (1)	.02	.89	1.0	.00	.00
M4	.04 (1)	.04	.85	1.0	.00	.00
M5	.00 (0)	-	.00	1.0	.00	.00

Section 2: CLPM Model Fit Indices for Three Wave Model (Study 2)

Medication

FDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	16.14 (8)	2.02	.04	.98	.06	.04
M2	13.50 (6)	2.25	.04	.98	.07	.04
M3	11.50 (6)	1.92	.08	.98	.06	.03
M4	10.12 (6)	1.69	.12	.99	.05	.03
M5	8.70 (4)	2.18	.07	.99	.06	.03

MDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	19.80 (8)	2.48	.01	.95	.07	.05
M2	16.09 (6)	2.68	.01	.96	.08	.06
M3	17.5 (6)	2.92	.01	.95	.08	.05
M4	15.50 (6)	2.58	.02	.96	.07	.05
M5	13.71 (4)	3.43	.00	.96	.09	.04

Muscle Building

FDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	19.62 (8)	2.45	.01	.98	.07	.05
M2	13.18 (6)	2.20	.04	.99	.06	.03
M3	17.6 (6)	2.93	.01	.98	.08	.04
M4	15.31 (6)	2.55	.02	.98	.07	.03
M5	11.1 (4)	2.78	.03	.99	.07	.02

MDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	33.70 (8)	4.21	.00	.93	.11	.09
M2	25.15 (6)	4.20	.00	.95	.10	.09
M3	21.50 (6)	3.58	.00	.96	.09	.05
M4	22.40 (6)	3.73	.00	.96	.10	.06
M5	11.97 (4)	2.99	.02	.98	.08	.04

Weight Loss

FDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	19.7 (8)	2.46	.01	.96	.07	.04
M2	16.7 (6)	2.78	.01	.97	.08	.04
M3	17.8 (6)	2.97	.01	.96	.08	.04
M4	17.12 (6)	2.85	.01	.96	.08	.04
M5	14.03 (4)	3.51	.00	.97	.09	.03

MDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	15.03 (8)	1.88	.06	.96	.06	.07
M2	13.80 (6)	2.3	.03	.96	.07	.07
M3	12.11 (6)	2.02	.06	.97	.06	.04
M4	13.16 (6)	2.19	.04	.96	.06	.06
M5	11.10 (4)	2.78	.03	.96	.08	.04

Wellbeing

FDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	19.98 (8)	2.50	.01	.97	.07	.04
M2	18.5 (6)	3.08	.00	.96	.09	.04
M3	16.61 (6)	2.77	.01	.97	.08	.03
M4	16.34 (6)	2.72	.01	.97	.08	.03
M5	14.6 (4)	3.65	.00	.97	.09	.03

MDA

	Chi² (*df*)	Chi²/*df*	p	CFI	RMSEA	SRMR
M1	26.40 (8)	3.30	.00	.92	.09	.05
M2	23.30 (6)	3.88	.00	.93	.10	.05
M3	22.50 (6)	3.75	.00	.93	.10	.05
M4	23.52 (6)	3.92	.00	.93	.10	.05
M5	19.03 (4)	4.76	.00	.94	.11	.04

Section 3: Supplement use and frequency at Time Point 2 (Two-Wave Study)

Table S1: *Supplement Use and Frequency at Time Point 2*

Substance /Method	Use			Frequency				
	Never	Prior to Past 6 months	During Past 6 months	<1/ week	weekly	3-4 times/ week	5+ times/ week	Not reported
Nutritional Supplements								
BCAA	153	5	22	5	2	10	4	1
Creatine	145	10	25	5	4	7	7	2
Protein	89	20	71	4	20	22	24	1
Caffeine	132	6	42	10	22	4	2	4
Taurine	159	3	18	11	5	2	0	0
Other Fat Burners	174	2	4	3	0	0	0	1
Laxatives	176	3	1	1	0	0	0	0
Meal Replacements	156	8	16	5	4	6	0	0
Pre-Workout	142	9	29	6	7	13	1	2
Multivitamin no Minerals	118	20	42	6	7	11	17	1
Multivitamin plus minerals	112	13	55	8	6	20	20	1
Magnesium	171	3	6	2	2	0	1	1
ZMA	174	3	3	1	0	1	0	1
Vitamin C	118	10	52	7	7	14	22	2
Vitamin D	147	11	22	3	4	5	8	2
Vitamin E	163	6	11	2	3	2	3	1
Selenium	177	1	2	0	0	0	0	2
Iron	158	4	18	0	4	3	10	1
Performance Enhancing Technologies								
Altitude Tent	179	1	0					
Altitude Mask	177	1	2	1	1	0	0	0
Compression Garment	167	4	9	4	4	1	0	0
Environmental Chamber	180	0	0					
Medications								
Aspirin	150	11	19	15	3	0	0	1
CBD	179	0	1	0	0	0	1	0
Narcotic Analgesics	174	3	3	3	0	0	0	0
NSAIDS	117	11	52	33	14	4	0	1
Paracetamol	64	16	100	71	19	8	0	2
Anticholinergic	180	0	0					
Benylin	178	0	2	2	0	0	0	0
Beta 2 Agonist	180	0	0					
Prohibited Substances / Methods								
Anabolic Steroids	179	0	1	0	0	0	0	1
Growth Hormone	179	0	1	1	0	0	0	0
Insulin	180	0	0					

