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Sport Supplement Use Predicts Doping Attitudes and Likelihood via Sport Supplement Beliefs

Running title: Sport supplements, beliefs and doping

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Abstract

The aim of this study was to examine: 1) whether sport supplement use is related to doping and 2) whether sport supplement beliefs mediated this relationship. In Study 1, athletes (N = 598), completed measures of sport supplement use, sport supplement beliefs, and doping attitudes. In Study 2, athletes (N = 475) completed measures of sport supplement use, sport supplement beliefs, and doping likelihood. In both studies, sport supplement use predicted doping outcomes indirectly via sport supplement beliefs. Our findings provide novel evidence to suggest that sport supplement users, who strongly believe that sport supplements are effective, are more likely to dope. For anti-doping organisations wishing to prevent doping, targeting an athlete's beliefs about sport supplements may improve the effectiveness of anti-doping prevention programmes.

Key words: drug, gateway hypothesis, Incremental Model of Doping Behaviour, nutrition, performance enhancement

Introduction

According to the World Anti-Doping Agency (WADA), doping represents an athlete or athlete-support personnel (e.g. coach, physiotherapist, doctor) committing an anti-doping rule violation. Ten violations exist, including: presence of a banned substance in sample; use or attempted use of a banned substance or method; evading, refusing, or failing to submit a sample; whereabouts failure; tampering with doping control; possession of a banned substance or method; trafficking a banned substance or method; administering banned substances or methods; complicity; and prohibited association (WADC, 2015). The most widely recognised anti-doping rule violation is an athlete's use of a banned performance enhancing substance or method.

Factors associated with doping have received increased attention in the past decade (see Backhouse, Whitaker, Patterson, Erickson, & McKenna, 2016). Research that identifies such factors is important, as it helps anti-doping organisations and researchers design more effective anti-doping prevention programmes. A large number of factors have been proposed to explain doping in sport. It has been reported that the use of non-banned sport supplements (e.g., caffeine, creatine and sodium bicarbonate) can increase the likelihood of an athlete doping (Backhouse, Whitaker, & Petroczi, 2013; Boardley, Grix, & Harkin, 2015). However, little research has investigated what accounts for any such relationship. Recent data highlight the potential importance of sport supplement beliefs influencing future doping (Hurst, Foad, Coleman, & Beedie, 2017b). The main rationale for this suggestion is that sport supplement use may lead athletes to develop beliefs about their effectiveness, which in turn, may lead to the development of beliefs about doping substances and influence future doping behaviour. However, to the authors' knowledge, no research has investigated whether beliefs influence the supplement use-doping relationship. We therefore aimed to extend understanding in the area by 1) investigating whether a

relationship exists between sport supplement use and doping, and 2) whether sport supplement beliefs mediates any association.

Sport Supplement Use and Doping

Sport supplements are widely used by athletes of all ages and abilities, with the aim of enhancing performance, promoting recovery, and correcting or preventing nutrient deficiencies (Maughan et al., 2018). Prevalence of supplement use is between 40-70%, with estimates varying by gender, age, sport type, time of the season, and type of supplement used (Knapik et al., 2016). While use of sport supplements is generally widespread, their use involves risk because supplements can be contaminated with banned substances (Geyer et al., 2004; Geyer et al., 2008). Geyer et al. (2008) analysed 634 sport supplements in 13 countries and reported that 15% of sport supplements were contaminated with anabolic steroids and testosterone. Further, Cohen, Bloszies, Yee, and Gerona (2016) reported that of 21 supplements sampled, 52.4% contained stimulants. Thus, for athletes using sport supplements, the possibility of failing a drug test through inadvertent means is high.

Cross-contamination of a sport supplement occurs as a result of insufficient surveillance and quality control by the sport supplement industry (Geyer et al., 2004). Many supplements by-pass the most rudimentary pharmaceutical safeguards and banned substances can often be added to the supplement accidentally or deliberately. Given that the World Anti-Doping Agency (WADA) enforces a "strict liability" under Articles 2.1 and 2.2 of the Code (WADC, 2015; p. 141) an athlete can be banned from sport for up to 4 years after using a sport supplement without having to demonstrate "intent, negligence or knowing Use on the Athlete's part".

