Development and validation of the Sports Supplements Beliefs Scale

Abstract

It has been proposed that the use of sports supplements by athletes might lead to the use of banned substances. This has been termed the gateway hypothesis. Given this hypothesis, if we accept that athletes use non-banned sports supplements because they believe that they will be effective, a measure of athletes' beliefs about supplements might allow practitioners to identify athletes at risk of doping. We report the five-stage development of the Sports Supplements Beliefs Scale (SSBS). In study 1 we evaluated athletes' beliefs about sports supplements by conducting semi-structured interviews on 16 athletes. Inductive and deductive analyses resulted in a pool of 26 items. In study 2 we recruited a panel of experts and athletes to evaluate the content validity of the 26 items. 15 items were eliminated at this stage. In study 3 we subjected the responses of 171 athletes to exploratory factor analysis to determine the factor structure of the scale. A two-factor model emerged, with one strong six-item factor, a less coherent four-item factor, and one item that cross loaded. In study 4, responses of a sample of 412 team sports athletes were subjected to confirmatory factor analysis. Of three competing models tested, a six-item single-factor model demonstrated best model fit (χ^2/df = 2.894, RMSEA = 0.068; 90% CI = 0.038 to 0.099, P = 0.146, SRMR = 0.0246, CFI = 0.987, TLI = 0.978, AIC = 50.045, EVCI = 0.122). Factor loadings ranged from 0.4 and 0.9. All *t*-values were statistically significant (P <0.001) and ranged from 10.3 to 13.3. In study 5 we examined relationships between scores on the six-item scale and supplement use. Linear regression indicated that higher scores were significantly associated with the use of a greater number of supplements (β = 0.534, P <0.001, r^2 = 0.285) and higher frequency of supplement use (β = -0.517, P <0.001, r^2 = 0.267). Scores of users and non-users of supplements differed significantly (mean differences = 6.37 ± 0.56, U = 8,357, P <0.001), with discriminant function analysis indicating that scores correctly predicted 76% of sport supplement users and 66% of non-users (Wilks Lambda = 0.760 χ^2 = 110.988, P <0.001). Whilst future research will be required to demonstrate its predictive validity, the SSBS has utility in the assessment of athletes' beliefs about sports supplements. In the context of the gateway hypothesis, SSBS scores might play a meaningful role in identifying at risk athletes and in evaluating interventions.

Key words: anti-doping; athletes; drugs; factor analysis.

1.1 Introduction

Doping, the use of banned substances by athletes, undermines the ethos of sport and can place the health of athletes at risk. To deter doping, national anti-doping agencies devote substantial resources to detecting and punishing athletes who are using banned substances, with up to 250,000 tests conducted annually (Pound, Ayotte, Parkinson, Pengilly, & Ryan, 2012). However, analytical findings of drug tests have remained the same for the past 10 years, with only ~1-2% of tests showing a positive result. The World Anti-Doping Agency has thus endorsed a preventative approach (World Anti-Doping, 2015) with many researchers seeking to identify the psychological risk factors for doping (see Ntoumanis et al., 2014 for review) that might inform policy.

In relation to the last point above, it has been proposed that the use of non-banned sport supplements such as caffeine, creatine and sodium bicarbonate, might be a risk factor for doping. In short, the use of non-banned substances can lead to the use of banned substances. In a recent meta-analysis (Ntoumanis et al., 2014), the strongest correlate of doping behaviour was the use of sport supplements. Sports supplements are widely used by athletes of all ages and abilities (Knapik et al., 2016), with the aim of enhancing performance, recovery, and/or other sport related factors (Nieper, 2004; Maughan, King, & Lea, 2004; Lun, Erdman, Fung, & Reimer, 2012).

The idea that use of non-banned and arguably safe substances by athletes might lead to the use of banned and potentially unsafe ones is provocative. However, several hypotheses might explain this association. Thorndike's (1911) 'law of effect,' suggests that the probability of a response being made is increased when followed by a reward and decreased when followed by discomfort. An athlete using a sport supplement for the first time is likely to attribute any potential improvements (or decrements) in performance to the supplement, with improvements in the athlete's performance suggested to increase the likelihood of future supplement use and decrements suggested to decrease this. Further positive experiences of supplementation reinforce the belief that the supplement is effective, and negative experiences reinforce the belief that the supplement is ineffective. The response to the supplement is thus reinforced by the outcome in performance. This is underpinned by Pavlovian conditioning, where a stimulus (i.e. sport supplement) is associated with a response (i.e. improvement in performance), which can reinforce the substances effectiveness (Everitt & Robbins, 2013). These experiences can create cues that embody affective states and strengthen the association between the response and the stimuli (Stewart, De Wit, & Eikelboom, 1984). The conditioned effects of a substance can activate neural mechanisms that mimic the neural activity of the substance, and it is the activation of these states by conditioned stimuli that initiates further substance use behaviour (Everitt & Robbins, 2005; 2013). However, with repeated exposure of a substance, the pharmacological effects are often markedly reduced over time and the brain systems that are normally involved become desensitised to the physiological effects, but more significantly, become hypersensitive to the associated stimuli (Hyman & Malenka, 2001). Sensitisation of substances may lead to an increased use of the same substance or use of another, stronger, substance; a process termed 'cross-sensitisation' (Robinson & Berridge, 1993).