Peptide Hormones	180	0	0					
Prohormones	180	0	0					
Testosterone Boosters	180	0	0					
Amphetamines	177	0	3	1	0	0	0	2
Cocaine	159	10	11	7	1	0	0	3
DMAA	180	0	0					
Ephedrine	180	0	0					
Modafinil	165	3	12	3	7	2	0	0
Adderall	179	0	1	1	0	0	0	0
Ritalin	180	0	0					
Clenbuterol	179	1	0					
DNP	180	0	0					
Sibutramine	180	0	0					
Triiodothyronine (T3)	180	0	0					
Corticosteroids	178	1	1	0	0	1	0	0
Beta Blockers	180	0	0					
Meldonium	180	0	0					
SARMs	180	0	0					
Blood Doping	180	0	0					

Section 4: Questionnaire

QUESTIONNAIRE PACK

School of Sport, Exercise and Rehabilitation Sciences

Participant Code __________

Thank you for choosing to participate in this study, your responses will help us understand factors that influence supplement use and doping in sport. Please answer every question honestly and remember your responses are completely anonymous.

Age:

- ☐ 18-20
- ☐ 21-23
- ☐ 24-26
- ☐ 27-29
- ☐ 30-32
- ☐ 32+

Gender:

- ☐ Male
- ☐ Female
- ☐ Other (Please specify) ______________
- ☐ Prefer not to say

Level of study:

- ☐ Undergraduate
- ☐ Postgraduate

Year of study: ________

Main sport played: ______________________________________

Number of years playing main sport:

- ☐ >1 yr
- ☐ 1-3 yrs
- ☐ 4-7 yrs
- ☐ 7+ yrs

Highest level of current competition:

- ☐ University level (BUCS)
- ☐ County level
- ☐ Regional level
- ☐ National level
- ☐ International level

Have you ever completed any anti-doping education?

- ☐ Yes
- ☐ No

If **Yes** please specify which course and the last date it was completed:

____

____

____

*A number of statements describing **thoughts that athletes might have about doping** are listed below. Please read these statements carefully and indicate your level of agreement with each one by circling the appropriate number. Please respond **honestly.***

*What is your **level** of **agreement** with the following **statements**?*	**Strongly Disagree**	**Disagree**	**Slightly Disagree**	**Neutral**	**Slightly Agree**	**Agree**	**Strongly Agree**
1. It is okay to dope if it helps an athlete to provide for his/her family.	1	2	3	4	5	6	7
2. Saying you "take steroids" feels worse than saying you "use some gear".	1	2	3	4	5	6	7
3. Compared to most lifestyles in the general public, doping isn't that bad.	1	2	3	4	5	6	7
4. Athletes shouldn't be blamed for doping if training partners/teammates pressure them to do it.	1	2	3	4	5	6	7
5. If most athletes in a sport dope, no one athlete should be held responsible for doing it.	1	2	3	4	5	6	7
6. Risks associated with doping are exaggerated.	1	2	3	4	5	6	7
7. Doping is okay if it helps an athlete advise others on how to do it right.	1	2	3	4	5	6	7
8. Using words like "roids", "gear" and "pinning" makes doping feel more acceptable.	1	2	3	4	5	6	7
9. Compared to smoking, doping is pretty safe.	1	2	3	4	5	6	7
10. An athlete shouldn't be blamed for doping if a member of his/her training group has encouraged it.	1	2	3	4	5	6	7
11. It's not right to condemn individuals who dope when many in their sport are doing the same.	1	2	3	4	5	6	7
12. Doping doesn't really harm anyone else.	1	2	3	4	5	6	7
13. It is acceptable to dope if knowledge gained helps an athlete advise others on safe doping.	1	2	3	4	5	6	7
14. Using terms such as "gear" or "juice" makes doping sound less harmful.	1	2	3	4	5	6	7
15. Compared to physical violence, doping isn't that serious.	1	2	3	4	5	6	7
16. An athlete shouldn't be held responsible for doping if his/her coach encouraged him/her to do it.	1	2	3	4	5	6	7
17. If an athlete trains/competes in an environment in which doping is the norm, he/she shouldn't be held accountable for doing it.	1	2	3	4	5	6	7
18. The negative aspects of doping are exaggerated by the media.	1	2	3	4	5	6	7

