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Article

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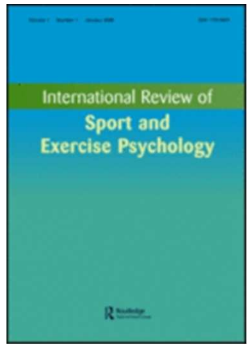

A Meta-Analysis of the Drive for Muscularity's Relationships with Exercise Behaviour, Disordered Eating, Supplement Consumption, and Exercise Dependence

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Abstract

We examined the drive for muscularity's (DFM) relationships with exercise behaviour, disordered eating, supplement consumption, and exercise dependence in males. By searching electronic databases, manually reviewing journal table of contents and retrieved article reference lists, and corresponding with leading researchers, we identified 77 studies. A random effects model was applied to perform analyses and we adjusted results for possible publication bias. The average effect sizes (r) the DFM had with weight training (.31), non-weight training (.11), disordered eating (.30), supplement consumption (.36), and exercise dependence (.43) were significant ($P < .05$). The relationship between the attitudes and behavioural subscales of the DFM Scale ($r = .47$) was significant ($P < .001$). For supplement consumption, moderator analysis indicated that r varied significantly for questionnaire type and participant status (student versus non-student, $P < .01$). The small-to-moderate relationships indicate the value of adopting theoretical perspectives allowing the examination of the DFM's role in predicting exercise and dietary behaviour within a broader psychosocial context. Most researchers have studied these relationships in isolation. The relationship between the two DFM subscales implies that the questionnaire total score may better represent a commitment to muscularity rather than a drive *per se*.

Keywords: body image; self-perceptions; male ideal physique; eating behaviour; eating disorder; body dysmorphia

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Historically, body image research has focused on females, weight loss, and eating disorders, whereas more recently, investigators have also increased attention paid to men's body image issues (Edwards, Tod, & Molnar, 2014). Although some men wish to lose weight, particularly adipose tissue, other males desire to gain weight, especially muscle mass (Hildebrandt, Schlundt, Langenbucher, & Chung, 2006). To stimulate research, McCreary and Sasse (2000) coined the term *drive for muscularity* and developed their Drive for Muscularity Scale. Drive for muscularity is the desire individuals have to develop a muscular physique (McCreary & Sasse, 2000). Since this seminal paper, other researchers have developed measures, with the most commonly used examples being the Drive for Muscularity Attitudes Questionnaire (Morrison, Morrison, Hopkins, & Rowan, 2004), the Swansea Muscularity Attitudes Questionnaire (Edwards & Launder, 2000), and a Drive for Muscularity Scale paralleling the Eating Disorder Inventory's Drive for Thinness subscale (Yelland & Tiggemann, 2003). Some research has demonstrated acceptable convergent validity among the questionnaires (e.g., Tod, Morrison, & Edwards, 2012a).

Theorists have provided explanations for why people may develop a drive for muscularity and why the drive might stimulate appearance-related behaviours and cognitions (Morrison, Morrison, & McCann, 2006). Central to these explanations is the postulate that if people learn from their environments that a muscular physique is valued and desirable, then they will compare themselves against others to determine if they have sufficient or inadequate levels of muscle. If they deem themselves to be inadequately muscular then they will develop a high drive which will stimulate engagement in appearance change behaviours and cognitions (Morrison et al., 2006). Based on these explanations, researchers hypothesize that increased levels of the drive for muscularity are related to specific appearance altering behaviours, including exercise participation, disordered eating, and supplement consumption (Dakanalis, Timko, et al., 2015; Galli, Petrie, Reel, Chatterton, & Baghurst, 2014; Leone et al., 2015). With respect to these specific correlates, however, there is mixed evidence for the hypothesised relationships (Edwards et al., 2014).

A number of these appearance-related behaviours and cognitions may have health consequences, such as excessive exercise, restrictive diets, and anxiety or shame. The evidence however, that the drive for muscularity is positively related with negative health states and behaviours, such as depression, eating disorder symptoms, exercise dependence, anxiety, lowered self-esteem, and intention to consume illegal or banned substances is mixed (Edwards et al., 2014). One reason that the evidence may appear mixed is because researchers have sometimes confounded the drive for muscularity with muscle dysmorphia by using the terms and questionnaires interchangeably, such as using a drive for muscularity questionnaire as a measure of muscle dysmorphia. Although the drive has been correlated with muscle dysmorphia (Robert, Munroe-Chandler, & Gammage, 2009), they are different constructs. Muscle dysmorphia refers to a perceived inadequacy of size and muscularity accompanied with social and occupational dysfunction, excessive exercise, restrictive dieting, and risky supplement and drug use (Pope, Gruber, Choi, Olivardia, & Phillips, 1997). Muscle dysmorphia is diagnosable condition listed in the American Psychiatric Association's (2013) *Diagnostic and statistical manual-5* as a variant of body dysmorphic disorder. The drive for muscularity is a person's desire to increase levels of muscle and decrease body fat to achieve a muscular physique. Potentially, a person may have a high drive for muscularity, but not be distressed by a perceived inadequacy. For example, some strength athletes may be happy that their muscularity levels are greater than those of the general population, but desire more for performance reasons. One way to help unravel the relationship between the drive for muscularity and health-related behaviours would be to focus on studies that have used drive for muscularity measures rather than muscle dysmorphia assessments.

We examined the drive for muscularity's relationship with exercise behaviour, exercise dependence, disordered eating, and supplement consumption for several reasons. First, we focused on the common behaviours used to increase muscularity: exercise, eating, and supplement consumption for which there is mixed evidence (Edwards et al., 2014). Although other behaviours are associated with muscularity-related self-perceptions, such as camouflaging or body checking (Hildebrandt, Walker, Alfano, Delinsky, & Bannon, 2010), these actions do not change one's physique, but rather focus on self-monitoring or influence the way the body is presented to others. Second, we focused on behaviours typically interpreted as consequences of a desire to increase muscularity, rather than normally being discussed as variables that increase the drive (e.g., internalisation of social norms regarding attractiveness). We considered including steroid use, but decided against inclusion because there were few studies examining the relationship with the drive for muscularity quantitatively.