Whilst it is clear that numerous hypotheses might explain the progression to strong drugs through the use of weaker ones, the term 'gateway hypothesis' has been used as a coverall. Originally credited to Kandel, (1975), the gateway hypothesis proposes that individuals become increasingly involved in drugs in stages and in sequences. Kandel (1975) reported that if adolescents progress to marijuana use, the likelihood of using harder illicit drugs, such as cocaine and heroin, would significantly increase from 2 and 3% to between 16 and 23%. More recent epidemiological data report that 56.3% and 84.5% of high school students would smoke tobacco or drink alcohol before progressing to marijuana and cocaine respectively (Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2013). Further evidence from the Substance Abuse and Mental Health Services Administration (2013) revealed that 65% of marijuana users started smoking or drinking before they started using marijuana, whilst 97% of cocaine users started smoking or drinking before progressing to cocaine. Fergusson & Horwood (2000) reported that over 99% of illicit drug users in New Zealand would use cannabis first before progressing to other illicit drugs and Prince van Leeuwen et al. (2013) reported that tobacco use in the Netherlands was associated with a higher likelihood of developing a marijuana use disorder.

Although the above epidemiological evidence has arguably established a weak drug-strong drug sequence in which different substances are used, it has not identified what causes the progression from one drug to the next. For this reason, many authors have criticised the validity of the gateway hypothesis and its causal mechanisms (Vanyukov et al., 2012; Kleinig, 2015). However, animal studies have shown that the intake of a 'softer' drug can increase the intake of a 'harder' drug; for example animals sensitised to amphetamines have shown an increased intake of cocaine (Ferrario & Robinson, 2007), whilst animals given access to sugar increase the intake of alcohol (Avena, Carrillo, Needham, Leibowtiz, & Hoebel, 2004) and cross-sensitise to cocaine (Gosnell, 2005). Levine et al. (2011) proposed a molecular explanation for the gateway hypothesis and the sequence of drug use, suggesting that exposure to nicotine causes specific changes in the brain that make it more vulnerable to cocaine addiction. It was also shown that pre-treatment with nicotine greatly alters the response to cocaine in terms of addicted related behaviour and changes in brain regions critical for addiction related rewards. Furthermore, and at a molecular level, nicotine enhanced the effect of cocaine when it was administered for several days prior to the use of cocaine. These results stimulated further analysis of epidemiology data, where Kandel & Kandel (2014) reported cocaine users would often start using cocaine only after prolonged smoking of tobacco. Collectively, data suggest that in the general population in Western societies, there is a well-defined sequence of progression of drug use. That is illicit drug use often starts with a softer drug and proceeds to harder drug use. The idea of the gateway hypothesis has influenced US drug policy since the 1950’s (Morral, McCaffrey, & Paddock, 2002).

Whilst the sport-specific database is less well developed than the substance use literature, it is proposed that in a manner similar to that in which the use of legal recreational drugs (e.g., alcohol and nicotine) leads progressively to the use of stronger illegal drugs in the general population, the use of sport supplements by athletes might lead to the use of stronger and often banned substances (Lentillon-Kaestner & Carstairs, 2010; Hildebrandt, Harty, & Langenbucher, 2012).

The available research in sport is based on the testimony of athletes, and not on experimental or epidemiological data. Furthermore those testimonies are in relation to a contentious subject, so cannot be described as entirely unproblematic (for example, it is as plausible that athletes who dope use supplements to optimise drug effects as it is that athletes who use supplements go on to dope). It must also be made clear that as is the case with progression from alcohol and marijuana, for example, progression from sport supplements to doping substances is far from inevitable. However, given both the physiological and epidemiological evidence above, and given that there is no reason to suggest that sport represents a special case in relation to substance use, the gateway hypothesis represents a plausible mechanism and warrants further investigation.

