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# Psychosocial predictors of doping intentions and use in sport and exercise: a systematic review and meta-analysis

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## ABSTRACT

**Objective** To conduct a meta-analytic review of psychosocial predictors of doping intention, doping use and inadvertent doping in sport and exercise settings.
**Design** Systematic review and meta-analysis.
**Data sources** Scopus, Medline, Embase, PsychINFO, CINAHL Plus, ProQuest Dissertations/Theses and Open Grey.
**Eligibility criteria** Studies (of any design) that measured the outcome variables of doping intention, doping use and/or inadvertent doping *and* at least one psychosocial determinant of those three variables.
**Results** We included studies from 25 experiments (N=13 586) and 186 observational samples (N=3 09 130). Experimental groups reported lower doping intentions ($g$=−0.21, 95% CI (−0.31 to −0.12)) and doping use ($g$=−0.08, 95% CI (−0.14 to −0.03), but not inadvertent doping ($g$=−0.70, 95% CI (−1.95 to 0.55)), relative to comparators. For observational studies, protective factors were inversely associated with doping intentions ($z$=−0.28, 95% CI −0.31 to −0.24), doping use ($z$=−0.09, 95% CI −0.13 to to −0.05) and inadvertent doping ($z$=−0.19, 95% CI −0.32 to −0.06). Risk factors were positively associated with doping intentions ($z$=0.29, 95% CI 0.26 to 0.32) and use ($z$=0.17, 95% CI 0.15 to 0.19), but not inadvertent doping ($z$=0.08, 95% CI −0.06 to 0.22). Risk factors for both doping intentions and use included prodoping norms and attitudes, supplement use, body dissatisfaction and ill-being. Protective factors for both doping intentions and use included self-efficacy and positive morality.
**Conclusion** This study identified several protective and risk factors for doping intention and use that may be viable intervention targets for antidoping programmes. Protective factors were negatively associated with inadvertent doping; however, the empirical volume is limited to draw firm conclusions.

### WHAT IS ALREADY KNOWN?

⇒ Athletes and exercisers' doping intentions and use are associated with personal factors such as morality, attitudes, motivation and antisocial behaviour.
⇒ The environment in which individuals operate also plays a significant role, for instance, team or coach-related motivation and morality variables as well as social norms about doping.

### WHAT ARE THE NEW FINDINGS?

⇒ Non-performance factors, such as body dissatisfaction, exposure to fitness appearance media posts and ill-being, are emerging psychosocial predictors of doping.
⇒ There is probably higher susceptibility to doping among subelite or older athletes.
⇒ Protective factors are associated with a lower risk of inadvertent doping; however, the empirical volume on inadvertent doping is limited to draw firm conclusions.

## INTRODUCTION

Doping refers to the use of performance-enhancing drugs (PED) and methods, prohibited by the World Anti-Doping Agency, to improve performance.[1] Although it is difficult to ascertain the prevalence of doping in sport, estimates based on biological parameters and indirect questionnaire techniques indicate potential prevalence rates in elite athlete populations of between 14% and 39%.[2] For recreational athletes and exercisers, estimates are in the region of 18%–24%.[3 4] In order to reduce such incidences and increase the efficacy of doping prevention efforts, it is essential to understand the psychosocial mechanisms that are risk factors for, or protective factors against, doping intentions and use.[5]

The first meta-analytic review published in 2014[6] of psychosocial predictors of doping intentions and use in sport and physical activity settings identified prodoping social norms, positive doping attitudes and use of nutritional supplements as the strongest risk factors for doping intentions and behaviours; morality and self-efficacy to avoid doping were the strongest protective factors. Further reviews have subsequently been published, but they have either been narrative,[7] and/or limited in scope, for instance, focusing exclusively on one type of population group (eg, adolescent athletes,[8] elite athletes[9]) or specific predictors of doping intention/use (eg, attitudes,[10] perfectionism,[11] nutritional supplement use[12]). Narrative reviews cannot provide indices of the magnitude of effects, nor estimates of study quality, publication bias and statistical power. Hence, narrative reviews, in general, are more prone to subjective bias and misinterpretation, compared with meta-analyses.[13]

To address these limitations, we conducted an up-to-date meta-analytical review of diverse psychosocial predictors of antidoping intentions and use across various sport and exercise settings. We aimed to (1) update the empirical evidence by including numerous new studies, particularly interventions completed since 2014[14–16] as well as studies predicting inadvertent doping as an outcome[17] or measuring new psychosocial predictors (eg, anticipated guilt; moral identity; team moral disengagement; sporting moral values[18–21]), (2) improve the methodology used in the 2014 meta-analysis[6] by accounting for dependency of effect sizes within studies and providing better estimates of study quality, risk of bias and homogeneity of effects and (3) offer recommendations for education/practice and future research from a social sciences perspective. Given the prevalence rates of doping in sport and exercise settings, our review may be of practical importance as it can inform the design of psychosocial interventions as well as education programmes offered by antidoping agencies, which are based on updated evidence by identifying the most important targets and practices for such interventions. Our work may also offer guidance regarding methodological quality and rigour of existing studies that can inform the design of future research in the field.

## METHODOLOGY

We prospectively registered our protocol in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P)[22] via the Open Science Framework (OSF; https://bit.ly/doping-meta-registration). This review complies with the[23]PRISMA 2020 guidelines.[23] Our search results, final data file, analyses scripts and online supplemental material are openly available (https://bit.ly/doping-meta-project).

### Eligibility criteria

We considered studies eligible for inclusion if they measured the outcome variables of doping use, risk of inadvertent doping (referred to as inadvertent doping hereafter) and/or doping intention, *and* at least one psychosocial determinant (specified as such by the authors of primary studies based on theory, past research, and/or experimental manipulation) of those three doping-related variables. We included correlational and experimental designs, with participants of any age, gender and nationality, in sport or other (eg, gym-users, students) contexts.

We excluded studies that measured (1) non-PED related behaviour (eg, technological doping); (2) PED use for mental performance outside of sport/exercise (eg, ADHD medication use in education); (3) prohibited substance/s (eg, cannabis, psychedelics) used in non-performance or appearance-enhancing contexts or (4) psychosocial predictors of other doping-related variables (eg, attitudes, pressure to dope), but not doping use, inadvertent doping and/or doping intention, (5) we also excluded studies when they included *only* demographic, supplement use and substance use variables as determinants, but we coded such variables in studies that had also measured psychosocial predictors that met our inclusion criteria; (6) assessed psychosocial predictors of doping among coaches and other athlete support personnel or (7) were written in non-Latin or non-Germanic-based languages, due to poor translations initially obtained via Google Scholar.

### Information sources and search strategy

Full details of our search strategy are provided in the online supplemental material. First, SD conducted an electronic literature search via Scopus, Medline, Embase, PsychINFO, CINAHL Plus and ProQuest Dissertations and Theses from the earliest date available to 31 March 2023. The search string encompassed two blocks with free text (eg, keywords) and subject headings; one block focused on psychosocial variables and the other focused on doping outcomes. Second, SD searched reference lists and forward citations of previous relevant systematic reviews and meta-analyses. Third, SD searched Open Grey for grey literature, which yielded zero eligible studies.

### Selection process

We imported identified records to Endnote and Covidence and deleted duplicates. Abstracts and titles were uploaded on Research Screener, a semiautomated web application that uses machine learning algorithms to optimise the screening process.[24] Initially, Research Screener rank-ordered abstracts according to six seed articles[8 16 18 25–27] were identified by our team as studies, which captured the inclusion criteria, including a systematic review that included many relevant keywords to train the algorithm. The algorithm produced the first block of 50 articles based on these seed articles. Learning from analysts' decisions about what studies are in/eligible, it subsequently identified further articles in blocks of 50.