One possible reason why a recent systematic review found mixed evidence for the relationship between the drive and exercise behaviour may be because authors have often failed to differentiate between weight training and non-weight training behaviour (Edwards et al., 2014). In the current meta-analysis we separated measures into 2 categories; those that were weight training specific or non-weight training specific. A male ideal physique involves visible muscularity which is achieved by both an increase in muscle mass and a decrease in adipose tissue. Weight training is the intervention of choice to increase muscle mass, whereas other forms of exercise are better suited to consuming adipose tissue. As such, both exercise modalities are hypothesised to be related with the drive for muscularity. Nevertheless, in the general population's vernacular the term muscularity is used interchangeably with words related to size and bulk (Morrison et al., 2006), and our conjecture is that there is likely to be a stronger connection with weight training than non-weight training exercise. We did not, however, investigate exercise modality as a potential moderator (weight training versus non-weight training behaviour) in the drive for muscularity and exercise relationship. Different types of exercise (e.g., weight training versus aerobic activity) represent dissimilar activities, typically pursued for mutually exclusive goals (especially related to physique change), and stressing alternative components of human physiology. To include exercise modality as a moderator in this meta-analysis was akin to comparing apples with oranges.

Further related to exercise, we also examined the relationship between the two subscales of McCreary and Sasse's (2000) Drive for Muscularity Scale: the attitudes and behavioural subscales (the other common drive for muscularity scales do not contain behavioural subscales). The attitudes subscale contains items about the wish or desire to be more muscular (e.g., "I wish that I were more muscular"). The behaviour-oriented subscale is often used as a proxy for engagement in various muscle building behaviours (e.g., Tylka, 2011). To illustrate, one item asks participants to indicate the degree to which the statement "I lift weights to build up muscle" applies to them (from 1 = always to 6 = never) rather than indicating how many times a week they weight train. The subscale contains items, however, focused on feelings of guilt associated with, and perceptions of others' views on, weight training behaviour, and is not a direct measure of reported behaviour. The two subscales are often combined to generate a total score which some investigators interpret as a measure of the drive for muscularity. Other researchers use only the attitudes subscale to measure the drive. The interpretation of the total score may be unclear, however. Defining the drive as a desire to increase muscularity separates behaviour from attitude. Examining the relationship between the two subscales may help with interpretation. If the relationship is low to moderate, then it is likely the scales are measuring different constructs and the total score is not a measure of the drive. In addition, the behaviour scale has not always demonstrated robustness across studies in which it has been subject to factor analysis (Robert, Munroe-Chandler, & Gammage, 2009; Smolak & Stein, 2006). Based on these observations, we hypothesised that the relationship between the two subscales would vary with the behavioural subscale's internal consistency, as represented by the Cronbach's alpha.

When conducting meta-analyses, some researchers assess individual studies' research design quality and calculate a score used to determine inclusion or exclusion in the review. Other researchers, however, argue that design features can be examined as potential moderators (Card, 2011). The advantage of examining design features as moderators over assigning quality scores is that the knowledge gained can help researchers account for influential methodological factors when planning investigations. For example, if a measure's internal reliability is found to attenuate correlations, then researchers can employ correction formulae to help calculate accurate estimates (Murphy & Davidshofer, 1998). In the current study, we examined the drive for muscularity scales' Cronbach alphas as a potential moderator. We hypothesized that higher Cronbach alpha's would be significantly associated with stronger relationships between the drive for muscularity and its correlates.

Drive for muscularity questionnaire type was a second design factor included in moderator analysis. The questionnaires contain different items, have been subject to differing degrees of psychometric testing, and have different developmental histories (e.g., Tod et al., 2012a; Tod, Morrison, & Edwards, 2012b; Wojtowicz & von Ranson, 2006). For example, the items in Yelland and Tiggemann's questionnaire (2003) were created to parallel the Eating Disorder Inventory's Drive for Thinness subscale. In contrast, the final Drive for Muscularity Attitudes Questionnaire items were those surviving from an initial pool of 41 after traditional item reduction procedures were conducted (Morrison et al., 2004). Although we hypothesised that questionnaire type might moderate relationships, there was insufficient evidence to move from a two-tailed to one-tailed hypothesis.

Related to design features are the demographic characteristics defining employed samples. A criticism levelled at drive for muscularity research is the high percentage of student samples (Edwards et al., 2014). Although students represent a significant population segment in the countries where the majority of the drive for muscularity research has occurred, and are worthy of examination, they may differ from nonstudents. For example, many students have relatively flexible timetables compared with groups of nonstudents (e.g., those employed) and the freedom to pursue exercise and to adjust eating habits if they have a high drive for muscularity. Examining the possibility that student status may moderate drive for muscularity's relationships with correlates will help with theory development, such as knowing whether findings generated from a student population might be generalizable to similar groups of nonstudents. Although we hypothesised that student status would moderate the relationships, due to insufficient evidence we did not specify a direction.

We limited the scope of the current study to research using males. Morrison et al. (2006) argued that the drive is evident (although not exclusively) in males, because it reflects a masculine body ideal, the core features of which typically do not apply to the feminine standard. Morrison et al. concluded that Drive for Muscularity scales need to be gender specific, because the construct will likely manifest differently for males and females. Additionally, given the small number of female samples, we considered that there was insufficient research to meta-analyse.