As suggested above, anti-doping agencies seek methods to identify athletes more susceptible to doping. Although still a developing field, the main focus of this work has been involved with the development and validation of psychometric measures that sufficiently identify and quantify psychological constructs of doping behaviours (Petróczi et al., 2015). However, obtaining reliable self-report information about *explicit* doping behaviours is associated with several ethical and practical challenges, including the considerable problem that an admission of use of a banned substance can result in the athlete losing their right to participate in sport. For this reason, researchers generally use one or more psychological constructs as a proxy to doping behaviour. To date, the validated psychological methods used have mainly focused on quantifying athletes’ attitudes towards doping (e.g. Petróczi & Aidman, 2009; Brand, Melzer, & Hagemann, 2011). Athletes reporting more favourable attitudes towards banned substances are predicted to be more likely to initiate the behaviour. Other cognitive variables, for example moral disengagement, sport orientation and task and ego orientation, have also been used to describe an athletes doping mindset (Petróczi et al., 2015).

Recent data suggest that athletes who use sport supplements tend to express more favourable beliefs about the effectiveness of these types of substances compared to non-users (Backhouse et al., 2013). Furthermore, athletes’ beliefs about sport supplements influence future behaviours and intentions (Bell, Dorsch, McCreary, & Hovey, 2004). Hypothetically therefore, if athletes’ beliefs about sports supplements influence current and future supplement use, and if current/future supplement use predicts future doping, it is reasonable to suggest a relationship between current beliefs about supplements and future doping. Given this, an instrument facilitating the reliable and valid assessment of beliefs about supplements could represent a useful tool in the development and evaluation of anti-doping interventions. To our knowledge no validated measure of athletes’ beliefs about sport supplements has been published.

Mazanov 2016) emphasised that authors reporting data of relevance to doping should explicitly state their biases and research aims. Our position is that anti-doping policy is absolutely necessary to both protect the integrity of sports, which are after all defined by their rules, and even more importantly, to ensure the health and wellbeing of athletes. We argue that detection and deterrence methods used by anti-doping authorities are often ineffective and/or draconian (Dimeo, 2016). We value a preventative approach that places emphasis on providing athletes with education, information and strategies to inform and support their decision to not use banned performance enhancing substances. Given the possible relationships between athletes’ beliefs about sport supplements and doping, the aim of this study was to develop and validate a psychometric measure that might identify at-risk athletes.

Below we report the multi-stage validation of such a measure that could facilitate future research investigating the psychological underpinnings of substance use behaviours. Anastasi and Urbina (1997) argue that the validation of any psychometric instrument requires multiple procedures, which are employed sequentially at different stages of construction. Validity is thus built into the test at the outset rather than being limited to the last stages of test development, as in traditional criterion-related validation. Each of these procedures/stages can be seen as fundamental to demonstrating the two sources of information described by Murphy and Davidshofer (1998) as representing strong evidence for the validity of measurement, that is, content and construct validity. Murphy and Davidshofer proposed that the empirical and theoretical basis for the construct, the interpretability of that construct, the generalisability of the construct definition, and the applicability of the initial item pool to that definition, all jointly determine the content validity of the questionnaire. Similarly, the results of empirical item analyses, factor analyses, and criterion analyses jointly indicate construct validity.

In line with the proposals above, we report the results of semi-structured interviews exploring athletes' beliefs about sport supplements (study 1), initial instrument development and content validity procedures (study 2), exploratory and confirmatory factor analyses of responses to the questionnaire from n=171 and n=412 athletes respectively (studies 3 and 4), and relationships between questionnaire scores and supplement use (study 5). Our institutional research ethics committee approved all studies. Informed consent was obtained from each participant in each of the studies prior to their involvement.

Study 1

2.1 Aims

We aimed to explore and demonstrate the empirical basis for the questionnaire through the identification of themes and dimensions relating to the use of sports supplements by athletes.

2.2 Method

DeVellis (2012) and Lynn (1995) recommend that in questionnaire development, core concepts be identified using qualitative interviews. We therefore used semi-structure interviews to explore athletes' beliefs about sports supplements.

2.2.1 Participants. Sixteen athletes (6 females and 10 males; age = 24 ± 3; years training = 10 ± 4; hours per week training = 13 ± 4), were recruited via social media. To ensure that responses were not affected by specific sport cultures and practices, athletes of varying abilities were recruited from various sports including football, gymnastics, mixed martial arts, rowing, Rugby union, track and field and weightlifting. Participants had a range of athletic experience, with 13% competing at club level, 19% at county, 19% at regional, 25% at national and 25% at international.

2.2.2 Procedure. Each athlete was interviewed individually by the lead author either face-to-face or via Skype. Initially adopting a deductive approach, an interview guide based upon the available literature was developed. However, the semi-structured interview schedule was developed to be sufficiently flexible to allow new concepts to surface inductively (Ntoumanis, Pensgaard, Martin, & Pipe, 2004).