Consistent with recommendations,[24] SD screened the abstracts of the first 50% of the records identified by Research Screener for eligibility and the titles of the remaining 50%. Of the 7258 records screened, 491 articles were full text screened. SD found 274 records eligible for inclusion. Of these eligible studies, we included 202 records and 211 independent samples in our meta-analytic review. JSH double screened a random sample of 15% of the full-text articles; Cohen's Kappa indicated 'almost perfect'[28] agreement ($k=0.83$) between the raters, and the few conflicts were resolved by discussion.

### Data extraction

In addition to doping use and intention, we also included proxies of intentions, such as susceptibility, willingness, likelihood and 'potential' doping use. We collapsed all these variables under the broad label 'intentions', based on meta-regression findings, which showed that for experimental studies, the type of intention did not moderate the obtained effect size ($F$ (3, 47)=1.28; $p=0.29$. Also, for observational studies, the type of intention was a statistically inconsequential predictor of risk ($F$ (3, 167)=1.02, $p=0.38$) and protective ($F$ (3, 333)=0.18, $p=0.18$) factors. We also measured inadvertent doping, operationalised in primary studies as behaviours or intentions that put oneself at higher (eg, not checking ingredient lists) or lower (eg, adherence to doping prevention behaviours) risk for doping unintentionally. Where applicable, we reverse-coded scores, so that all positive effect sizes indicate higher risk for inadvertent doping. Details about the coding of sport level and participant category (eg, athletes, students) are provided in the online supplemental material.

SD led the data extraction process including effect size coding, which JSH double-checked for accuracy and consistency (97% initial agreement). We calculated Hedges'*g* for experimental and Pearson's r for observational studies via a published excel calculator.[29] Using established formulas,[30] we converted ORs and standardised mean differences into Pearson's r. For any other statistics (eg, $\chi^2$) reported in primary studies, we calculated effect sizes using the Campbell Collaboration effect size calculator.[31] We refer to effect sizes throughout this manuscript for both observational and experimental studies, but we acknowledge that in the case of the former type of studies, effect sizes capture associations and do not imply causality. The variance of the effect sizes was calculated according to recommendations.[30] When the article had insufficient statistical information, we contacted the corresponding author with two reminders (if needed), each one week apart. Most (97.6%) of the extracted effect sizes were

**Table 1** Meta-analytic summary estimates of primary outcomes for experimental and observational studies

| | | | | Main estimate | | | | Variance | | Prediction interval | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Outcome** | **Studies** | **Effects** | **N** | **ES** | **95% CI** | | **p** | **Level 2** | **Level 3** | **95% PI** | |
| Experimental studies | | | | | | | | | | | |
| Doping use | 4 | 6 | 3312 | −0.08 | −0.14 | −0.03 | 0.01 | 0% | 0% | −0.14 | −0.03 |
| Inadvertent doping | 3 | 5 | 1417 | −0.70 | −1.95 | 0.55 | .19 | 0.03% | 99.15% | −3.20 | 1.80 |
| Doping intention | 25 | 51 | 12 673 | −0.21 | −0.31 | −0.12 | <0.001 | 17.17% | 69.87% | −0.65 | 0.22 |
| Observational studies | | | | | | | | | | | |
| Doping use | | | | | | | | | | | |
| Risk factors | 118 | 550 | 261 133 | 0.17 | 0.15 | 0.19 | <0.001 | 0.00% | 13.11% | 0.04 | 0.31 |
| Protective factors | 44 | 108 | 79 434 | −0.09 | −0.13 | −0.05 | <0.001 | 0.00% | 4.07% | −0.18 | 0.00 |
| Inadvertent doping | | | | | | | | | | | |
| Risk factors | 5 | 33 | 1859 | 0.08 | −0.06 | 0.22 | .24 | 0.00% | 13.58% | −0.16 | 0.32 |
| Protective factors | 3 | 13 | 1511 | −0.19 | −0.32 | −0.06 | .01 | 0.00% | 0.00% | −0.32 | −0.06 |
| Doping intention | | | | | | | | | | | |
| Risk factors | 78 | 337 | 36 079 | 0.29 | 0.26 | 0.32 | <0.001 | 0.00% | 12.39% | 0.12 | 0.46 |
| Protective factors | 60 | 171 | 27 905 | −0.28 | −0.31 | −0.24 | <0.001 | 15.15% | 0.00% | −0.47 | −0.08 |

The experimental studies test the effects of different forms of intervention on inadvertent doping, intention to dope and doping use. The observational studies test the associations between risk and protective factors (see online supplemental table S1) with doping use, inadvertent doping and intentions. The compatibility and prediction intervals are roughly equivalent for meta-analytic estimates where there is an absence of heterogeneity among studies within tested models.
CI, compatibility interval; ES, effect size (Hedges'g for experiments, correlation for observational data); PI, prediction interval.

unadjusted. For observational data, we applied Fisher's r-to-z transformation for all correlation coefficients and their variances to normalise their distribution properties and generate less biased estimates.[32] To interpret our findings, we use benchmarks for effect sizes based on empirically derived conclusions from the psychological literature.[33 34] Namely, $r$=0.05, 0.10, 0.20 and 0.30 are interpreted as very small, small, medium and large effect sizes, respectively. Effect sizes $g$ are approximately double the size of correlations and we interpret them accordingly (eg, we consider $g$=0.40 as medium effect size). We also follow recent recommendations[35] and use the expression 'high compatibility' instead of 'statistically significant'.

SD coded and extracted information on moderators; JSH independently double coded a random sample of 60% of studies to check for accuracy and consistency. Discrepancies were resolved via discussion. For observational studies, there were well over 100 psychosocial determinants of doping intention, doping use and inadvertent doping. Accordingly, NN and SD grouped the determinants into specific and general factors. As in a previous meta-analysis,[6] general factors were further grouped into a third level as either protective or risk factor (see online supplemental table 1. eg), the general factor of prodoping attitudes was further classified as a risk factor. IDB and VB reviewed the classification scheme, with discrepancies resolved via discussion with DFG. The grouping was undertaken to maximise the number of independent samples used in the calculation of effect sizes.

## Statistical analyses

Our analytical approach followed guidelines[29] for conducting meta-analyses when effect sizes are non-independent (eg, multiple effects from a single study). We synthesised experimental (tables 1 and 2) and observational data (tables 1 and 3) separately using a three-level, random effects model with restricted maximum likelihood estimation via the *metafor* package.[36] For the observational data, we categorised outcomes as intention (including intention, willingness, susceptibility and likelihood), inadvertent doping or doping use. Regarding sensitivity analyses, we examined the influence of outliers and influence cases on the overall pooled effect.[37] As a complement to these traditional sensitivity tests, we used correlated and hierarchical effect models via robust variance estimation[38] to examine variations in the overall pooled effect with varying constant correlations (ρ=0.20, 0.40, 0.60, 0.80) among effects within studies using the *clubSandwich* package.[39] Regarding heterogeneity, we calculated $I^2$ and the variance distribution across each level with the mlm.variance.distribution function of the *dmetar* package[40] and 95% prediction intervals.[41] Finally, we examined different forms of bias, for instance, publication bias via the multilevel extension of Egger's test,[42] bias as a function of publication type (published vs unpublished), study rating in terms of risk of bias assessment, study sample size and power of included studies to detect varying effect sizes of interest (d=0.10–0.40[43];) via the *metaviz* package[44] as well as moderator effects (eg, characteristics of participants and study design) within a meta-regression framework in which the overall pooled effect was regressed on predictor variables. Regarding our primary outcomes, we examined moderators of doping intentions only for experimental data, and for doping use and doping intentions where there were at least 2 (table 3) or 20 effects (online supplemental table S6) for observational data. All meta-regression models included an outcome variable that consisted of effect sizes calculated for each study; normally distributed random effects nested to study (level 2) and individual effects within each study (level 1); error distribution across both levels; p values computed based on a t/F distribution; and identity link function, where the expected value of the outcome variable was modelled as a linear combination of predictors. Our moderator analyses are exploratory rather than confirmatory, as we excluded a priori predictions in our preregistered protocol. We performed meta-regression assumption checks for doping intentions with experimental data, and doping use and doping intentions for observational data at the highest levels reported in table 1. These tests included normality of residuals (QQ plots), model comparisons to test homoscedasticity of residual variances for categorical moderators and linearity for continuous moderators (age only). Given the exploratory nature of our meta-regressions, we provide full results of these analyses on our OSF project page. Briefly, the findings suggest these regression assumptions held, except for