The first purpose of the current review was to examine the relationship between the drive for muscularity and exercise behaviour, exercise dependence, disordered eating, and supplement consumption. We hypothesised that the analysis would yield a positive effect size for the relationships between the drive for muscularity and weight training behaviour, non-weight training exercise behaviour, exercise dependence, disordered eating, and supplement consumption. A second purpose was to examine the relationship between the two subscales of McCreary and Sasse's (2000) Drive for Muscularity Scale. We hypothesised there would be a positive effect size for the relationship between the two subscales. A third purpose was to examine drive for muscularity questionnaire Cronbach alpha, drive for muscularity questionnaire type, and student status as potential moderators. We hypothesised that the relationship effect sizes between the drive for muscularity and the correlates examined in the current review would be moderated positively by the drive for muscularity questionnaire Cronbach alpha. Further, we hypothesized the drive for muscularity questionnaire used and the sample student status would moderate the relationship effect sizes for the correlates examined in the current review. Results from the current meta-analysis will help researchers and practitioners interpret the meaningfulness of the findings and may help in theory development and clinical practice.

Method

Selection of Studies

We adhered to the PRISMA guidelines and available as online supplementary material is a copy of the PRISMA checklist. The search strategy included: (a) an online search of the following electronic databases: SPORTDiscus, PsycINFO, PsycARTICLES, PubMed, Annual Reviews, Science Direct, Taylor and Francis Journals, Sage Journals, and Web of Science; (b) a manual review of reference lists within retrieved articles; and (c) a manual search of journals, including those that had yielded three or more retrieved articles and included: *Advances in Eating Disorders, Body Image, British Journal of Sports Medicine, Comprehensive Psychiatry, Drug & Alcohol Dependence, Eating and Weight Disorders, Eating Behaviors, European Eating Disorders Review, International Journal of Eating Disorders, International Journal of Men's Health, Journal of Clinical Sport Psychology,* *Journal of Eating Disorders, Journal of Sport and Exercise Psychology*, *Journal of Sports Medicine and Physical Fitness, Journal of Strength and Conditioning Research, Psychology of Men & Masculinity, Psychology of Sport and Exercise, Strength and Conditioning Journal.* Keywords used during the search included *drive for muscularity, pursuit of muscularity, desire for muscularity, Drive for Muscularity Scale, Swansea Muscularity Attitudes Questionnaire, and Drive for Muscularity Attitudes Questionnaire*, *male body image*, and *muscularity and self-perceptions.*

Figure 1 presents a Prisma diagram summarizing the search results. These search strategies generated an initial pool of 50, 796 possible articles. After removing duplicates and documents that did not meet the inclusion criteria after a title and abstract review, the available pool was reduced to 262 documents. After a full-text assessment of the remaining documents against the inclusion criteria, 112 publications remained. Data were extracted from 77 studies and are identified in the reference list with an "*". To assess the adequacy of the search, prior to implementing the protocol, 50 studies known to have included a drive for muscularity questionnaire were identified as a test pool. All 50 articles surfaced during the search protocol.

Inclusion and Exclusion Criteria

To be included, studies had to have: (a) used a drive for muscularity questionnaire; (b) used a quantitative measure of exercise, exercise dependence, disordered eating, or supplement consumption; (c) collected data from a male sample, and (d) been written in English. Studies were excluded (a) if they failed any of the inclusion criteria or (b) if after attempts to contact the authors (see below) we were unable to extract sufficient information from the paper to calculate the effect sizes needed to enter the study into the main analysis. In studies that had not reported relevant results, we emailed authors and requested either the information needed to include their study or access to the data file so we could calculate the results. We emailed the authors of 41 studies, and were able to add the results of 16 studies to our data spreadsheet.

Data Extraction and Coding of Studies

Pearson's correlation, *r*, was the effect size selected because the majority of the research reported *r,* it is easily calculated from chi-square, *t*, *f*, and *d* values (Card, 2011), and it is readily understood and interpreted by many people (Field & Gillett, 2010). In longitudinal studies and repeated measures designs, effect sizes were calculated from time 1 assessments. Where researchers had reported non-significant results, but had not given enough details to calculate an effect size we excluded the study. Although such a strategy may lead to an overestimation of the combined effect, such a possibility was countered by adopting Vevea and Woods' (2005) severe two-tailed selection bias model (discussed below).

When researchers had included both the total and attitudes subscale scores from McCreary and Sasse's (2000) Drive for Muscularity Scale, the attitudes subscale score was selected because it more closely aligns to the definition of the construct. Following Card's (2011) recommendation, however, main analyses were rerun after switching the two scales to assess any change in results. There were no changes to the pattern or significance of the results. When researchers had used multiple measures of the drive or disordered eating, we observed the following guidelines, adapted from Stice and Shaw (2004): effect sizes were calculated for the scale that had the strongest construct validity. If two scales had strong evidence for construct validity, we used the scale with the best reliability result in the study under question. These guidelines ensured the best quality measure was used when researchers had employed multiple scales in their studies. For the reasons discussed in the introduction, exercise was coded as either weight training specific or non-weight training specific and these categories were treated as separate variables.

Drive for muscularity Cronbach's alpha was treated as a continuous variable. The drive for muscularity questionnaires type was treated as a categorical variable based on the scale's name. Student status was defined as either wholly student or not wholly student samples. The definition was applied because researchers did not normally detail a percentage breakdown of individuals when they reported mixed samples and it is likely that samples gathered from community settings will have included some students.

To assess the quality of the data mining, 2 people extracted data from the studies independently of each other and there was over 95% agreement. Each person independently created tables detailing the characteristics of included studies, and the tables were compared to assess agreement and disagreement. The two individuals met to discuss disagreements until a consensus was reached, and the original papers were re-read in this meeting. All the disagreements focused on instances where information had been obtained from the original authors because they had not been reported in the publication.