Athletes were asked to describe their decisions for using or not using sport supplements, the factors that influenced these decisions, and any experiences of using sport supplements. The semi-structured interviews consisted of a series of questions of four interrelated sections: 1) what is a sport supplement; 2) experiences of sport supplements; 3) beliefs about sport supplements and 4) influences to use sport supplements. Interview times ranged from 36 to 91 minutes (mean ± SD = 56 ± 21 minutes). All participants had the right to stop the interview and/or participation at any time. All participants were emailed a copy of the transcript to enable them to revise responses. Data analyses began only after the athlete accepted the final version of the transcript.

2.2.3 Data analysis. Audio recordings were transferred onto the software QSR NVivo 10. The lead investigator read each transcript several times to familiarise himself with the data. This process allowed ordinate and sub-ordinate themes to emerge. Both deductive and inductive approaches to thematic analysis were used. Data analysis followed a three-stage coding process adapted from Smith et al., (2010): first, a summary report of the individual interviews to highlight the most pertinent issues; second a pool of narratives centred on specific ordinate themes; and third, a thematic grouping structure around sub-ordinate themes.

2.3 Results

A summary of the main findings is presented in table 1. Four ordinate themes emerged from the data. The first related to the performance enhancing effects of sport supplements, contained three sub-ordinate themes: improved performance, higher chance of winning, and competitive edge. A second ordinate theme related to athletes' perceptions that sport supplements could help improve recovery and health, also contained three sub-ordinate themes: improved recovery, overcoming illness, and reduced chance of injury. A third ordinate theme related to athletes' perceptions that sport supplements were necessary for performance, and contained two sub-ordinate themes: performance advantage, and the similarity between the use of supplements and the use of up-to-date equipment. A final ordinate theme related to the psychological effects associated with sport supplement use, contained two sub-ordinate themes: confidence and anxiety.

Study 2

3.1 Aims

We aimed to develop a pool of items derived from responses to study 1 and to demonstrate the content validity of these.

3.2 Method

Based on responses reported in study 1, we developed a pool of 26 items. Subsequently a panel of experts and athletes assessed the content validity of the resultant measure.

3.2.1 Participants. Participants were a sample of six experts on anti-doping and 23 British athletes. Experts had all published in the anti-doping literature and were situated in Australia (n = 2), United Kingdom (n = 1), United States (n = 1), Italy (n = 1) and Canada (n = 1). Athletes (57% male, years training = 11 ± 6, hours per week training = 9 ± 6) were of a variety of ages, the majority aged between 18 and 24 (48%). Athletes competed at various levels, with county being most common (48%), followed by national (35%), international (13%) and club (4%). Athletes were drawn from a variety of sports including track and field, weightlifting, triathlon, Rugby union, field hockey and badminton. No participants from study 1 were recruited to study 2.

3.2.2 Procedures. We developed an online survey to enable academic experts to assess content validity and sent individual emails to a number of experts worldwide requesting their participation. We provided experts with the 26 items and asked them to respond on a 4-point Likert type-scale (1 = not relevant; 4 = highly relevant) as to how they believed each item related to athletes' beliefs about sport supplements. Free-text boxes for each item facilitated comments, as did a similar free-text box at the end of the scale. Participants had a range of athletic experience, with 13% competing at club level, 19% at county, 19% at regional, 25% at national and 25% at international.

3.3 Results

We summarised expert ratings of content validity by dividing the number of experts who provided a rating of 3 or 4 by the total number of experts (Lynn, 1986). Lynn proposed that when six or more experts review the content validity index (CVI) of a scale, values equal to or greater than 0.8 are acceptable (see also Polit, Beck, & Owen, 2007). CVI values of less than 0.8 were evident for seven items and these were removed from further analysis.

Athletes reported that the items adequately represented their beliefs about sport supplements. However, athletes reported that certain types of sport supplements do not elicit specific performance effects and suggested that the type of supplement they used influences their belief about its effects. For example, athletes who used protein drinks did not believe that this type of supplement would influence performance, but did believe that it would improve recovery. Based upon these comments, we deleted eight items relating to specific performance enhancing effects of sport supplements (e.g., fatigue, pain, recovery). A final pool of 11 items remained.

Study 3

4.1 Aims

Following content validity procedures, we examined the factor structure of the 11-item measure. Factor analysis is a statistical procedure applied to a single set of variables where the researcher is interested in discovering which variables in the set form coherent subsets that are relatively independent of each other.

Essentially, the aim of factor analysis is to reduce a large number of variables to a smaller number of factors (Tabachnick & Fidell, 2007), and to indicate how many factors are needed to describe the data.