**Table 2** Meta-regression estimates for experiments

| | Significance test | | | Main estimates | | | |
|---|---|---|---|---|---|---|---|
| **Moderator** | **F** | **df** | ***p*** | **k** | **ES** | **95% CI** | |
| Experiment type | 6.00 | 1,49 | 0.02 | | | | |
| Field intervention | | | | 37 | −0.16 | −0.26 | −0.08 |
| Experimental manipulation | | | | 14 | −0.41 | −0.58 | −0.23 |
| Pre–post follow-up | 0.74 | 1,49 | 0.39 | | | | |
| From pre to follow-up | | | | 13 | −0.18 | −0.30 | −0.05 |
| From pre to post | | | | 38 | −0.23 | −0.32 | −0.13 |
| Study design | 2.27 | 2,48 | 0.11 | | | | |
| Between group (post only) | | | | 5 | −0.17 | −0.47 | 0.13 |
| Between group (pre–post) | | | | 34 | −0.16 | −0.27 | −0.05 |
| Within group | | | | 12 | −0.37 | −0.54 | −0.20 |
| Participant category | 0.54 | 2,48 | 0.59 | | | | |
| Athletes | | | | 41 | −0.24 | −0.35 | −0.13 |
| Mixed | | | | – | – | – | – |
| Non-athletes | | | | 4 | −0.17 | −0.47 | 0.13 |
| Students | | | | 6 | −0.10 | −0.36 | 0.17 |
| Sport type | 0.25 | 2,38 | 0.78 | | | | |
| Individual | | | | 3 | −0.30 | −0.61 | 0.01 |
| Mixed | | | | 22 | −0.30 | −0.48 | −0.12 |
| Team | | | | 16 | −0.22 | −0.40 | −0.04 |
| Sport level | 3.48 | 3,35 | 0.03 | | | | |
| Elite | | | | 6 | −0.32 | −0.56 | −0.08 |
| Mixed | | | | 5 | −0.28 | −0.51 | −0.04 |
| Non-elite | | | | 16 | −0.12 | −0.26 | 0.02 |
| Sub-elite | | | | 12 | −0.54 | −0.77 | −0.31 |
| Gender | 0.62 | 2,48 | 0.54 | | | | |
| Females | | | | 1 | −0.15 | −0.59 | 0.29 |
| Male | | | | 12 | −0.14 | −0.31 | 0.03 |
| Mixed | | | | 38 | −0.25 | −0.37 | −0.14 |
| Mean/median age (years) | 1.06 | 1,39 | 0.31 | | | | |
| Intercept | | | | – | −0.19 | −0.28 | −0.11 |
| Moderator | | | | – | −0.01 | −0.03 | 0.01 |
| Substance type | 1.16 | 1,49 | 0.29 | | | | |
| Illegal | | | | 47 | −0.23 | −0.33 | −0.13 |
| Mixed | | | | 4 | −0.08 | −0.35 | 0.20 |

The statistics under significance test provide an omnibus test of the significance of each moderator, which indicates if the moderator has significantly differently effects at each level. In contrast, the information reported in the Main Estimates section provides values for each level of the moderator in terms of the direction, magnitude, and precision of those estimates.
CI, compatibility interval; ES, effect size (Hedges' g).

minor deviations in some cases (primarily where there are few effects available).

## Risk of bias assessment

SD and JSH assessed the quality of all studies independently. For randomised experiments, we used Cochrane's risk of bias tool for randomised trials (RoB-2[45]) to examine the randomisation process, deviations from intended interventions, missing outcome data, measurement of the outcomes and selection of the reported outcomes. The overall assessment of each study is determined by an algorithm in RoB-2. For non-randomised experiments, we used the Joanna Briggs Institute (JBI) assessment tool[46] for quasi-experimental studies. We opted for the AXIS tool[47] to assess observational studies, which includes 20 questions covering reporting quality, study design quality and various sources of bias in the study. The AXIS tool lacks questions for dealing with missing follow-up data, hence we added two questions adopted from,[6] when coding longitudinal studies. Cohen's Kappa indicated moderate and substantial agreement between the two assessors for experimental and observational studies for their overall quality (k=0.58; k=0.74, respectively). SD and JSH resolved all conflicts without the need for a third assessor.

## Certainty of evidence

We assessed the overall quality of evidence using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[48] This involves examining the methodological flaws of the studies (ie, risk of bias), the heterogeneity of results across studies (ie, inconsistency), the generalisability of the findings to the target population (ie, indirectness), imprecision of estimates and the risk of publication bias.

## Deviations from registered protocol

First, due to numerous studies and limited resources, we decided to exclude studies that only reported demographic variables, supplement use and substance use as predictors (ie, reported no psychosocial predictors). Second, we added the JBI assessment tool for quasi-experimental studies to assess the risk of bias for non-randomised studies, as we did not anticipate such studies originally. Third, we expanded our sensitivity analyses by using correlated and hierarchical effects models via robust variance estimation.

## Equity, diversity and inclusion

Gender, race, sexual orientation, socioeconomic level or other demographics that describe marginalised groups were not criteria for study eligibility. Where information was available, these variables were tested as moderators or antecedents (eg, internalised heterosexualism). The author team included researchers from various career stages and countries, but, unintentionally, was male dominated.

# RESULTS

## Study selection

Of the 7258 records screened, we retained 491 for full-text screening, of which we eventually used 202 (211 independent samples) for analysis (figure 1; see also online supplemental materials for a description of each study).

## Study characteristics

An overview of key study characteristics of the analysed studies is in online supplemental table S2. We included studies from 25 experiments (57 effects N=13 586; $M_{age}$=18.37) and 186 observational samples (1239 effects; N=3 09 130; $M_{age}$=22.18) for statistical synthesis. Experimental studies (including both cross-sectional experiments as well as longitudinal educational programmes) were primarily published (96%), reported pre–post between-subjects designs (60%), included athletes (72%), mix of individual and team sports (44%), non-elite level (50%) and mixed gender (68%). Observational studies were primarily published (92.5%), reported cross-sectional designs (95.7%), included athletes (50%), mix of individual and team sports (52%), elite level (39%) and both genders (66.5%).