Researchers have suggested that use of sport supplements may over time increase the likelihood of athletes doping (e.g., Backhouse et al., 2013; Hurst et al., 2017b; Petróczi, 2013). Two theoretical frameworks underpinning the sport supplement-doping association

are the *gateway hypothesis* (Kandel, 1975) and the *incremental model of doping behaviour* (IMDB; Petróczi, 2013). Both propose that doping evolves as part of a routine application of the use of banned performance-enhancing substances and methods.

The gateway hypothesis (Kandel, 1975) posited that the use of softer drugs (e.g., alcohol, marijuana), often precedes the use of harder drugs (e.g., cocaine, heroin). In sport, researchers have suggested that the use of sport supplements may similarly facilitate use of banned substances (Backhouse et al., 2013; Hildebrandt, Harty, & Langenbucher, 2012; Hurst et al., 2017b). It is argued that supplement use could have an impact on athletes' tendency to feel comfortable with taking a substance to improve performance and lead to the use of banned substances. Thus, the continued use of sport supplements could precede and increase the likely consumption of banned substances.

The incremental model of doping behaviour (Petróczi, 2013) proposes a link between supplement use and doping use based on their common intended outcome of performance enhancement. The model posits that doping is a motivated, goal-directed behaviour, and prolonged involvement in performance enhancement methods can lead to doping. From this perspective, the IMDB can be seen as describing a behavioural translation, in which doping is the eventual outcome of systematic efforts aimed to maximise athletic ability through performance-enhancement methods. In short, the continued use of performance enhancement methods and the search for additional and better performance enhancing methods, could ultimately lead an athlete to dope.

Several studies have confirmed a positive association between sport supplement use and doping (e.g., Backhouse et al., 2013; Boardley et al., 2015; Hildebrandt et al., 2012), thereby providing support for both the gateway hypothesis and the IMDB. Qualitative studies have revealed that some athletes dope to improve performance and overcome performance plateaus while taking sport supplements (Boardley et al., 2015). Cross-sectional research has

reported that supplement users are three and half times more likely to dope (Backhouse et al., 2013). In a meta-analysis, Ntoumanis, Ng, Barkoukis, and Backhouse (2014) reported that use of sport supplements was one of the strongest predictors of doping (Odds Ratio = 8.24, 95% CI = 5.07 to 13.39). Although this evidence is based solely on athlete testimony, it suggests that the use of sport supplements represents a risk factor for doping. Further research is needed to better elucidate the nature of the sport supplement-doping relationship.

It has been suggested that sport supplement users may express more favourable beliefs about their effectiveness compared to non-users (Backhouse et al., 2013; Hurst et al., 2017b). In this context, beliefs refer to perceptions of an association between behaviour (e.g., sport supplement use) and outcome (e.g., improvement in performance). Zelli, Mallia, and Lucidi (2010) reported that beliefs accounted for nearly 50% of the variance of adolescents' doping intentions. Moreover, Bloodworth, Petroczi, Bailey, Pearce, and McNamee (2012) suggested that athletes who believed that sport supplementation was a necessity for optimal sports performance were more likely to dope. Further, Hurst et al. (2017b) showed a positive association between athletes' sport supplement use and beliefs about their effectiveness. When considered alongside the main tenets of the gateway hypothesis and IMDB, this evidence suggests that the use of sport supplements may put athletes at greater risk of doping via the development of more positive beliefs about their effectiveness. However, there is relative dearth of research that has investigated sport supplement beliefs and how these may explain the sport supplement use-doping relationship. The current study was designed to address this gap in our understanding of this relationship and investigate if sport supplement beliefs mediate any association between supplement use and doping.