Exploratory factor analysis (EFA) is an inductive process that in essence 'explores' the data, and results in a set of latent variables that explain correlations among the measured, or manifest, variables. Marsh and Yeung (1997) argued that "a long history of factor analytic research has demonstrated that this purely exploratory approach to factor analysis is typically ineffective" (p. 33), and Hendrickson and Jones (1987), in an often-cited phrase, suggested that EFA is no more than "an undisciplined romp through a correlation matrix" (p. 105). As a consequence of its limitations, it has been proposed that EFA is appropriate only when the analyst does not know what the underlying factor structure of a set of data should be (Biddle, Markland, Gilbourne, Chatzisarantis, & Sparkes, 2001). Several authors (Anastasi & Urbina, 1997; Marsh & Yeung, 1997; Schutz, 1994; Schutz & Gessaroli, 1993; Tabachnick & Fidell, 2007) proposed that confirmatory factor analysis (CFA), which permits the analyst to test an *a priori* model of relationships between the manifest and latent variables, should be used in preference to EFA.

However, in studies 1 and 2 above we adopted an empirical and largely atheoretical approach in deriving items. We therefore posited no a-priori theory as to any potential inter-correlations between items. On this basis we believe that the optimal approach to demonstrating factorial validity would be to report the results of both EFA and CFA procedures. We therefore used EFA on a first sample of athletes and subsequently interrogated, modified and confirmed the resultant factor structure using CFA on a different sample (study 4).

4.2 Method

4.2.1 Participants. Participants were 171 athletes (67% male; years training = 12 ± 9; hours per week training = 11 ± 7). Over 25 different sports were represented, with the highest proportions of athletes from athletics (43%), triathlon (18%), cycling (13%), and weightlifting (5%). Athletes were between the ages of 18 and 24 (24%), 25 and 34 (26%), 35 and 44 (25%) and 45 or older (25%) and were of differing competitive levels with 30% competing at club level, 19% county, 27% national, and 24% international. We recruited athletes via social media, and requested that they complete the questionnaire via a secure online survey platform (www.surveymonkey.com).

4.2.2 Procedure. Athletes' completed the newly developed 11-item instrument, which was labelled the 'Sport Supplements Belief Scale' (SSBS). The SSBS required athletes to respond on a 6-point Likert-type scale with scores ranging from strongly disagree (1) to strongly agree (6). We used a Likert-type scale following Comrey's (1988) recommendations that multiple-choice scales are more reliable and produce better scales than other formats (e.g., visual analogue scales, checklists).

4.2.3 Data analysis. We inputted data into SPSS v22.0. A missing values analysis indicated that of a possible 1881 data points only 15 (0.7%) were missing from 12 respondents (8%). No respondents had less than 5% of missing data and Little's MCAR test revealed data were missing completely at random (χ^2 =146.093, *df* = 50, *P* = 0.957). We replaced missing values using a multiple imputation model that generated five data sets with a maximum number of parameters set at 100. The average value of the missing data sets was used for the subsequent analysis.

We used EFA with the Maximum Likelihood method to examine the dimensionality of responses to items. Sample size recommendations for EFA vary, but given that 5-10 participants per item are considered acceptable (Bentler & Chou, 1987), the sample size of 171 for the 11 items is adequate. We used oblique (promax) rotation, as we anticipated correlation among factors. Factors with eigenvalue greater than 1 were extracted, primary loadings of 0.3 or above were considered interpretable, and loadings 0.4 or above considered important (Hair, Black, Babin, & Anderson, 2006). We excluded any item associated with a loading below 0.3. We report Cronbach's alpha to indicate the internal consistency of the scale, with adequate reliability demonstrated at levels above 0.7 (Nunnally, 1978).

4.3 Results

A two-factor model emerged. Item 10 'Using supplements makes me optimistic about my performance' cross-loaded, so we removed this item and repeated the procedure with 10 items. Once again a two-factor model emerged with an explained variance of 48.83%. Factor 1 (7-items) appeared to describe the beliefs of athletes regarding the outcomes of using supplements themselves, whilst Factor 2 (3-items), although less clear, could be interpreted as normative beliefs of athletes about supplements, that is, athletes' perceptions that supplements are an accepted means of performance enhancement. Bartlett's test of sphericity was significant,

χ^2 = 490.963, *df* = 15, *P* <0.001 and the Kaiser-Meyer-Olkin statistic was considered good (0.884). The 10 items and their respective factor loadings are presented in table 2.

Study 4

5. 1 Aims

The penultimate stage of the early development and validation process was to assess the factor structure of the instrument using confirmatory factor analysis (CFA).