## Risk of bias

We used the *robvis*R package[49] to summarise our risk of bias assessments. Online supplemental figure S1–S6 present for each design (experimental, quasi-experimental,

**Table 3** Meta-analytic summary estimates of predictors of doping use and doping intentions from the observational data

| | | | | Main estimates | | | Variance | | Prediction interval | |
|---|---|---|---|---|---|---|---|---|---|---|
| Outcome | Studies | Effects | N | ES | 95% CI | | Level 2 | Level 3 | 95% PI | |
| Adaptive motivation→Doping Use | 7 | 15 | 3643 | −0.06 | −0.19 | 0.07 | 0.00 | 0.00 | −0.19 | 0.07 |
| Antisocial behaviour→Doping Use | 9 | 19 | 81 789 | 0.17 | 0.11 | 0.23 | 0.00 | 0.00 | 0.11 | 0.23 |
| Attitudes→Doping Use | 52 | 95 | 33 710 | 0.21 | 0.16 | 0.26 | 0.00 | 8.52 | 0.16 | 0.26 |
| Availability→Doping Use | 3 | 4 | 2370 | 0.06 | −0.24 | 0.35 | 0.00 | 0.00 | −0.24 | 0.35 |
| BMI→Doping Use | 8 | 9 | 21 018 | 0.05 | −0.08 | 0.18 | 0.00 | 0.00 | −0.08 | 0.18 |
| Body dissatisfaction→Doping Use | 40 | 104 | 90 203 | 0.10 | 0.06 | 0.13 | 0.00 | 0.00 | 0.06 | 0.13 |
| Bullied or abused→Doping Use | 5 | 7 | 43 888 | 0.11 | −0.02 | 0.23 | 0.00 | 0.00 | −0.02 | 0.23 |
| Competitive level→Doping Use | 5 | 5 | 6205 | 0.07 | −0.14 | 0.29 | 0.00 | 0.00 | −0.14 | 0.29 |
| Education level→Doping Use | 2 | 2 | 1169 | −0.12 | −2.16 | 1.93 | 0.00 | 0.00 | −2.16 | 1.93 |
| Exposure to fitness appearance media→Doping Use | 4 | 13 | 1643 | 0.17 | 0.04 | 0.30 | 0.00 | 0.00 | 0.04 | 0.30 |
| Extraversion→Doping Use | 2 | 2 | 475 | −0.02 | −2.40 | 2.36 | 3.42 | 3.42 | −2.40 | 2.36 |
| Gender (male)→Doping Use | 8 | 8 | 25 192 | 0.09 | −0.03 | 0.21 | 0.00 | 0.00 | −0.03 | 0.21 |
| Ill being→Doping Use | 19 | 38 | 110 301 | 0.11 | 0.06 | 0.16 | 0.00 | 0.00 | 0.06 | 0.16 |
| Intention→Doping Use | 17 | 22 | 14 068 | 0.37 | 0.25 | 0.48 | 0.00 | 29.50 | 0.25 | 0.48 |
| Internalised heterosexism→Doping Use | 1 | 3 | 962 | 0.41 | −0.03 | 0.86 | 0.00 | 0.00 | −0.03 | 0.86 |
| Knowledge→Doping Use | 7 | 11 | 4033 | 0.05 | −0.12 | 0.22 | 0.00 | 9.71 | −0.12 | 0.22 |
| Maladaptive motivation→Doping Use | 7 | 20 | 3557 | 0.07 | −0.04 | 0.17 | 0.00 | 0.00 | −0.04 | 0.17 |
| Masculinity→Doping Use | 8 | 9 | 8413 | 0.11 | −0.03 | 0.26 | 0.00 | 0.00 | −0.03 | 0.26 |
| Negative morality→Doping Use | 6 | 11 | 4014 | 0.11 | −0.02 | 0.25 | 0.00 | 0.00 | −0.02 | 0.25 |
| Negative personality→Doping Use | 6 | 8 | 2410 | 0.17 | −0.05 | 0.39 | 0.00 | 12.83 | −0.05 | 0.39 |
| Norms→Doping Use | 29 | 58 | 20 729 | 0.28 | 0.22 | 0.35 | 0.00 | 12.82 | 0.22 | 0.35 |
| Perceived health→Doping Use | 2 | 3 | 32 681 | 0.00 | −0.21 | 0.22 | 0.00 | 0.00 | −0.21 | 0.22 |
| Positive morality→Doping Use | 13 | 30 | 6483 | −0.16 | −0.24 | −0.07 | 0.00 | 0.00 | −0.24 | −0.07 |
| Positive personality→Doping Use | 3 | 5 | 3016 | −0.17 | −0.48 | 0.13 | 11.83 | 0.00 | −0.48 | 0.13 |
| Prescription drugs→Doping Use | 2 | 2 | 1533 | 0.17 | −1.62 | 1.97 | 0.00 | 0.00 | −1.62 | 1.97 |
| Religiousness→Doping Use | 2 | 2 | 2548 | −0.20 | −3.85 | 3.45 | 22.86 | 22.86 | −3.85 | 3.45 |
| Romantic appeal→Doping Use | 2 | 2 | 8237 | 0.03 | −1.24 | 1.30 | 0.00 | 0.00 | −1.24 | 1.30 |
| Self-efficacy to avoid doping→Doping Use | 10 | 19 | 10 529 | −0.16 | −0.26 | −0.05 | 0.00 | 12.25 | −0.26 | −0.05 |
| Sexual activity→Doping Use | 3 | 3 | 25 109 | 0.11 | −0.21 | 0.42 | 12.66 | 12.66 | −0.21 | 0.42 |
| Social desirability→Doping Use | 3 | 3 | 1968 | −0.09 | −0.60 | 0.41 | 0.00 | 0.00 | −0.60 | 0.41 |
| Sport confidence→Doping Use | 3 | 3 | 9299 | −0.06 | −0.43 | 0.31 | 0.00 | 0.00 | −0.43 | 0.31 |
| Sport involvement→Doping Use | 5 | 5 | 17 237 | 0.06 | −0.13 | 0.25 | 0.00 | 0.00 | −0.13 | 0.25 |
| Sport supplement beliefs→Doping Use | 3 | 3 | 977 | 0.26 | −0.41 | 0.93 | 11.30 | 11.30 | −0.41 | 0.93 |
| Strong family values→Doping Use | 2 | 2 | 261 | −0.28 | −2.96 | 2.39 | 0.00 | 0.00 | −2.96 | 2.39 |
| Substance use→Doping Use | 20 | 47 | 64 045 | 0.19 | 0.13 | 0.26 | 0.00 | 26.87 | 0.13 | 0.26 |
| Supplement use→Doping Use | 21 | 27 | 25 755 | 0.22 | 0.13 | 0.32 | 0.00 | 13.92 | 0.13 | 0.32 |
| Training volume→Doping Use | 10 | 14 | 25 332 | 0.09 | 0.00 | 0.18 | 0.00 | 0.00 | 0.00 | 0.18 |
| Well-being→Doping Use | 10 | 11 | 18 904 | −0.04 | −0.16 | 0.07 | 0.00 | 0.00 | −0.16 | 0.07 |
| Adaptive motivation →Inadvertent doping | 2 | 5 | 732 | −0.13 | −0.41 | 0.15 | 0.00 | 0.00 | −0.41 | 0.15 |
| Attitudes→Inadvertent doping | 3 | 14 | 758 | 0.04 | −0.11 | 0.20 | 0.00 | 0.00 | −0.11 | 0.20 |
| Coach doping confrontation efficacy→Inadvertent doping | 1 | 2 | 779 | −0.16 | −1.86 | 1.55 | 0.00 | 0.00 | −1.86 | 1.55 |