Computation and Analysis of Effect Size

Main and moderation analyses were undertaken with SPSS 22 using Field and Gillet's (2010) syntax. Hedges-Vevea's (1998) random effects model was used in keeping with Field's (2005) recommendations. Hedges-Vevea's method was applied using Fisher-transformed correlation coefficients which were back transformed to Pearson's correlations prior to being presented in the results section. The Q statistic, based on the chi square test, was calculated to assess for heterogeneity in the effect sizes. In addition, I^2 was calculated and represents the percentage of the variability in effects due to heterogeneity. Based on the Cochrane handbook (Higgins & Green, 2011), when the I^2 value was above 30%, moderation analysis was undertaken in the current study. Forests plots were used to inspect results visually. Moderator analyses were conducted using a random-effects general linear model in which each z-transformed effect size can be predicted from the transformed moderator effect, represented by β, the regression coefficient (estimated using the generalised least squared method).

Rosenthal's (1979) fail-safe *N* was calculated to assess the number of studies needed to return a non-significant result. Funnel plots were constructed and interpreted visually, and Begg and Mazumdar's (1994) rank correlation test was used to estimate the bias quantitatively. Funnel plots are scatter plots on which each study's effect size is graphed against its standard error. Presence of bias is indicated when the pattern of effect sizes deviates from a funnel appearance. Where the profile of results indicated a publication bias, Vevea and Woods' (2005) correction model was applied to revise the estimated effect size.

Results

The following is available online as supplementary material: (a) tables presenting specific details about the studies used in each analysis, including lead authors, year of publication, *r*, *n*, drive for muscularity questionnaire employed, and details extracted for moderator analysis; (b) forest plots; (c) funnel plots; and (d) the PRIMA checklist. As presented in the supplementary material, all funnel plots indicated publication bias and we have included both adjusted and unadjusted *r*s throughout the results.

Analysis of Drive for Muscularity Measures and Exercise Behaviour

Table 1 presents results from the analysis examining the relationship between the drive for muscularity and weight training. The *r* value of .31 was significant ($P < .001$, $N = 15$). On the basis that the Q statistic was non-significant and $I^2 = 9.2\%$, moderator analysis was not undertaken. The Rosenthal fail-safe indicated 1, 097 unpublished studies would be needed to return a non-significant result. The Begg and Mazumdar correlation was non-significant (.05). As presented in Table 1, the adjusted *r* value, using a severe two-tailed selection model, was .28, indicating that after accounting for a publication bias (based on the funnel plot available online), there remained a small-to-moderate relationship.

Regarding non-weight training exercise, Table 1 presents the results from the analysis. The *r* value of .11 was significant (P < .05, *N* = 24). On the basis that the *Q* statistic was non-significant and I^2 = 3.1%, moderator analysis was not undertaken. The Rosenthal fail-safe indicated 647 unpublished studies would be needed to return a non-significant result. The Begg and Mazumdar correlation was non-significant (-.10). As presented in Table 1, the adjusted *r* value, using a severe two-tailed selection model, was .09, indicating a weak relationship.

Analysis of McCreary and Sasse's Attitude and Behaviour Subscales

One study had an *r* value that appeared to be an outlier (Hale, Roth, DeLong, & Briggs, 2010, *r* = .87) and was the only study to use a sample consisting exclusively of weight lifters (power lifters, bodybuilders, and fitness lifters). The study was excluded from analysis because we considered the sample to have come from a different super population compared with the participants from the other studies. The *r* value of .47 was significant (P < .001, *N* = 34). The *Q* statistic was non-significant, but because I^2 = 37% moderator analysis was undertaken and results are reported in the next paragraph. The Rosenthal fail-safe indicated 25, 364 unpublished studies would be needed to return a non-significant result, and the Begg and Mazumdar correlation was non-significant (-.16). As presented in Table 1, the adjusted *r* value, using a severe two-tailed selection model, was unchanged to 2 decimal places.

The relationship between McCreary and Sasse's (2000) subscales was not moderated by the attitudes subscale's α (β = 0.90, 95% CI = -0.35-2.15, *SE* = 0.61, *df* = 27, *t* = 1.47, *P* > .05), the behaviour subscale's α. (β = 0.59, 95% CI = -0.43-1.60, *SE* = 0.501, *df* = 27, *t* = 1.18, *P* > .05), or participant type (χ^2 = 3.76, *df* = 1, *P* > .05).

Analysis of the Drive for Muscularity and Disordered Eating Relationship

Table 1 presents the results from the analysis of the drive's relationship with disordered eating. The *r* value of .30 was significant (P < .001, *N* = 49). On the basis that the *Q* statistic was non-significant and $I^2 = 7.0\%$, moderator analysis was not undertaken. The Rosenthal fail-safe indicated 12, 135 unpublished studies would be needed to return a non-significant result, and the Begg and Mazumdar correlation was non-significant (-.02). As presented in Table 1, the adjusted *r* value, using a severe two-tailed selection model, was .27, suggesting that after accounting for a publication bias a small-to-moderate relationship exists between the two variables.

Analysis of Drive for Muscularity and Supplement Use

Presented in Table 1 are the results from the analysis of the relationship between the drive and supplement use. The *r* value of .36 was significant (*P* < .001, *N* = 16). The *Q* statistic was non-significant, but moderator analysis was undertaken because $I^2 = 67\%$, and the results are described in the next paragraph. The Rosenthal fail-safe *N* indicated 2, 217 unpublished studies would be needed to return a non-significant result, and the Begg and Mazumdar correlation was non-significant (.00). As presented in Table 1, the adjusted *r* value was .34, using a severe two-tailed selection model, indicating that after adjusting for a publication bias a small-to-moderate relationship exists between the two variables.