Doping Attitudes and Likelihood

Typically, research on substance use frames the behaviour as one of decision-making and the explicit processes involved (Hauw & McNamee, 2015). Accordingly, several researchers have used the Theory of Reasoned Action (Ajzen & Fishbein, 1975) and Theory of Planned Behaviour (Ajzen, 1985) to examine athletes' attitudes and likelihood of doping (e.g., Backhouse et al., 2013; Chan et al., 2015; Elbe & Brand, 2016). Attitudes are an evaluation of an object of thought (Bohner & Dickel, 2011) and can be anything that a person may have in mind, ranging from people, groups, ideas and objects. They are stable entities stored in memory and represent evaluative judgements that are constructed in the situation based on current accessible information (Schwarz, 2007). Researchers interested in doping attitudes are therefore aiming to understand athletes' judgements about banned substances. A large body of literature has reported that attitudes are associated with doping use (Backhouse et al., 2013; Whitaker, Long, Petróczi, & Backhouse, 2014) and doping likelihood (Chan et al., 2015; Lazuras, Barkoukis, Mallia, Lucidi, & Brand, 2017), and that users of sports supplements show more favourable attitudes towards doping than non-users (Backhouse et al., 2013; Lazuras et al., 2017).

The Theory of Reasoned Action also suggests that attitudes are influenced by beliefs (Ajzen & Fishbein, 1975). For example, an athlete who holds strong positive beliefs about the effectiveness of anabolic steroids is expected to have positive attitudes towards them. In turn, this influences the athlete's intention to use anabolic steroids, which ultimately influences their likelihood of using them. There is accumulating evidence to support this model of doping. Petróczi (2007) reported that stronger beliefs about doping were associated with more favourable doping attitudes. Chan et al. (2015) showed that beliefs about the advantages of using banned substances positively predicted doping attitudes and intention to dope. Other studies have shown that athletes who use sport supplements express more positive beliefs about these types of substances than non-users (Backhouse et al., 2013; Dascombe, Karunaratna, Cartoon, Fergie, & Goodman, 2010). Research examining

beliefs about banned and non-banned substance use is limited, but there is sufficient evidence to suggest that they can influence doping attitudes and likelihood.

The Present Research

In sum, research assessed doping attitudes and doping likelihood in order to better understand doping behaviour. In a meta-analysis of the predictors of doping, Ntoumanis et al. (2014) reported that the use of sport supplements was one of the strongest. However, no study has investigated what may mediate the relationship between sport supplement use and doping. We conducted two studies to examine whether sport supplement beliefs mediate any relationships between sport supplement use and doping attitudes/likelihood. In Study 1, we examined the relationships between sport supplement use, beliefs and doping attitudes, and tested two hypotheses. First, we hypothesised sport supplement use would be positively associated with doping attitudes. Second, we hypothesised that this relationship would be mediated by sport supplement beliefs. In an extension to Study 1, in Study 2, we examined the relationships between sport supplement use, sport supplement beliefs, and doping likelihood. We hypothesised that sport supplement use would be positively associated with doping likelihood and that this association would be mediated by sport supplement beliefs.

Study 1

Method

Participants

Competitive male (*n* = 417) and female (*n* = 191) athletes volunteered to participate in the study (mean + SD; age = 21.2 ± 4.5 years, years competing = 10.8 ± 5.9, hours per week training = 6.0 ± 3.7). Athletes had competed at club (26.3%), county (33.3%), regional

(24.1%) and national level (16.3%). Athletes participated in individual (31.9%) and team sports (69.1%).

Measures

Sport Supplement Use

Athletes were asked to indicate whether they use sports supplements. Responses were scored as 0 (no) and 1 (yes).

Sport Supplement Beliefs

We measured sport supplement beliefs using the Sports Supplements Beliefs Scale (SSBS; Hurst et al., 2017b). This unidimensional instrument designed to assess athletes' beliefs about the effectiveness of sports supplements was developed by Hurst et al. (2017b), who provided evidence supporting the factorial validity of SSBS scores through exploratory and confirmatory factor analyses. The SSBS includes six-statements related to beliefs about sport supplements (e.g. "sport supplements are necessary for me to be competitive"). Athletes indicated their level of agreement to each statement using a Likert-type scale, anchored by 1 (*strongly disagree*) and 6 (*strongly agree*). The mean of the six statements was computed as a measure of athletes' belief about the effectiveness of sport supplements, with higher scores indicating a more positive belief in their effectiveness. Cronbach alpha values were very good in this study (α = .91).