Continued

**Table 3** Continued

| | | | | Main estimates | | | | Variance | Prediction interval | |
|---|---|---|---|---|---|---|---|---|---|---|
| Inadvertent doping→Inadvertent doping * | 1 | 2 | 410 | −0.08 | −2.08 | 1.92 | 0.00 | 0.00 | −2.08 | 1.92 |
| Intention→Inadvertent doping | 2 | 8 | 1189 | 0.18 | −0.11 | 0.47 | 0.00 | 27.20 | −0.11 | 0.47 |
| Maladaptive motivation→Inadvertent doping | 1 | 8 | 410 | −0.07 | −0.26 | 0.11 | 0.00 | 0.00 | −0.26 | 0.11 |
| Positive morality→Inadvertent doping | 1 | 2 | 322 | −0.23 | −2.35 | 1.90 | 0.00 | 0.00 | −2.35 | 1.90 |
| Self-efficacy to avoid doping→Inadvertent doping | 3 | 4 | 1511 | −0.27 | −0.61 | 0.08 | 0.00 | 0.00 | −0.61 | 0.08 |
| Adaptive motivation→Intentions | 14 | 23 | 6658 | −0.16 | −0.25 | −0.06 | 0.00 | 0.00 | −0.25 | −0.06 |
| Antisocial behaviour→Intentions | 3 | 7 | 1466 | 0.21 | −0.02 | 0.43 | 0.00 | 0.00 | −0.02 | 0.43 |
| Attitudes→Intentions | 40 | 84 | 16 081 | 0.39 | 0.34 | 0.44 | 0.00 | 2.89 | 0.34 | 0.44 |
| Availability→Intentions | 2 | 2 | 478 | 0.28 | −2.01 | 2.58 | 0.00 | 0.00 | −2.01 | 2.58 |
| Body dissatisfaction→Intentions | 8 | 20 | 2481 | 0.26 | 0.14 | 0.37 | 0.00 | 0.00 | 0.14 | 0.37 |
| Coach doping confrontation efficacy→Intentions | 1 | 2 | 779 | −0.13 | −1.83 | 1.57 | 0.00 | 0.00 | −1.83 | 1.57 |
| Competitive level→Intentions | 6 | 8 | 1584 | −0.06 | −0.30 | 0.18 | 0.00 | 0.00 | −0.30 | 0.18 |
| Conservation→Intentions | 2 | 2 | 423 | −0.22 | −2.58 | 2.15 | 0.00 | 0.00 | −2.58 | 2.15 |
| Education level→Intentions | 4 | 4 | 282 | 0.02 | −0.55 | 0.58 | 0.00 | 0.00 | −0.55 | 0.58 |
| Gender (male)→Intentions | 8 | 9 | 3226 | 0.10 | −0.08 | 0.28 | 0.00 | 0.00 | −0.08 | 0.28 |
| Ill being→Intentions | 6 | 8 | 6371 | 0.18 | 0.02 | 0.33 | 0.00 | 0.00 | 0.02 | 0.33 |
| Inadvertent doping→Intentions | 2 | 5 | 732 | 0.00 | −0.28 | 0.28 | 0.00 | 0.00 | −0.28 | 0.28 |
| Intention→Intentions | 4 | 4 | 848 | 0.43 | 0.01 | 0.85 | 0.00 | 0.00 | 0.01 | 0.85 |
| Knowledge→Intentions | 6 | 7 | 848 | 0.00 | −0.28 | 0.29 | 0.00 | 0.00 | −0.28 | 0.29 |
| Legitimacy→Intentions | 4 | 4 | 3064 | −0.18 | −0.51 | 0.15 | 0.00 | 0.00 | −0.51 | 0.15 |
| Maladaptive motivation→Intentions | 15 | 39 | 8865 | 0.13 | 0.07 | 0.20 | 0.00 | 0.00 | 0.07 | 0.20 |
| Negative morality→Intentions | 29 | 39 | 11 649 | 0.45 | 0.37 | 0.52 | 0.00 | 0.00 | 0.37 | 0.52 |
| Negative personality→Intentions | 2 | 3 | 462 | 0.22 | −0.44 | 0.87 | 0.00 | 0.00 | −0.44 | 0.87 |
| Norms→Intentions | 34 | 66 | 13 528 | 0.34 | 0.28 | 0.41 | 0.00 | 7.44 | 0.28 | 0.41 |
| Openness to change→Intentions | 2 | 2 | 423 | 0.03 | −2.34 | 2.39 | 0.00 | 0.00 | −2.34 | 2.39 |
| Positive morality→Intentions | 30 | 65 | 13 940 | −0.35 | −0.42 | −0.28 | 2.43 | 13.21 | −0.42 | −0.28 |
| Positive personality→Intentions | 1 | 3 | 178 | −0.26 | −0.94 | 0.43 | 0.00 | 0.00 | −0.94 | 0.43 |
| Prosocial behaviour→Intentions | 2 | 6 | 468 | 0.02 | −0.25 | 0.29 | 0.00 | 0.00 | −0.25 | 0.29 |
| Religiousness→Intentions | 4 | 5 | 222 | −0.14 | −0.64 | 0.37 | 0.00 | 0.00 | −0.64 | 0.37 |
| Self-efficacy to avoid doping→Intentions | 25 | 44 | 12 034 | −0.39 | −0.47 | −0.31 | 16.25 | 7.28 | −0.47 | −0.31 |
| Self enhancement→Intentions | 2 | 2 | 423 | 0.33 | −2.04 | 2.69 | 0.00 | 0.00 | −2.04 | 2.69 |
| Self-transcendence→Intentions | 2 | 2 | 423 | −0.20 | −2.56 | 2.17 | 0.00 | 0.00 | −2.56 | 2.17 |
| Social desirability→Intentions | 5 | 5 | 2411 | −0.15 | −0.42 | 0.13 | 0.00 | 0.00 | −0.42 | 0.13 |
| Sport supplement beliefs→Intentions | 2 | 2 | 837 | 0.26 | −1.73 | 2.25 | 0.00 | 0.00 | −1.73 | 2.25 |
| Substance use→Intentions | 5 | 8 | 1490 | 0.11 | −0.12 | 0.33 | 0.00 | 0.00 | −0.12 | 0.33 |
| Supplement use→Intentions | 13 | 15 | 5228 | 0.23 | 0.11 | 0.35 | 0.00 | 0.00 | 0.11 | 0.35 |
| Training volume→Intentions | 4 | 5 | 581 | 0.14 | −0.23 | 0.51 | 0.00 | 0.00 | −0.23 | 0.51 |
| Well-being→Intentions | 5 | 6 | 4620 | −0.13 | −0.33 | 0.06 | 0.00 | 0.00 | −0.33 | 0.06 |

Based on the Cochrane Consumers and Communication Group[61] recommendations, we report the results for overall effect sizes that contained information from at least two unique studies that were combined when they were 'sufficiently similar'. The information reported in the Main estimates section provides values for each level of the moderator in terms of the direction, magnitude and precision of those estimates.
*This effect size refers to one inadvertent doping behaviour (eg, eating a foreign substance) predicting another inadvertent doping behaviour (eg, not using batch-tested supplements).
BMI, body mass index; ES, effect size (correlation for observational data); PI, prediction interval.