5.2 Method

Confirmatory factor analysis is a statistical procedure for testing theory. As such it contrasts with EFA in that in CFA, the test developer specifies the item-to-factor loadings in advance and assesses the 'goodness of fit' between this model and the reported data. The principal indicator of good model fit is a small and non-significant χ^2 (Biddle et al., 2001). However, it is often unclear whether a significant χ^2 is the result of poor fit or large sample size (larger samples tend to produce larger values of χ^2 that are also more likely to be significant, i.e., a Type I error, whereas small samples may accept poor models, i.e., a Type II error). To moderate the effects of sample size on model fit, several authors have recommended that the χ^2 to degrees of freedom ratio be used in preference to χ^2 alone (e.g. Heene, Hilbert, Draxler, Ziegler, & Bühner, 2011; Marsh, Balla, & McDonald, 1988) whilst others have suggested that authors rely on other types of fit indices (Byrne, 1998; Hu & Bentler, 1999). These include Comparative Fit Index (CFI); Root Mean Square Error of Approximation (RMSEA); Standardized Root Mean Squared Residual (SRMR); Tucker-Lewis Index (TLI), Akaike Information Criterion (AIC) and the Expected Cross-Validation Index (EVCI).

5.2.1 Participants. Four hundred and sixty-eight competitive male and female athletes (81% male, years training = 10 ± 6, hours per week training = 6 ± 4) volunteered to participate in the study. Over 12 different sports were represented, with the highest proportions of athletes from Rugby union (54%), football (23%), hockey (5%), and American football (4%). Athletes were between the ages of 18 and 24 (64%), 25 and 34 (24%), 35 and 44 (4%) and undisclosed (8%) and were of differing competitive levels with 23% competing at club level, 32% county, 26% national, 10% international and 9% undisclosed.

5.2.2 Procedure. We asked athletes to complete the ten-item questionnaire reported in study 3. Athletes were required to read and respond to each statement on a 6-point Likert-type scale ranging from strongly disagree (1) to strongly agree (6). All statements were scored in the same direction and total scores ranged from 10 to 60.

5.2.3 Data analysis. We inputted data into SPSS v22.0 and Amos v22.0. Examination of data revealed that 16 respondents did not respond to any of the items on the scale and were thus deleted. A further 40 respondents were removed after examination of the data revealed they were unengaged (i.e., responses were coded the same for each item). A missing values analysis indicated that, of a possible 2,652 data points, only 8 (0.17%) were missing from 8 respondents (1.8%). Little's MCAR test revealed data were missing completely at random (χ^2 =25.775, *df* = 24, *P* = 0.365). Missing values were replaced using a multiple imputation model that generated five data sets with a maximum number of parameters set at 100. The average value of the missing data sets was used for subsequent analysis.

We examined measurement model fit using CFA and the Maximum Likelihood procedure on AMOS v22.0. Model fit was expressed as acceptable when the ratio between chi-square statistic and the degrees of freedom (χ^2/df) ranged between 1 and 3 (Kline, 2011). The overall fit of the model was also assessed with the RMSEA, SRMR, CFI, and TLI. Model fit was considered acceptable with values of RMSEA close or less than 0.06, of SRMR close to or less than 0.08, and of CFI and TLI close to or greater than 0.95 (Hu & Bentler, 1999). The AIC and ECVI do not have a specified acceptable value, but the lower the value amongst competing models is considered to be the most parsimonious and most likely to be replicated by other samples. Finally, to determine the significant parameter estimates, we calculated *t*-values by dividing the factor loading by the standard error. We classified *t*-values exceeding 1.96 and 2.56 as significant at the 0.05 and 0.01 level respectively (Suhr, 2006).

As per published recommendations (Bentler, 2006), each hypothesised relationship between the latent factor and factor loadings was a free parameter, with the exception of a single item that was randomly assigned to unity to define the scale of the factor.

5.3 Results

Mean scores on the ten-item SSBS were 31.69 ± 9.59. Scores ranged from 11 to 59, with increasingly higher scores representing increasingly positive beliefs relating to sports supplements.

CFA of a two-factor, ten-item model revealed inadequate fit (χ^2/df = 3.832, RMSEA = 0.083; 90% CI = 0.068 to 0.098, P < 0.001, SRMR = 0.0731, CFI = 0.950, TLI = 0.934, AIC = 172.304, ECVI = 0.419). After examination of the scale we suspected that a single-factor, unidimensional scale, might improve model fit. The second factor of three items was therefore removed and the CFA was performed once more.

CFA of a single-factor seven-item model indicated improved model fit (χ^2/df = 3.239, RMSEA = 0.074; 90% CI = 0.05 to 0.098, P =0.047, SRMR = 0.0309, CFI = 0.978, TLI = 0.968, ACI = 73.349, ECVI = 0.178). However, modification indices revealed large overlap between item 1 ('Supplements improve my training') and item 7 ('Training increases the need for supplements'). As the items related to similar theoretical constructs, item 7 was removed.

CFA on a single-factor six-item scale indicated acceptable loadings for all indices (χ^2/df = 2.894, RMSEA = 0.068; 90% CI = 0.038 to 0.099, P = 0.146, SRMR = 0.0246, CFI = 0.987, TLI = 0.978, AIC = 50.045, EVCI = 0.122). The results of the final model are summarised in table 3 and factor loadings with standard errors are shown in figure 1.