Doping Attitudes

We measured doping attitudes with a shortened 5-item version of the Performance Enhancement Attitude Scale (Petróczi, 2006). This version has been reported to have better model fit than the original 17-item scale (Nicholls, Madigan, & Levy, 2017). Athletes responded to statements that represented their general attitudes towards doping (e.g., "doping is necessary to be competitive") on a six-point Likert-type scale, ranging from 1

(*strongly disagree*) to 6 (*strongly agree*). The mean of all statements was calculated, with higher scores indicating more positive attitudes towards doping. Cronbach alpha scores have been reported to range from .71 to .91 (Petróczi & Aidman, 2009). In the current sample internal consistency was very good (α = .90).

Procedure

After obtaining ethical approval from the institutional research ethics committee, athletes were recruited in person from sport clubs. Stakeholders of sport clubs (e.g., coaches, managers and secretaries) were first contacted via telephone and informed about the study purposes. After gaining permission to conduct the study from club stakeholders, athletes were recruited in person at the club's training facility. They were informed about the purpose of the study, that participation was voluntary, and that honesty in their responses was vital. Athletes did not disclose any personal information (e.g., names, date of births or contact details) and were told that all data would be kept anonymous and the information they provided would be used only for research purposes. After reading the study information sheet and providing informed consent, athletes completed the measures described above and returned the questionnaire in a sealed envelope.

Data Analysis

Preliminary data analysis revealed that 10 athletes did not complete the PEAS or SSBS scale. Their data were deleted leaving a final sample size of 598 for further analyses. Eleven athletes (1.9%) had missing data and Little's Missing Completely at Random test (MCAR; Little, 1988) indicated that data were missing completely at random (χ^2= 17.562, *df* = 27, *p* > .916). Missing values were replaced using a multiple imputation model that generated five data sets with maximum number of parameters set at 100. The average value of the missing data sets was used for subsequent analysis.

We used the PROCESS 2.16 (Hayes, 2013) SPSS macro (model 4) to test direct and indirect (via beliefs) effects of sport supplement use on doping attitudes. Direct effects are the effects of the predictor on the outcome variable that occur separately to the mediator, while indirect effects are the effects of the predictor on the outcome variable via the mediator. Bootstrapping was set at 10,000 samples to control for Type I error (Hayes, 2009; Preacher & Hayes, 2004) and bias-corrected 95% confidence intervals were calculated for all effects. When the confidence interval for indirect effects does not contain zero, this is indicative of mediation. The Completely Standardised Indirect Effect (CSIE) has been reported as the effect size metric and interpreted as 0.01 = small effect, 0.09 = medium effect and 0.25 = large effect (Preacher & Kelley, 2011). The level of statistical significance was set at $p \leq .05$.

Results

Descriptive Statistics and Zero-Order Correlations

Mean scores indicated that around half of athletes used sport supplements (51%) and overall the sample was characterised by low doping attitudes (mean ± SD = 2.09 ± 0.82; median = 2.00) and moderate beliefs about the effectiveness of sport supplements (mean ± SD = 3.01 ± 1.12; median = 3.17). Zero-order correlations provided support for our first hypothesis, that is sport supplement use was positively associated with attitudes towards doping ($r = .11$, $p = .005$). Also, positive relationships were found between sport supplement use and beliefs about sport supplements ($r = .51$, $p < .001$) and between sport supplement beliefs and doping attitudes ($r = .26$, $p < .001$).

Mediation Analysis

We hypothesized that sport supplement beliefs would mediate the relationship between sport supplement use and doping. This hypothesis was supported as sport supplement use had an indirect effect on doping attitudes via sport supplement beliefs ($b = 0.22$, 95% CI =

0.14 to 0.31, CSIE = 0.13, 95% CI = 0.09 to 0.19). In contrast, sport supplement use did not have a direct effect on doping attitudes (b = 0.03, 95% CI = –0.17 to 0.27). Overall the model accounted for 26% of the variance in doping attitudes ($F_{(2, 593)}$ = 207.62, p < .001, r = .51). Results are presented in Figure 1.