*Here we would like to get a better **understanding** of **experiences** that can be **difficult** to **manage**. For each of the questions listed below, please **circle the number** that best corresponds to **your level*** of ***confidence right now**. Please respond **honestly.***

*How **confident** are* you ***right now** in your **ability** to ...*	**No Confidence**		**Moderate Confidence**		**Complete Confidence**
1. …resist doping even if your training group encouraged you to do it?	1	2	3	4	5
2. …resist doping even if you knew you could get away with it?	1	2	3	4	5
3. …ignore the temptation to dope even if you knew it would improve your performance?	1	2	3	4	5
4. …resist peer pressure to dope?	1	2	3	4	5
5. …reject doping even if most of your training partners did it?	1	2	3	4	5
6. …ignore the temptation to dope when feeling down physically?	1	2	3	4	5

*A number of statements describing **thoughts that athletes might have about doping** are listed below. Please read these statements carefully and indicate your level of **agreement** with each one by circling the appropriate number. Please respond **honestly.***

*What is your **level** of **agreement** with the following **statements?***	**Strongly disagree**	**Disagree**	**Slightly Disagree**	**Slightly agree**	**Agree**	**Strongly Agree**
1. Using doping can make my results better.	-3	-2	-1	1	2	3
2. If I use doping, I will remain competitive.	-3	-2	-1	1	2	3
3. If I use doping, I will not know what I am capable of without drugs.	-3	-2	-1	1	2	3
4. Using doping can help to improve my athletic performance.	-3	-2	-1	1	2	3
5. If I don't use doping, I will not benefit from my hard work and training as much as I want to.	-3	-2	-1	1	2	3
6. Using doping will not help me train hard.	-3	-2	-1	1	2	3
7. Using doping after injury will not aid my recovery.	-3	-2	-1	1	2	3
8. If I refrain from using performance enhancing drugs, I can see the results of my natural ability.	-3	-2	-1	1	2	3
9. If I use doping, I will be a more competitive athlete.	-3	-2	-1	1	2	3
10. If I increase my performance with doping, my income will be higher.	-3	-2	-1	1	2	3

*A number of statements describing **thoughts that athletes might have about performance** are listed below. Please read these statements carefully and indicate the degree of **desirability** for each statement for you by circling the appropriate number. Please respond **honestly.***

*Indicate the level of **desirability** to you for each of the following:*	**Extremely Undesirable**	**Undesirable**	**Slightly Undesirable**	**Slightly Desirable**	**Desirable**	**Extremely Desirable**
1. Making my results better is...	1	2	3	4	5	6
2. Remaining competitive for me is…	1	2	3	4	5	6
3. Knowing what I am capable of for me is...	1	2	3	4	5	6
4. Improving my athletic performance is…	1	2	3	4	5	6
5. Getting return on my hard work and training for me is...	1	2	3	4	5	6
6. Training hard for me is...	1	2	3	4	5	6
7. Recovering fully and quickly after injury for me is ...	1	2	3	4	5	6
8. Seeing how far my natural talent can take me is...	1	2	3	4	5	6
9. Being a competitive athlete for me is...	1	2	3	4	5	6
10. Increasing my income for me is....	1	2	3	4	5	6

*A number of statements describing **thoughts that athletes might have about doping** are listed below. Please read these statements carefully and indicate your level of agreement with each one by*