Study 5

6.1 Aim

We aimed to demonstrate tentative construct validity of the SSBS through the examination of relationships between SSBS scores and self-reported supplement use.

6.2 Method

Murphy and Davidshofer (1998) argued that, whilst in the past validation strategies were distinct, that is information relating to predictive, discriminant, concurrent, and construct validity would be presented separately, researchers increasingly recognise that all validation procedures can be grouped under the heading of construct validity.

6.2.1 Participants. SSBS scores collected from the participants in study 4 were used in this study. We also asked participants to respond to a series of questions relating to the range of supplements they use and to the frequency of use.

6.2.2 Data analysis. We used linear regression to examine relationships between SSBS scores and both the total number of sport supplements used and frequency of use (i.e., daily, weekly, monthly and never). We used Mann-Whitney U tests to compare total SSBS scores of users and non-users of sport supplements followed by discriminant function analysis to determine the degree to which SSBS scores might predict which athletes fell into one of two groups; users of supplements and non-users of supplements. Finally, Cronbach's alpha was calculated to provide an indication of internal consistency.

6.3 Results

A Kolmogorov Smirnov test indicated that data violated normality *(P* <0.05). Linear regression indicated significant relationships between SSBS scores and supplement use. Specifically, higher SSBS scores were significantly associated with the use of greater variety of supplements (β = 0.534, P <0.001, r^2 = 0.285). Likewise higher SSBS scores were significantly related to higher frequency of supplement use (β = -0.517, P <0.001, r^2 = 0.267).

We assessed differences in SSBS scores of users and non-users using a Mann-Whitney U test. Users reported significantly higher SSBS scores than non-users (mean differences = 6.37 ± 0.5, U = 8,357, P <0.001, figure 2). Discriminant function analysis indicated that SSBS scores correctly predicted 76% of sport supplement users and 66% of non-users (Wilks Lambda = 0.760 χ^2 = 110.988, P <0.001). Tests of equality between groups were significant though (P <0.001). Cronbach's alpha of 0.891 indicated good internal consistency of the six-item scale.

7.1 General discussion

The gateway hypothesis predicts that athletes who use supplements are more likely to use banned substances. Given the demand characteristics inherent in any attempt to assess beliefs about banned drugs, a measure of beliefs relating to supplements might have utility in both predicting at-risk athletes and in verifying the effectiveness of interventions.

Above we reported the empirical five-stage development of the Sports Supplements Beliefs Scale, in which multiple methods were used to generate, synthesise, evaluate and test increasingly more parsimonious versions of the instrument. From this a brief, single-factor measure with six items emerged: 'Supplements improve my performance', 'Supplements are necessary for me to be competitive', 'Supplements improve my confidence', 'My chances of winning improve when I use supplements', 'Supplements help me realise my potential', and 'Supplements improve the quality of my training'. These six items formed a theoretically and statistically coherent scale relating to athletes' beliefs about the effects of supplements on their own performance and performance related constructs. Many items that were eliminated in studies 2 and 3 assessed, for example, respondents' beliefs relating to the effects of supplements on elite athletes, beliefs about specific supplements and normative beliefs. The resultant scale appears to tap into athletes' personal perspective on the effects of supplements on themselves.

Scores on the SSBS were associated with both the frequency and volume of supplement use among n=412 athletes. Theoretically therefore, given the gateway hypothesis, high scores on the SSBS might predict athletes at risk of doping. This has several implications for intervention and education efforts targeting the use of sport supplement and doping behaviours. For example, National Anti-Doping Organisations (NADO) typically pursue a multifaceted approach in their education methods, where the aim is to cover a range of topics such as the values of sport, the testing procedures, medications and therapeutic use exemption forms (e.g. WADA's Athlete Learning Program about Health and Anti-Doping, UKAD's 100% me programme and USADA's true sport community-based movement). This often leaves only a small portion of the intervention to the discussion of sport supplements. For an athlete that scores high on the SSBS, a greater proportion of time may be needed to discuss the issues related to sport supplements. To improve the effectiveness and efficiency of the education interventions delivered, the NADO could instead target athletes who score highly on the SSBS and provide a more individual and in-depth intervention. Targeting the behaviour at this stage could also improve the effectiveness of anti-doping education. As the consumption of sport supplements arguably creates a psychological and physiological need for further, stronger substances of the same type, athletes experimenting with chemically active supplements may experience no ill effects. This would appear to contradict and undermine the strong negative publicity directed at doping. The advice and education athletes receive in the future may then become less persuasive and could increase rather than reduce the number of athletes moving onto doping substances, undermining the interventions in place by NADO's and WADA (Pudney, 2003). Educating athletes about sport supplementation may therefore prevent athletes from progressing to doping substances and improve the interventions NADO's and WADA implement.