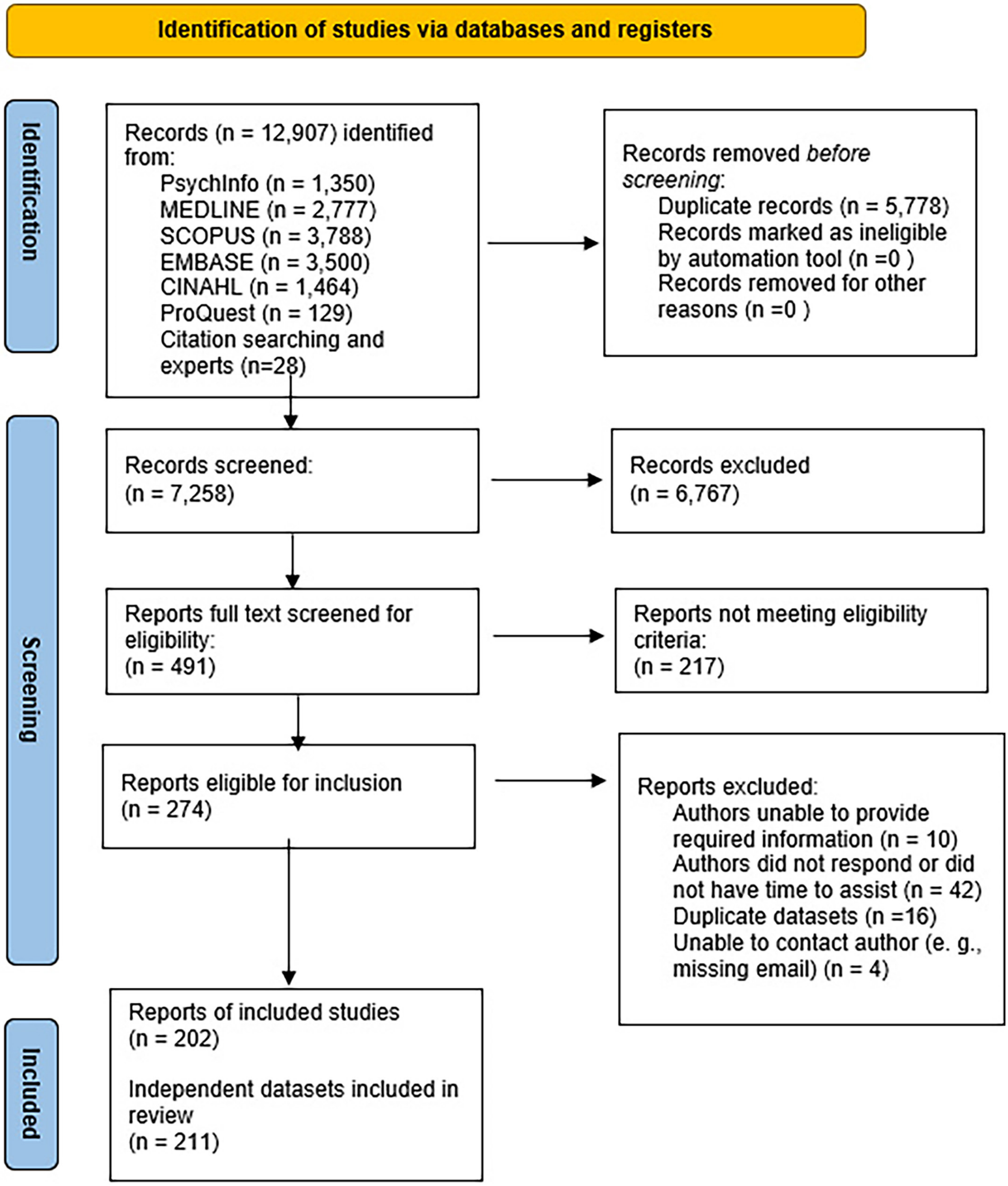


**Figure 1** PRISMA flowchart. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analysis.

observational) summaries across all studies as well as ratings of individual studies. For the experimental studies, there were some concerns regarding randomisation and reporting of results, particularly lack of reporting of study protocol. We rated several experimental studies of high quality as having some concerns, because the algorithm of RoB-2 assigns this label even if even only one of the domains in the study are rated as 'some concerns'. For the quasi-experimental studies, more than half lacked a control group. For the observational studies, there were some concerns in two domains related to the reporting and handling of non-responders and missing values.

## Meta-analysis

### Experimental data

An overview of the pooled effects is provided in table 1 and figure 2. Relative to comparators, experimental groups reported lower doping intentions ($g=-0.21$, 95% CI (−0.31 to –0.12) and doping use ($g=-0.08$, 95% compatibility interval (CI) (−0.14 to –0.03)), whereas less compatibility was shown for inadvertent doping ($g=-0.70$, 95% CI (−1.95 to 0.55)). Given the low number of studies and effects for doping use and inadvertent doping, we considered the evidential base insufficient and, therefore, exclude both outcomes from further interrogation. Outliers (none), influential cases (four effects) and variations in

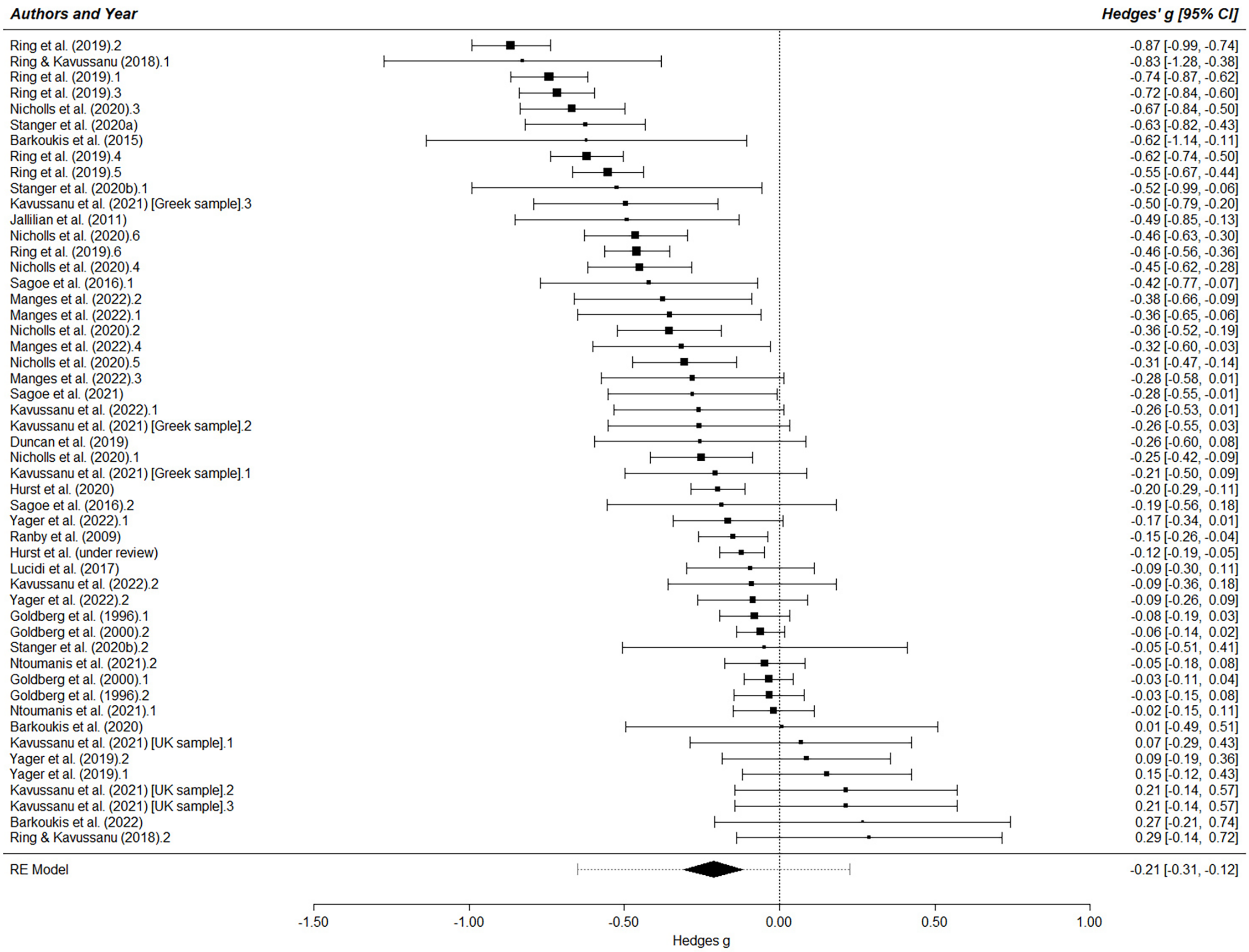

**Figure 2** Forest plot with experimental data for doping intentions, including overall effect, CI (black diamond) and prediction interval (dotted line).

common correlation among effects sizes within studies (see the Methodology section) indicated little sensitivity in the overall pooled effect for intention (see OSF page).