The results from the moderator analysis are summarised in Table 2, along with the number of studies included. The relationship between the drive for muscularity and supplement consumption was not moderated by the drive questionnaire's α ($\beta = 0.54$, 95% CI = -1.77-2.85, SE = 1.07, $P > .05$). The relationship was moderated by the type of drive questionnaire used ($\chi^2 = 25.89$, $df = 4$, $P < .001$). The relationship was also moderated by participant type (student versus nonstudent; $\chi^2 = 7.108$, $df = 1$, $P < .01$). The residual I^2 after moderation analysis reduced to 3.1%. The relationship was stronger in non-students (.57) than students (.43), although these results were based on unequal and small sample sizes.

The relationship was one of the strongest when using the total score from McCreary and Sasse's (2000) drive for muscularity scale, but weakest when using their attitudes subscale. Again, these results are based on small and unequal sample sizes.

Analysis of Drive for Muscularity and Exercise Dependence

Table 1 presents the results from the analysis of the relationship between the drive and exercise dependence. The *r* value of .43 was significant ($P < .001$, $N = 11$). The Q statistic was non-significant, $I^2 = 20\%$, and moderator analysis was not undertaken. The Rosenthal fail-safe *N* indicated 891 unpublished studies would be needed to return a non-significant result, and the Begg and Mazumdar correlation was non-significant (.13). As presented in Table 1, the adjusted *r* value was .42, using a severe two-tailed selection model, indicating that after adjusting for a publication bias a moderate relationship exists between the drive for muscularity and exercise dependence.

Discussion

The purpose of the current review was to examine the relationships the drive for muscularity had with exercise behaviour, disordered eating, supplement consumption, and exercise dependence. Estimated relationships were corrected for publication bias. We also examined the relationship between the two subscales of McCreary and Sasse's (2000) Drive for Muscularity Scale, and the effect of muscularity questionnaire Cronbach's alpha, drive for muscularity questionnaire type, and student status on relationships. Results indicated that the drive for muscularity had small to moderate relationships with exercise behaviour, disordered eating, supplement consumption, and exercise dependence. There was a moderate relationship between McCreary and Sasse's two subscales. Regarding moderation analysis, results indicated that the relationship between drive for muscularity and supplement consumption was moderated by questionnaire type and student status. There results extend knowledge in the following ways.

First, the results raise questions regarding the simplistic assumptions that have been implied in the literature: that the drive for muscularity predicts exercise, particularly weight training, eating behaviour, and supplement consumption. The assumed relationships make intuitive sense, because exercise, diet, and supplement consumption are promoted as ways to induce muscularity-related physique changes, such as increased muscle and lowered adipose tissue. In the current quantitative review, however, the relationships were small to moderate, implying the connection may not be simple or straightforward. Exercise, diet, and supplement behaviours are likely to be influenced by several psychological and environmental variables, suggesting that even if individuals have high drives to be muscular, other factors will influence their decisions to engage in specific physical activity and dietary manipulations. At present, researchers have mostly examined the drive for muscularity and exercise, diet, and supplement consumption relationships in isolation from other factors, perhaps leading to a biased perspective of the desire's role. Based on the current review, an avenue for future research would be to explore the drive for muscularity and exercise, diet, and supplement consumption relationships within a broader theoretical perspective that acknowledges other influential variables. For example, Perugini and Bagozzi's (2001) model of goal-directed behaviour, an extension of the theory of planned behaviour (Ajzen, 1991) illustrates one possible approach. Perugini and Bagozzi provided support for their model via two studies. The model proposes that desire (e.g., the desire to be muscular) mediates the relationships between motivational antecedents (attitudes, subjective norms, and anticipated emotions) and behavioural intention. In turn, behavioural intention increases behaviour. The model also proposes that perceived behavioural control, along with the frequency of existing and recent behaviour influences positively desire, behavioural intention, and behaviour (i.e., people who have greater perceived control of over exercise, who are currently exercising more, and who have exercised more recently are more likely to exercise in the future compared with individuals with lower perceived control, who are currently exercising less, and who have exercised less in the recent past). Operating from a model of goal-directed behaviour perspective, drive for muscularity would be hypothesised to have an indirect relationship with exercise behaviour, diet, and supplement consumption that is mediated by behavioural intention. Further, this indirect relationship would be influenced by individuals' perceived behavioural control and their current and recent actions. Although these hypotheses require testing, the model of goal-directed behaviour helps identify reasons why research has yielded small-to-moderate relationships between the drive for muscularity and exercise, diet, and supplement consumption and provides possible guidance for future inquiry. The model has been discussed here to illustrate the argument. It is also possible that researchers can test other behaviour change models to help position the drive for muscularity's role in health-related behaviour within a broader theoretical context.

As a second contribution to the literature, the moderate relationship between McCreary and Sasse's (2000) two subscales (with just 23% shared variance) provides an opportunity to consider what the total score may be measuring. These results suggest that the two scales tap into different constructs. If the drive for muscularity is defined as the desire to increase muscularity then the behavioural subscale and the total score are not measures of the drive. It may be that the total score reflects a commitment to muscularity, rather than a drive *per se*. Two dimensions of commitment that theorists have identified include attitude and behaviour (Brown, 1996), both of which are represented by McCreary and Sasse's inventory. Such a distinction may help to interpret some of the moderation results in the current review. If the attitude subscale and the total score were measuring the same construct then the correlations they had with supplement use would have been expected to be closer than they were in the current results. At present there is inconsistency in the literature with researchers labelling both the attitudes and total score as the drive for muscularity. Such inconsistency may lead to confusion regarding how best to interpret and compare results across studies. Repositioning the total score as reflecting a commitment to a muscular ideal, the attitudes subscale as a desire to increase muscularity, and the behavioural subscale as a proxy for engagement in muscularity enhancing behaviours would help researchers decide what construct is most relevant for their studies and may help reviewers make more specific interpretations of the literature.