It is reasonable to argue that interventions aimed at reducing athletes' confidence in, and reliance on, sports supplements might also reduce their likelihood to dope. This might happen via a direct belief-based pathway, that is, modifying an athlete's beliefs about supplements might at the same time modify that athlete's beliefs about doping. Alternatively it might result from an indirect behavioural pathway, that is, by modifying the athlete's behaviours in relation to supplements, for example their adopting non-natural forms of nutrition such as pills and powders, we might reduce the chance of those behaviours leading to a search for more effective substances. Either way, we argue that the SSBS will have utility in evidencing the effectiveness of such interventions.

Furthermore, the SSBS could be used within the battery of self-report instruments researchers use to understand athletes' doping behaviours. Doping is often viewed as a complex and multifaceted psychological phenomenon, where beliefs, desires, intentions, attitudes and perceptions of others, for example, can all intertwine and determine whether an athlete will decide to use banned substances or not (Hauw & McNamee, 2014). Researchers generally agree that there is no single factor that predisposes an individual to use banned substances and the gateway hypothesis is just one factor to consider within the realm of anti-doping interventions. For future research aiming to understand and uncover the influences of doping behaviours, the SSBS could be used alongside other instruments to generate a more complete picture of doping behaviours. Future work will need to evaluate the predictive validity of the SSBS by reporting the degree to which scores relate to future supplement use of athletes not currently using supplements, and whilst problematic, to doping behaviours. Future work should also aim to demonstrate the construct validity of the measure by assessing pre-post changes in SSBS scores following interventions designed to reduce athletes' reliance on and confidence in sports supplements.

Interestingly, the SSBS will also have utility in research investigating the effectiveness of sport supplements. Specifically it has been reported that the performance of athletes with strong beliefs in the effectiveness of sports supplements were more likely to improve following the administration of both supplements and placebos than were the performances of those with less belief (Beedie & Foad, 2009).

8.1 References

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9.1 Tables

Table 1. Ordinate and subordinate themes derived through interview data.

Ordinate theme	Sub-ordinate theme	Transcript example
Performance effects	Improved performance	"Supplements help me improve my performance. Whether pre, during or post competition"
	Higher chance of winning	"It's really pushing you beyond what you could normally achieve"
	Competitive edge	"I'm going to take full advantage of anything that is out there"
Recovery and health effects	Improve recovery	"I know that I need to like recover as quickly as possible and therefore... a protein shake is ideal"
	Overcome illness	"... a bit of supplementation wouldn’t go a miss… I think in terms of illness"
	Reduce injury	"I tend to just have it, because... I don’t want to have another injury"
Necessary for performance	Necessary to improve	"They were necessary... I felt a lot better after taking them and I felt that after a match where you feel beaten up… they were necessary"
	Same as equipment	"We are always looking for the fastest gear and the fastest kit. Supplements are just part of that"
Psychological effects	Increase in confidence	"I think it's as much confidence as well… you are maximising… you know, because recovery and preparation are as much part of the training and competitions as anything else"
	Decrease in anxiety	"I was shit scared to be honest… The preparation became a very much part of that, nutrition became definitely a safety blanket in that sense"

Table 2. Factor structure matrix of the 10-item scale derived from exploratory factor analysis

Item no.	Items	Factor loadings	
		Factor 1	Factor 2
1	Supplements improve my performance	0.800	
2	Supplements are necessary for me to be competitive	0.695	
3	Supplements improve my confidence	0.540	
4	My chances of winning improve when I use supplements	0.810	
5	Supplements help me realise my potential	0.725	
6	Supplements improve the quality of my training	0.830	
7	Athletes using supplements are usually the ones who medal at major championships		0.394
8	Supplements provide a greater improvement compared to a healthy diet		0.496
9	Supplements are the same as having the best equipment		0.772
10	Training increases the need for supplements	0.487	

Table 3. Factor loadings and *t*-values for the six-item version of the SBSS derived through confirmatory factor analysis

Item	Items	Factor Loading	*t-value*
1	Supplements improve my performance	0.652	13.306
2	Supplements are necessary for me to be competitive	0.966	12.880
3	Supplements improve my confidence	0.755	11.615
4	My chances of winning improve when I use supplements	0.463	10.289
5	Supplements help me realise my potential	0.581	11.173
6	Supplements improve the quality of my training	0.868	12.400

10.1 Figure captions

Figure 1. Single-factor model. All parameters standardised and significant (*P* <0.001)

Figure 2. Differences in sport supplement belief scores between users and non-users. ** = *P* <0.001.