Discussion

Researchers have supported the notion that an athlete's use of sport supplements is related to doping attitudes (e.g., Backhouse et al., 2013; Ntoumanis et al., 2014). However, to date, no study has attempted to understand the process through which sport supplement use may lead to doping. One potential explanation is that over time athletes develop beliefs about supplements. To move beyond simple description of the supplement use-doping relationship and extend understanding in this area, we investigated whether this relationship was mediated by sport supplement beliefs. The support provided for this mediational pathway suggests that use of sport supplements may lead athletes to develop beliefs about their effectiveness, possibly due to perceived improvements in performance. These beliefs, in turn, may lead to the development of favourable attitudes toward doping with possible implications for doping behaviour. The absence of a direct effect of sport supplement use on doping attitudes underscores the importance of beliefs as a mechanism that could explain the link between supplement use and doping attitudes.

Study 2

The results of Study 1 provided evidence consistent with the hypothesis that the relationship between sport supplement use and doping attitudes is mediated by sport supplement beliefs. However, the measure we used to assess doping attitudes has been criticised by some researchers for its poor predictive validity in relationship to doping behaviour (Nicholls et al., 2017). Specifically, the five-item version of the PEAS represents a mix of governmental (e.g., "legalising performance enhancement would be beneficial for sport"), moral ("doping

is not cheating") and functional ("doping is necessary to be competitive") statements. Therefore, when using this scale it is not possible to determine which of these sub-components of doping attitudes is/are most important.

As an alternative, researchers have advocated the use of hypothetical scenarios to assess doping intentions (e.g., Huybers & Mazanov, 2012; Kavussanu & Ring, 2017; Ring & Kavussanu, 2018). Athletes are presented with a hypothetical situation that they may encounter in their career and are asked to indicate how likely they would be to use a banned substance, if they were in that situation. Doping likelihood is reported to be one of the strongest predictors of doping behaviour (Ntoumanis et al., 2014) and has previously been shown to identify athletes at risk of doping (Kavussanu & Ring, 2017; Ring & Hurst, 2019; Ring, Kavussanu, Simms, & Mazanov, 2018). Therefore, in Study 2, we extended the results of Study 1 by aiming to 1) examine the relationship between athletes' use of sport supplements and doping likelihood, and 2) determine whether beliefs about the effectiveness of supplements mediate this relationship.

Method

Participants

Four-hundred and eighty-one competitive athletes volunteered to participate in the study (age = 20.3 ± 2.2 years; years competing = 5.9 ± 4.2, hours per week training = 6.3 ± 4.4). The sample comprised mostly males (69.5%), who competed in team (88.8%) and individual (11.2%) sports. The highest ever standard at which the athletes had competed at in their sport was club (27.6%), county (45.7%), regional (6.7%), and national level (20.0%).

Measures

Sport Supplement Use and Beliefs

These variables were assessed using the same measures described in Study 1.

304 *Doping Likelihood*

305 In line with previous research (Huybers & Mazanov, 2012; Kavussanu & Ring, 2017; Ring &
306 Kavussanu, 2018), we asked athletes to indicate how likely they are to dope during a
307 hypothetical scenario. This scenario focused on the benefits of using a banned substance to
308 help improve performance for a future competition and is presented below:

309 *It's the week before the most important competitive game/event of your season.*
310 *Lately, your performance has been below your best. You don't feel you have the*
311 *necessary fitness for this competition, and you're concerned about how you'll*
312 *perform. You mention this to a teammate, who tells you that he/she uses a new*
313 *substance that has enhanced his/her fitness and performance. The substance is*
314 *banned for use in sport, but there's no chance that you will be caught.*

315 After reading the scenario, athletes were asked to rate how likely they were to use the
316 banned substance on a Likert-type scale ranging from 1 (*not at all likely*) to 7 (*very likely*).

317 *Procedure*

318 After gaining ethical approval from the university research ethics committee, athletes were
319 recruited from sports clubs. Recruitment strategy and instructions were identical to those in
320 study 1, and athletes provided informed consent and completed the measures previously
321 described.

322 *Data Analysis*

323 Preliminary examination of the data revealed that six athletes did not complete the SSBS
324 scale. These were deleted, leaving a final sample size of 475. Two athletes (0.42%) had
325 missing data and Little's MCAR test revealed data were missing completely at random (χ^2=
326 5.142, *df* = 10, *p* > .882). Missing values were replaced using a multiple imputation model

that generated five data sets with maximum number of parameters set at 100. The average value of the missing data sets was used in subsequent analysis.