The results regarding supplement use may illustrate the above argument. McCreary and Sasse's (2000) drive for muscularity total score had one of the strongest relationships with supplement use, whereas their attitude subscale had the weakest. The total score is also the only measure containing items (n = 3) focused on nutrition practices, one of which refers to supplements. These 3 items may be responsible for the inflated correlation. They are also not focused on a desire for muscularity, but behavioural engagement.

As a third contribution to knowledge, the current results highlight some methodological implications. Despite adopting Vevea and Woods' (2005) most severe selection bias model, the reduction in overall r effect sizes was small across the various analyses. The greatest reduction was for weight training behaviour and consisted of a drop of .03, or less than 0.05% of shared variance. Although the funnel plots did indicate that a publication bias exists, these data provided evidence that a publication bias has not led to a gross misrepresentation of the relationship between the drive for muscularity, exercise, exercise dependence, diet, and supplement consumption.

Further, there was limited evidence that the methodological moderators examined in the current review influenced the relationships between the drive for muscularity and exercise and diet. Student status and drive for muscularity questionnaire type did moderate relationships with supplement consumption. These data, however, need to be considered as preliminary evidence. As mentioned in the results, these data were based on small and unequal sample sizes. According to Field and Gillet (2010), such situations do not invalidate a study or constitute reasons for abandoning moderation analysis. Instead, when moderation variables are under-represented, interpretations should be qualified and cautious, and as such, represent an avenue of future inquiry. As one implication, the possibility that student status may moderate the relationship that the drive shares with exercise and diet behaviour needs further testing, ideally with direct comparisons.

As a similar implication, further research will help establish the robustness of the finding that questionnaire type influenced the drive's relationship with supplement consumption. The variation may reflect the inventories' different development and psychometric evaluation histories. For some of the questionnaires, limited attention has been paid to their psychometric properties. Greater attention to psychometric evaluation will help refine these instruments allowing greater confidence in the knowledge generated from their use.

Similar to many meta-analyses, the current manuscript is limited to reports published in English. Our search strategies uncovered 6 documents in another language, including Japanese, German, Brazilian, Mexican, and Iranian. Based on the abstracts, none of these publications appeared to have data relevant to the topic. Although we believe these publications would not have been relevant if we had been able to read them, they indicate that the drive for muscularity has sparked researchers' interest around the globe. Cross-cultural research on the topic has been confined largely to developed and Western countries and these societies may have more similarities than differences. Researchers could undertake cross-cultural research on the drive for muscularity using samples from substantially different cultures, for example, individualistic and collectivist societies.

The research synthesised in this meta-analysis was typically descriptive. Even when a drive for muscularity has been measured in an experiment, it has not been the manipulated variable. As such, causality cannot be inferred from the current results. There are ethical reasons, however, why researchers are unlikely to manipulate the drive for muscularity to establish causal relationships. Although the relationships are moderate at best, some people who develop high levels of a desire for muscle experience negative health and well-being consequences (Pope, Gruber, Choi, Olivardia, & Phillips, 1997). It would be unethical to encourage a high drive for muscularity if there are possible negative health consequences. Nevertheless, the current review indicates the extent to which a drive for muscularity may be considered a risk factor or predictor of health behaviour and as such provides some help for the identification of males who may be at risk of excessive exercise and restrictive diets.

Throughout the discussion we have identified recommendations for future research that have arisen from the current findings and review of the literature. These suggestions include (a) using behaviour change theories to guide examinations of the drive's relationships with health-related behaviours, (b) assessing McCreary and Sasse's (2000) questionnaire as a measure of commitment to developing a muscular physique (based on commitment literature), (c) investigation of potential moderators to advance theoretical understanding (e.g., different types of athletes), (d) psychometric testing of the common questionnaires, (e) treating the drive for muscularity and muscle dysmorphia as related but separate constructs, (f) cross-cultural studies, and (g) the need for experimental research (although we acknowledge the potential ethical constraints). Many of these directions, and others might be addressed by using different types of qualitative research. Existing qualitative studies have not focused on the drive for muscularity specifically, but on other muscle-related issues, such as identity, muscle building culture, and steroid use (e.g., Klein, 1991; Mongahan, 2001; Sparkes, Batey, & Brown, 2005). Life histories, for example, might provide insights into how the interactions among social, interpersonal, psychological, and physical variables lead to a high drive for muscularity and behavioural engagement. Qualitative studies might also include the viewpoints of significant others to triangulate data and provide richer insights into what life is like for people with a high drive for muscularity. For example, parents, partners, and colleagues could be interviewed.

Investigators could employ longitudinal designs to overcome limitations with cross-sectional studies. Prospective longitudinal designs, for example, might assess how drive for muscularity levels change with variations in health-related behaviours. Measuring the drive before people engage in weight training might help assess the extent to which weight training influences the drive. Longitudinal designs might assess how the drive, when measured at an earlier time point might predict behaviour at a later moment. Two themes in the research recommendations outlined in the current review include the need for more studies than at present to be grounded in theoretical frameworks and the use of a greater diversity of methods to answer study questions than undertaken presently. Research guided by these two themes will help advance the area by assessing the robustness of the knowledge and identifying research questions that extend theory in a coherent systematic fashion.

The current meta-analysis indicates that the drive for muscularity has small to moderate relationships with exercise behaviour, exercise dependence, disordered eating, and supplement consumption in males. Although the drive for muscularity may predict these health-related behaviours, the current results imply the relationships may not be simple or straightforward. Much of the research, however, has examined these relationships in isolation. Investigators who adopt broader theoretical perspectives that include measurement of several contextual and psychological variables may shed new light on the role of the drive in predicting health behaviour. Such research may provide understanding on when a desire to build muscle may be either beneficial or detrimental to health and well-being.