*What is your **level** of **agreement** with the following **statements?***	**Strongly Disagree**	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1. Using doping is morally wrong.	-3	-2	-1	1	2	3
2. Using doping gives unfair advantage.	-3	-2	-1	1	2	3
3. If I use doping, I will feel I cheat.	-3	-2	-1	1	2	3
4. If I use doping, I will not harm others.	-3	-2	-1	1	2	3
5. Using doping is not against the spirit of sport.	-3	-2	-1	1	2	3
6. Using doping is against fair play.	-3	-2	-1	1	2	3
7. If I use doping, I will violate the anti-doping rules.	-3	-2	-1	1	2	3

*circling the appropriate number. Please respond **honestly.***

*A number of statements describing **thoughts that athletes might have about performance** are listed below. Please read these statements carefully and indicate the degree of **desirability** for each*

*Indicate the level of **desirability** to you for each of the following:*	**Extremely Undesirable**	**Undesirable**	**Slightly Undesirable**	**Slightly Desirable**	**Desirable**	**Extremely Desirable**
1. Doing what is morally right for me is…	1	2	3	4	5	6
2. Gaining unfair advantage for me is…	1	2	3	4	5	6
3. Cheating for me is…	1	2	3	4	5	6
4. Harming others for me is…	1	2	3	4	5	6
5. Keeping the sport clean of drugs for me is…	1	2	3	4	5	6
6. Fair play for me is…	1	2	3	4	5	6
7. Adhering to anti-doping rules for me is…	1	2	3	4	5	6

*statement for you by circling the appropriate number. Please respond **honestly.***

To follow are a series of statements relating to sport supplements. *Please read each question carefully and specify your level of agreement (between 'strongly disagree' to 'strongly agree') with the following:*

Performance Enhancing Supplements, Substances & Methods

In this section, we ask about supplements, substances & methods <u>FOR PERFORMANCE ENHANCEMENT ONLY</u>.

Supplement/Substance/Method	Have you used this in the past month?	If used in the past month, how often have you used it?
Anabolic steroids	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
BCAA (Branch Chain Amino Acids)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Creatine	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Human Growth Hormone	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Insulin	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Testosterone Boosters	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Whey (or other) Protein Powder	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly

*What is your **level of agreement** with the following **statements?***	**Strongly Disagree**	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1. Supplements improve my performance	1	2	3	4	5	6
2. Supplements are necessary for me to be competitive	1	2	3	4	5	6
3. Supplements improve my confidence	1	2	3	4	5	6
4. My chances of winning improve when I use supplements.	1	2	3	4	5	6
5. Supplements help me realise my potential.	1	2	3	4	5	6
6. Supplements improve the quality of my training.	1	2	3	4	5	6

Supplement/Substance/Method	Have you used this in the past month?	If used in the past month, how often have you used it?
		☐ 3 or more times per week
Amphetamines (Not recreationally)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Caffeine Tablets (for sport purposes)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Cocaine (Not recreationally)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Modafinil (for sport purposes)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Adderall (for sport purposes)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week

For instance; if you used aspirin for a headache, that does NOT count, but if you used it to help you train or compete, it DOES count. Only tell us if you used a supplement/substance to help you to train/compete, recover from an injury or perform better.

Supplement/Substance/Method	Have you used this in the past month?	If used in the past month, how often have you used it?
Taurine (for sport purposes)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Pre-Workout Drinks	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly

		☐ 3 or more times per week
Clenbuterol	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Fat Burners	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Laxatives	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Weight Loss Meal Replacement	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Thyroid Drugs (T3/T4)	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Aspirin	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
CBD Oil	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Codeine/Tramadol	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week

Ibuprofen/Diclofenac	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Paracetamol	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Multi-Vitamins/Minerals	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Magnesium	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
ZMA	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week

Supplement/Substance/Method	**Have you used this in the past month?**	**If used in the past month, how often have you used it?**
Vitamin C	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Vitamin D	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Vitamin E	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week

Selenium	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Iron	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Beta Blockers	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
SARMs	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Altitude Mask	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week
Compression Clothing	☐ Yes ☐ No	☐ Less than once per week ☐ Weekly ☐ 3 or more times per week

Final Question

How important is the use of the supplements used to your training? (Please circle an answer from 1 - 7)

1 (Not at all)

2

3

4 (Moderately)

5

6

7 (Extremely)

The questionnaire pack is now complete, please hand it back to the researcher. Many thanks for participating in our study.