Similar to Study 1, we used the PROCESS 2.16 (Hayes, 2013) SPSS macro (model 4) to test direct and indirect effects of sport supplement use on beliefs and doping likelihood. Bootstrapping was set at 10,000 samples and bias-corrected 95% confidence intervals were calculated for all effects. The CSIE was reported as the effect size metric and the level of statistical significance accepted was at $p \leq .05$.

Results

Descriptive Statistics and Zero-Order Correlations

Descriptive statistics indicated that on average, over two thirds of athletes used supplements (69%) and reported relatively moderate beliefs in their effectiveness (mean ± SD = 3.12 ± 1.41; median = 3.67). Athletes also reported relatively low doping likelihood scores (mean ± SD = 2.27 ± 1.53; median = 2.00). Supporting our first hypothesis, zero-order correlations showed the use of sport supplements was positively associated with likelihood of doping ($r = .15$, p = .002). Further, positive relationships were identified between sport supplement use and sport supplement beliefs ($r = .46$, $p < .001$), and sport supplement beliefs and likelihood of doping ($r = .22$, $p < .001$).

Mediation Analysis

Our second hypothesis posited that the relationship between supplement use and doping likelihood would be mediated by sport supplement beliefs. As can be seen in Figure 2, sport supplement use was not directly related to doping likelihood ($b = 0.17$, 95% CI = -0.15 to 0.50), but was indirectly related to doping likelihood via sport supplement beliefs ($b = 0.31$, 95% CI = 0.15 to 0.49, CSIE = 0.09, 95% CI = 0.05 to 0.15). Overall the model accounted for 21% of the variance in doping likelihood ($F_{(2, 473)} = 143.52$, $p < .001$, $r = .46$).

Discussion

Similar to Study 1, in Study 2, we found that sport supplement use indirectly predicted doping likelihood via sport supplement beliefs. This finding suggests that users of sport supplements may be more likely to dope because supplement use may lead one to develop beliefs about their effectiveness. In turn, these beliefs may influence doping likelihood.

General Discussion

It has been proposed that the use of sport supplements can lead an athlete to dope (Backhouse et al., 2013; Hurst et al., 2017b; Petróczi, 2013). Building on research conducted on the role of sport supplement use and doping (Backhouse et al., 2013), we examined the associations between athletes' use of sport supplements and both doping attitudes and doping likelihood, and whether beliefs about the effectiveness of supplements mediated any of these associations.

In support of our hypotheses, we found that sport supplement use was positively associated with both doping attitudes (Study 1) and doping likelihood (Study 2). These results are in line with existing cross-sectional research (Backhouse et al., 2013; Hildebrandt et al., 2012), which has reported a positive relationship between sport supplement use and doping. While sport supplements may help athletes meet nutritional targets, train harder, and stay healthy and injury-free (Maughan et al., 2018), their continued consumption may also lead to a greater willingness to engage in doping (i.e., via the gateway hypothesis or IMDB). If athletes perceive sport supplements as beneficial for performance, they may subsequently be more likely to consider doping. These findings provide some support for the gateway hypothesis and IMDB, namely, that the use of performance enhancing methods (e.g., sport supplements) could increase the likelihood of an athlete doping.

To our knowledge, this is the first study to examine the mediating role of sport supplement beliefs in the sport supplement use-doping relationship. We found support for the possibility

that sport supplement beliefs mediate the relationship between sport supplement use and both doping attitudes and likelihood. This suggests that athletes who use sport supplements may develop beliefs about their effectiveness over time and as a result be more likely to dope. This may happen because athletes believe that doping can improve performance to the same, or to a greater extent to that of supplements. In other words, the perceived beneficial effects of sport supplements may augment the belief that they are effective, which in turn may lead to doping. Given the IMDB, which posits that the continued use of non-banned performance enhancing methods can lead to doping (Petróczi, 2013), the more an athlete believes in the effectiveness of these types of methods, the more likely they are to dope. Overall, our results underline the potentially important role of sport supplement beliefs in doping.