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Table 1

Meta-Analysis Results for each Outcome Variable

Variable	*k*	*r*	95% CI	*Q*	I^2	$r_{ADJUSTED}$
Weight training	15	$.31^{*}$	.21-.41	12.82	9%	.28
Exercise (non-weight training)	24	$.11^{\#}$	.01-.20	22.30	3%	.09
Drive for Muscularity behaviour subscale	34	$.47^{*}$	.43-.51	24.03	37%	.47
Disordered eating	49	$.30^{*}$	.26-.34	52.69	7%	.27
Supplement use	16	$.36^{*}$	.26-.44	8.97	67%	.34
Exercise dependence	11	$.43^{*}$	.33-.53	12.45	20%	.42

Note: 95% CI = 95% Confidence Interval, $^{*}P < .001$, $^{\#}P < .05$

Table 2

Revised r Effects from the Moderator Analysis involving Supplement Consumption

Moderator	*r*	*n*
Drive for muscularity questionnaire		
Drive for Muscularity Scale-Total (McCreary & Sasse, 2000)	.50	6
Drive for Muscularity Scale-Attitude (McCreary & Sasse, 2000)	.22	7
Drive for Muscularity Scale (Yelland & Tiggemann, 2003)	.53	2
Drive for Muscularity Attitudes Questionnaire (Morrison et al., 2004)	.45	2
Swansea Muscularity Attitudes Questionnaire (Edwards & Lauder, 2000)	.39	1
Participant type		
Student	.43	24
Non-student	.57	2

Please note: We suggest the following tables are placed online as supplementary material

Supplementary Table 1

Characteristics of Studies used in the Meta-Analysis of the Drive for Muscularity Attitudes and Weight Training Relationship

Author	Year	*r*	*n*	Age	Age SD	DMQ	DMQ α	Participant
Bratland-Sandra et al.	2012	0.37	388	15.03	--	MSDMST	0.89	Student
Chandler et al.*	2009	0.32	97	21.75	4.52	MSDMSA	0.91	Student
Chittester & Hausenblas*	2009	0.11	113	20.34	1.52	MSDMSA	0.88	Student
Hallsworth et al.	2005	0.61	83	27.69	--	YTDMS	0.85	Community
Litt & Dodge	2008	0.05	167	--	--	MSDMSA	0.81	Student
Maida & Armstrong	2005	0.24	106	--	--	MSDMST	--	Community
McCray	2004	0.26	65	27.24	7.98	SMAQD	--	Student
Morrison et al.	2004	0.25	304	23	5.7	DMAQ	0.82	Student
Neufeld, grade 4 sample	2009	0.37	37	8.97	0.16	MSDMST	0.9	Student
Neufeld, grade 7 sample	2009	0.04	35	12.06	0.24	MSDMST	0.9	Student
Neufeld, grade 10 sample	2009	0.08	33	15.33	0.48	MSDMST	0.9	Student
Neufeld, college sample	2009	0.57	32	18.81	0.74	MSDMST	0.9	Student
Robert et al.*	2009	0.29	150	26.89	9.8	MSDMSA	0.88	Student
Thomas et al.	2014	0.33	146	22.8	5	DMAQ	0.81	Community
Tod et al.b	2012	0.59	356	20.24	3.85	YTDMS	0.9	Student

Note: DMQ = Drive for Muscularity Questionnaire, MSDMST = McCreary & Sasse's Drive for Muscularity Questionnaire Total Score, MSDMSA = McCreary & Sasse's Drive for Muscularity Questionnaire Attitudes Score, YTDMS = Yelland & Tiggemann's Drive for Muscularity Scale, SMAQD = Swansea Muscularity Questionnaire Drive for Muscularity Subscale, DMAQ = Drive for Muscularity Attitudes Questionnaire; * Additional information provided by author

Supplementary Table 2

Characteristics of Studies used in the Meta-Analysis of the Drive for Muscularity Attitudes and Non-Weight Training Exercise Relationship

Author	Year	*r*	*n*	Age	Age SD	DMQ	DMQ α	Participant
Bratland-Sandra et al.	2012	0.03	388	15.03	--	MSDMST	0.89	Student
Cafri et al.	2006	0	269	14.64	1.03	MSDMSA	.90	Student
Campana, Tavares et al.*	2013	0.1	878	20.9	4.74	MSDMSA	0.87	Community
Campana, Swami et al.*	2013	0.39	325	23	6.64	MSDMSA	0.88	Community
Chandler et al.*	2009	0.04	97	21.75	4.52	MSDMSA	0.91	Student
Chittester & Hausenblas *	2009	-0.01	113	20.34	1.52	MSDMSA	0.88	Student
Dakanalis, Timko et al. *	2015	0.57	655	25.8	9.3	YTDMS	0.93	Community
Davids & Green, bisexual male sample *	2011	0.16	36	33.22	13.95	MSDMST	0.84	Community
Davids & Green, gay male sample *	2011	-0.28	92	26.28	8.53	MSDMST	0.88	Community
Davids & Green, heterosexual male sample *	2011	-0.43	33	23.74	7.08	MSDMST	0.88	Community
Dodge et al.	2008	0.07	99	--	--	MSDMSA	0.86	Student
Grieve & Helmick *	2008	-0.07	71	27.54	10.56	MSDMSA	0.86	Community
Jankauskiene & Kairaitis	2007	0.01	100	14.63	1.97	MSDMST	0.80	Student
Karazsia et al.	2013	0.1	448	19.54	2.21	MSDMSA	0.88	Student
Keum et al.	in press	.05	200	27.90	7.45	MSDMSA	.91	Community
Leone et al. *	2015	0.01	281	22.49	4.38	MSDMSA	0.70	Student
Martin & Govender	2011	0.14	508	16.6	--	MSDMST	0.90	Student
McCray	2004	0.28	65	27.24	7.98	SMAQD	--	Student
Mish	2008	0.56	24	33.33	9.63	MSDMST	--	Community
Morrison et al.	2004	0.13	304	23	5.7	DMAQ	0.82	Student
Petrie et al.	2014	0.11	203	20.29	1.64	MSDMSA	0.88	Student
Robert et al. *	2009	-0.2	148	26.89	9.8	MSDMSA	0.88	Student
Slater & Tiggemann	2011	0.17	382	14.47	0.62	YTDMS	0.86	Student
Yelland & Tiggemann, heterosexual male sample *	2003	0.37	51	33.6	15.4	YTDMS	0.87	Community
Yelland & Tiggemann, gay male sample *	2003	0.13	52	32.7	15.8	YTDMS	0.87	Community