For doping intentions, the multilevel extension of Egger's test and visual inspection of the funnel plot (see online supplemental figure S7) supported an interpretation of symmetry. Meta-bias analyses indicated that publication status, risk of bias for randomised and non-randomised experiments and sample size were inconsequential predictors of the overall pooled effect for intentions. Results of the moderation tests are provided in table 2. Only experiment type and sport level were meaningful moderators of the overall pooled effect for intentions. Namely, experimental manipulations reported stronger effects ($g=-0.41$, 95% CI (−0.58 to –0.23)) than field-based interventions ($g=-0.16$, 95% CI (−0.26 to –0.08)]). Regarding sport level, the strongest effects were observed with subelite athletes ($g=-0.54$, 95% CI (−0.77 to –0.31)), followed by elite athletes ($g=-0.32$, 95% CI (−0.56 to –0.08)) and mixed samples ($g=-0.28$, 95% CI (−0.51 to –0.04)); the effect for non-elite athletes was inconsequential ($g=-0.12$, 95% CI (−0.26 to 0.02)). Finally, power-enhanced plots (see online supplemental figure S8–S9) indicated most experimental studies included in the meta-analysis were sufficiently powered to detect moderate effects for intention ($d=0.40$, median power=82.3%) and small effects for inadvertent doping ($d=0.20$, median power=85.4%).

## Observational data

An overview of the overall pooled effects is provided in table 1. An overall composite representing protective factors was inversely associated with doping intentions ($z=-0.28$, 95% CI −0.31 to–0.24), doping use ($z=-0.09$, 95% CI −0.13 to –0.05) and inadvertent doping ($z=-0.19$, 95% CI−0.32 to –0.06). Similarly, an overall composite representing risk factors was positively associated with doping intentions ($z=0.29$, 95% CI 0.26 to 0.32) and doping use ($z=0.17$, 95% CI 0.15 to 0.19), but not inadvertent doping ($z=0.08$, 95% CI−0.06 to 0.22). Outliers (none), influential cases and variations in common correlation among effect sizes within studies indicated little sensitivity in the overall pooled effect for all six predictor-outcome combinations (risk and protective factors with doping use, inadvertent doping, doping intentions) (see OSF page). Meta-bias tests of these six combinations are provided in online supplemental table S4. These findings suggest that bias is minimal.

Meta-analytic estimates of general factors (see online supplemental table S1) are presented in table 3. In total, 23 of 79 effect sizes showed high compatibility, 11 predicting intentions and 12 doping use, all of which were small-to-large in magnitude ($z=0.09$ to 0.45).[34] Prodoping attitudes and norms, antisocial behaviour, body dissatisfaction, ill-being, intentions, maladaptive motivation, negative morality, exposure to fitness appearance media posts, training volume and substance and supplement use were meaningful positive correlates for doping use and/or intentions. In contrast, self-efficacy to avoid doping, positive morality and adaptive motivational factors were negative correlates. Meta-bias tests of these correlation pairs indicated minimal bias (online supplemental table S5).

Moderation analyses of individual predictor-outcome combinations are presented in online supplemental table S6). Only 9 of these tests showed high compatibility. The negative associations between self-efficacy and intentions to avoid doping decreased with age (B=−0.16); the negative association between positive morality and intentions (B=−0.07) and the positive association between norms and doping use (B=0.13) increased with age. Regarding the positive association between norms and doping use, the association was strongest for non-athletes (z=0.43) relative to athletes (z=0.28) and students (z=0.15). Regarding the positive association between substance use and doping use, the association was strongest when assessed as continuous (z=0.35) versus dichotomous ($z$=0.14) data type; among athletes (z=0.76) relative to students (z=0.17) and non-athletes (z=0.16); among participants sampled as mixed (z=0.91) relative to individual (z=0.20) sports; and when the substance type is mixed (z=0.39) relative to illegal (z=0.16). Finally, the positive association between supplement use and doping use was strongest when data are cross-sectional (z=0.28) relative to longitudinal (z=0.02).

## Certainty of evidence

We assessed the certainty of evidence separately for experimental and observational studies, in terms of predicting doping use, intentions and inadvertent doping (see online supplemental table S7). For experimental studies, the certainty of evidence was graded as moderate for doping use, low for doping intention and very low only for inadvertent doping. The evidence for intentions was downgraded due to high risk of bias, as most studies had insufficient reporting on the randomisation procedures and for only 2 of 25 studies a protocol was available. Furthermore, there was substantial heterogeneity between study results, except for predicting doping use, for which heterogeneity is likely uninformative because we located four studies only. For the observational studies, the risk of bias was judged as non-serious, nevertheless, there was a lack of assessment of non-responders. The certainty of evidence was downgraded due to large heterogeneity between study results. For doping use and doping intentions, there was a small study bias, as the visual inspection of the funnel plots showed clear asymmetry.

## DISCUSSION

This meta-analysis provides an updated synthesis of empirical evidence on the fast-growing body of research examining psychosocial predictors of doping intention, use and inadvertent doping in sport and exercise settings. In comparison to a comprehensive meta-analysis[6] in this field about a decade ago, our work includes a substantially larger number of independent data sets (211 vs 63), more experimental studies (25 vs 4) and a new outcome variable, inadvertent doping (9 vs 0).

Regarding experimental studies, we found that they have a compatible, but small ($g$=0.21) effect in reducing doping intentions. The effect was somewhat larger than that reported in the previous meta-analysis[6] (d=−0.12), but power-enhanced plots indicated that most studies were underpowered to detect it. In some studies, the comparison was in favour of the control group, hence the negative effect sizes. Moderation tests showed that the overall effect was stronger in subelite athletes (vs elite or non-elite). It is possible some subelite athletes consider the perceived benefits as high (ie, progression to elite level) and the perceived costs as low (ie, little risk of being caught).[50] Moderation analyses also showed that studies using one-off experimental manipulations (eg, self-affirmation instructions[14]) reported stronger effects than interventions delivered via longitudinal educational programmes. It is plausible that the effects of experimental manipulations are transient, and hence, emphasis should be given to developing stronger field-based-antidoping programmes. Such programmes should be cocreated with athletes and athlete support personnel and employ digital solutions to maximise acceptability and longevity. The effect of experimental studies on doping use was compatible but very small ($g$=−0.08). Overall, there is a dearth of experimental studies assessing doping use, possibly due to demand characteristics in experimental behavioural research[51] and the apparent obstacles in attempting to obtain objective assessments. Considering the high number of positive antidoping tests claimed to be due to careless nutritional supplement and medication use,[52] we analysed the effects of antidoping interventions in reducing the risk of inadvertent doping. We included three studies with an overall large effect ($g$=−0.70), however, the CI was too wide to draw any conclusions. This is a clear gap in the psychosocial literature on doping and more experimental programmes, in particular field-interventions, should consider inadvertent doping as a primary or a coprimary outcome (eg, alongside intentional doping use).

Most included samples in our review were from observational studies (k=186). These studies measured a wide array of psychosocial predictors (theory assumed as opposed to experimentally manipulated), stemming from different theoretical frameworks. To summarise the literature in a meaningful way, we categorised these predictors as protective and risk factors, an approach also taken in the 2014 meta-analysis.[6] Overall, we found protective factors had large, medium and small associations when predicting doping intentions, inadvertent doping and doping use, respectively. In terms of risk factors, the association with doping use was small to medium, whereas the association with intentions was large; the effect size for inadvertent doping was small and its CI indicated lack of compatibility. The results of follow-up analyses are summarised in figure 3. Overall, risk factors were far more researched than protective factors, particularly for doping use. Clearly, more research is needed to better understand the role of protective factors in the doping decision-making process. Also, similar to experimental studies, there were only a handful of observational studies assessing the risk of inadvertent doping. Our findings provide similar conclusions to those of the 2014 meta-analysis, although the effect sizes are not strictly comparable due to the differences in the analytic strategies between the two reviews. One noteworthy discrepancy between the two meta-analyses is the increasing empirical emphasis on non-performance factors, evidenced by the substantially larger number of body image-related variables in the current one, and the lack of ill-being and well-being factors in the previous meta-analysis. The increased emphasis on non-performance factors also reflects the recruitment of more diverse samples in the extant literature.