Practical Implications

Our findings have practical implications for organisations and researchers aiming to prevent doping in sport. They show that sport supplement use is indirectly related to doping attitudes and likelihood via beliefs about the effectiveness of sport supplements. Thus, anti-doping prevention programmes need to focus on reducing the belief about the effectiveness of sport supplements. This could be achieved by downplaying their effectiveness during nutritional and anti-doping interventions. There is a body of evidence suggesting that a large proportion of the effectiveness of sport supplements is the result of a *placebo effect* (Beedie et al., 2018; Hurst, Foad, Coleman, & Beedie, 2017a). Informing athletes about the placebo effect could help them to make more informed choices about the use of sport supplements and banned substances, which, in turn, may modify their beliefs about their effectiveness.

Alternatively, a more indirect way to modify beliefs could be for practitioners to promote an environment that fosters behaviours away from the use of sport supplements. For example, providing athletes with a “food-first approach” could provide athletes with functional

401 alternatives to sport supplementation (Whitaker & Backhouse, 2017). This may indirectly
402 modify an athlete's behaviour in relationship to supplements. For example, instead of an
403 athlete adopting non-natural forms of nutrition, such as powders and pills, that athlete may
404 adopt more natural means of nutrition, and have a reduced belief in the effectiveness of
405 sport supplements. It is reasonable to suggest that based on the results of this and other
406 studies (Backhouse et al., 2013; Hurst et al., 2017b), as well as the gateway hypothesis and
407 the IMBD, a reduction in the use of sport supplements might change an athlete's belief in
408 their effectiveness, and subsequently the chance of that athlete doping.

409 *Limitations and Future Research Directions*

410 In this multi-study research programme, we have reported some novel findings. However,
411 these need to be interpreted in light of the following limitations. First, both studies are
412 cross-sectional, and, therefore, a causal link between supplement use and doping outcomes
413 cannot be asserted. It could be argued that beliefs about supplements influence supplement
414 use which in turn influences doping. Future research should examine whether supplement
415 use acts a mediator between supplement beliefs and doping[1]. Similarly, researchers should
416 also investigate how athletes develop beliefs about banned and non-banned substances and
417 whether they are related to future substance use. This could help determine how athletes
418 learn and interpret information about performance enhancing substances, which could be
419 used to facilitate the development of anti-doping educational interventions. Second, the
420 effect sizes between sport supplement use and doping were small (r = .11 and .15, for
421 doping attitudes and likelihood, respectively). This suggests that any potential causal
422 relationship between the use of sport supplements and doping could be influenced by other
423 factors that may be more influential in leading athletes to dope. Third, and like other

[1] In this study, we were unable to analyse whether sport supplement use mediated the relationship between supplement beliefs and doping as supplement use was measured on a dichotomous scale (i.e. 0 = no, 1 = yes).

research in this area (Kavussanu & Ring, 2017; Ring et al., 2018), participants had relatively low doping attitudes and likelihood scores. It is unknown whether the results from this study are similar for athletes with higher scores on these variables. Future research is therefore needed that examines the mediating role of sport supplements and the supplement use-doping relationship in an athletic sample with higher doping scores.

Conclusion

In conclusion, the results from our research demonstrate that sport supplement use is related to both doping attitudes and doping likelihood. That is, athletes using sport supplements are more likely to report a more favourable attitude to doping and indicate a greater likelihood of doping. Moreover, we provide novel evidence to suggest that sport supplement users, who have a strong belief in the effectiveness of the supplements, may be more likely to dope, and these beliefs may explain the relationship between sport supplement use and doping. For anti-doping organisations and researchers aiming to prevent doping, targeting athletes' beliefs about the effectiveness of sport supplements may improve anti-doping prevention programmes. Research investigating the effects of belief-based interventions on sport supplement use in sport is now needed.

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Figure Captions

Figure 1. The effects of supplement use on doping attitudes and the mediating role of sport supplement beliefs. *Note*. Values are the unstandardized regression coefficients. * $p < .01$

Figure 2. The effects of supplement use on doping likelihood and the mediating role of sport supplement beliefs. *Note.* Values are the unstandardized regression coefficients. * $p < .01$