A few more findings from the observational studies are noteworthy. First, the effect size of intention on doping use was z=0.37. Although considered large for psychological research,[33] and hence intentions should be targeted by antidoping programmes, its absolute value signifies a gap between intention and the manifestation of behaviour, perhaps due to substance availability,[53] fear of consequences[54] or consideration of the health hazards of doping.[55] This finding highlights the importance of researchers measuring doping use alongside intentions.

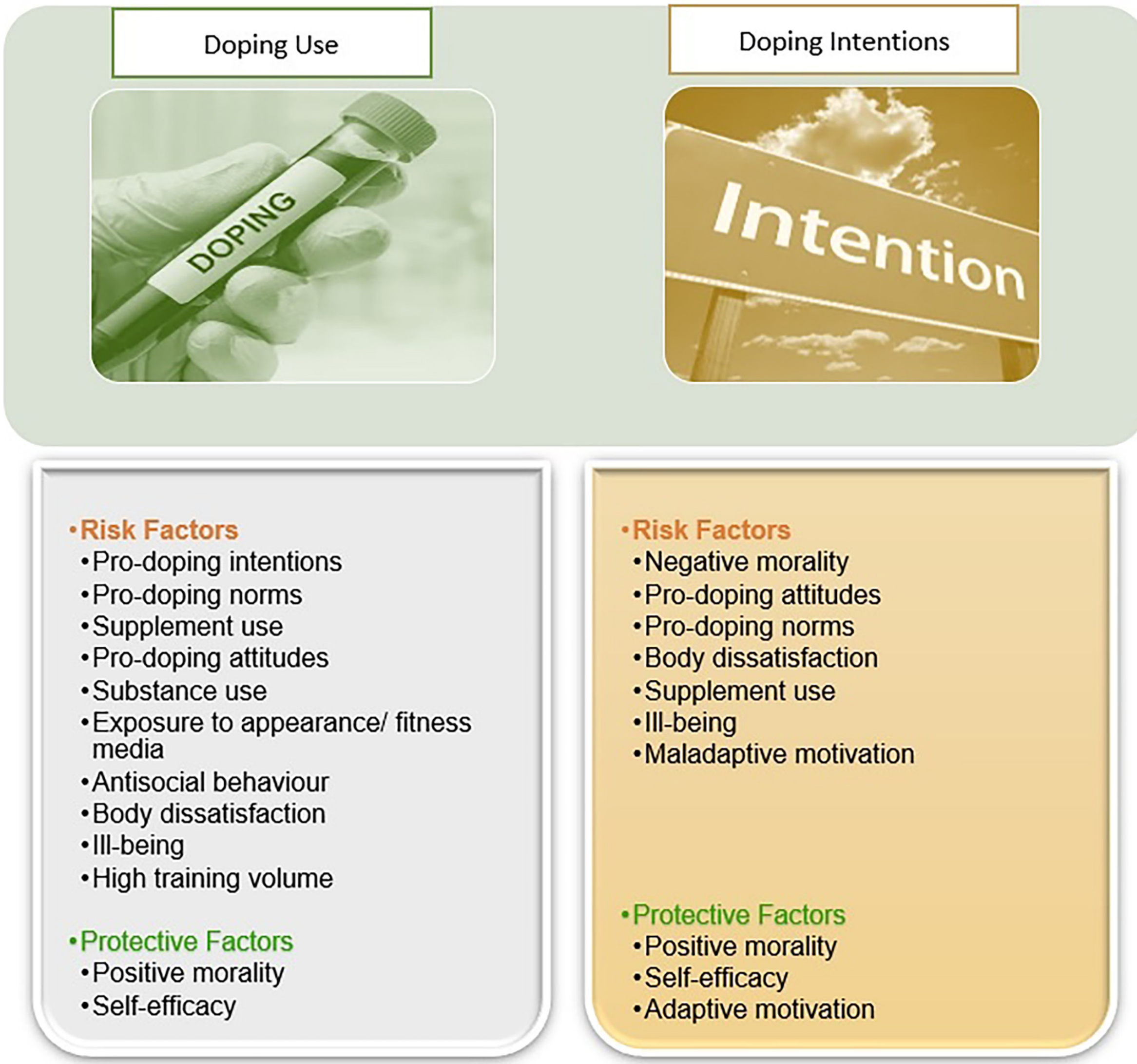


**Figure 3** A list of risk and protective factors with evidence of high compatibility, obtained from observational studies of doping use and doping intentions and ranked by effect size magnitude.

Second, the number of studies measuring moral disengagement has increased substantially since the 2014 meta-analysis. In fact, moral disengagement comprised most of the effect sizes grouped under the factor of negative morality, which showed a strong negative association with intentions ($g=-45$). A third noteworthy finding is that supplement use was associated with doping use in cross-sectional, but not in longitudinal studies. This evidence implies a co-occurrence between supplement use and doping[56] rather than supplement use constituting a gateway to doping.[57] Future research with causal designs should further investigate the role of supplement use on intentions and actual doping use.

Meta-bias and influence case tests for both observational and experimental studies showed that the obtained effect sizes were largely unaffected by various biases (eg, publication status) or outliers. However, the overall certainty of evidence was rated as low in the GRADE assessment, due to inconsistency and impression of effect sizes. Furthermore, confounding could be present in the meta-analysis of our observational studies and when comparing results between experimental studies, due to differences in outcomes and populations. Such factors, alongside the limitations and future research directions identified earlier, should be considered in the design of future studies.

## Practical implications

With the proliferation of social media, the gateways to doping use might be somewhat different today than in the past. We identified exposure to fitness appearance media posts and body image dissatisfaction as new important predictors. This signifies the need for both educational programmes and future RCTs to target such risk factors where appropriate. Several moderation effects suggested that there might be higher susceptibility to doping among subelite or older athletes. The latter aligns with previous findings underscoring the significance of reaching a performance plateau or nearing the end of one's career as influential factors in the initiation of doping practices.[58] Antidoping education programmes tailored for different career stages or age groups might be more effective than generic ones. Given the strong effect size we found for moral disengagement, we suggest this may be a key variable to target in future antidoping efforts.[59] Furthermore, the predictive role of social norms, particularly among athletes relative to non-athletes or students, underscores the utility of developing system-based approaches[60] to antidoping prevention in sport. Such approaches, in contrast to single-level ones (eg, athletes or coaches only), target multiple social agents simultaneously and are currently missing in antidoping strategies. In conclusion, we meta-analysed evidence from 311 independent samples (total N=322 716) testing psychosocial predictors of doping. Our findings indicate that antidoping interventions have a small effect in reducing doping use and intentions. Observational evidence suggests a variety of risk factors (eg, prodoping norms and attitudes, supplement use, body dissatisfaction and ill-being) and protective factors (eg, self-efficacy and positive morality) for both doping intentions and use. The empirical evidence for psychococial predictors of inadvertent doping is rather limited to establish clear conclusions.

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**Contributors** NN, VB, IDB and DFG conceived the project and obtained the project funding. NN had the overall responsibility for the project and the manuscript. SD and JSH extracted and coded the data. DFG conducted the statistical analyses. VB, IDB and CBJ, provided intellectual input. All authors contributed to the refinement of the manuscript and approved the final version. NN is guarantor. As explained in the Methods section, we employed Research Screener, a semi-automated web application that uses machine learning algorithms to optimise the screening process.

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**Data availability statement** Data are available in a public, open access repository. Our search results, final data file, analysis scripts and supplementary material are openly available (https://bit.ly/doping-meta-project).



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