Note: DMQ = Drive for Muscularity Questionnaire, MSDMST = McCreary & Sasse's Drive for Muscularity Questionnaire Total Score, MSDMSA = McCreary & Sasse's Drive for Muscularity Questionnaire Attitudes Score, YTDMS = Yelland & Tiggemann's Drive for Muscularity Scale, SMAQD = Swansea Muscularity Questionnaire Drive for Muscularity Subscale, DMAQ = Drive for Muscularity Attitudes Questionnaire; * Additional information provided by author

Supplementary Table 3

Characteristics of Studies used in the Meta-Analysis of McCreary and Sasse's (2000) Drive for Muscularity Attitudes and Behaviour Subscales

Author	Year	*r*	*n*	Age	Age SD	Attitudes α	Behaviour α	Participant
Bergenon & Tylka	2007	.35	368	19.11	1.90	.90	.86	Student
Cafri & Thompson	2004	.48	76	21.12	2.60	.88	.86	Student
Campana, Tavares et al. *	2013	.65	878	20.90	4.74	.87	.86	Community
Campana, Swami et al. *	2013	.48	325	23.00	6.64	.88	.79	Community
Chandler et al. *	2009	.58	97	21.75	4.52	.91	.86	Student
Chittester & Hausenblas *	2009	.44	113	20.34	1.52	.88	.83	Student
Daniel & Bridges	2013	.48	153	21.43	4.05	.90	.85	Student
Davis, fraternity sample	2009	.48	80	20.30	1.80	.90	.86	Student
Davis, non-fraternity sample	2009	.40	96	20.30	1.80	.90	.86	Student
Dodge et al.	2008	.39	99	--	--	.86	.83	Student
Engeln et al. *	2013	.45	65	20.33	1.30	--	--	Student
Escoto et al., sample "A"	2013	.46	369	20.93	2.00	.87	.79	Student
Escoto et al., sample "B"	2013	.22	200	20.79	2.01	.88	.72	Student
Galli et al. *	2014	.65	698	19.85	1.39	.94	.85	Student
Giles & Close	2008	.55	161	22.17	3.45	.90	.89	Student
Grieve & Helmick *	2008	.38	70	27.54	10.56	.86	.81	Community
Guðnadóttir & Garðarsdóttir	2014	.25	226	22.81	3.00	.88	.85	Student
Hale et al.	2010	.87	146	--	--	.95	.95	Community

Karazsia & Crowther *	2008	.37	210	19.60	2.40	.88	.85	Student
Karazsia & Crowther	2010	.35	156	19.34	1.92	.88	.85	Student
Keum et al.	in press	.33	200	27.90	7.45	.91	.82	Community
Leone et al. *	2015	.42	304	22.49	4.38	.70	.87	Student
Litt & Dodge	2008	.35	167	--	--	.81	.86	Student
McCreary et al.	2004	.43	276	17.50	3.90	.88	.81	Student
McCreary et al.	2006	.46	100	22.80	3.30	.92	.87	Student
McFarland & Petrie	2012	.49	188	20.30	2.29	.92	.88	Student
McPherson et al.	2010	.55	594	38.90	9.80	.92	.85	Community
Nowell & Ricciardelli	2008	.49	214	22.52	3.36	.90	.86	Community
Petrie et al.	2014	.55	203	20.29	1.64	.88	.83	Student
Robert et al. *	2009	.56	148	26.89	9.80	.88	.66	Student
Smolak & Stein	2006	.46	220	12.90	0.72	.89	.93	Student
Swami et al.	2014	.65	292	28.55	11.41	.88	.92	Community
Tod et al.a	2012	.60	272	20.30	4.00	.91	.89	Student
Tod & Edwards	2013	.50	339	20.00	2.59	.90	.89	Student
Tylka et al.	2005	.43	294	19.70	3.00	.89	.86	Student

Note: * Additional information provided by author

Supplementary Table 4

Characteristics of Studies used in the Meta-Analysis of the Drive for Muscularity and Disordered Eating Relationship

Author	Year	*r*	*n*	Age	Age SD	DMQ	DMQ α	Participant
Bratland-Sandra et al.	2012	.32	384	15.03	--	MDDMST	.89	Student
Brennan et al.	2012	.24	400	--	--	MSDMST	.89	Community
Brennan et al.	2011	.11	383	--	--	MSDMSA	.90	Community
Brunet et al.	2010	.34	190	15.40	1.11	MSDMST	.85	Student
Dakanalis et al., gay male sample *	2012	.51	125	20.89	1.01	YTDMS	--	Student
Dakanalis et al., heterosexual male sample *	2012	.40	130	20.70	1.30	YTDMS	--	Student
Dakanalis, Favagrossa et al. *	2015	.41	551	20.82	4.43	YTDMS	.92	Student
Dakanalis, Timko et al. *	2015	.52	655	25.80	9.30	YTDMS	.93	Community
Dakanalis, Zanetti et al. *	2015	.45	405	23.10	3.50	YTDMS	.91	Student
Davids & Green, bisexual male sample *	2011	-.05	33	33.22	13.45	MSDMST	.84	Community
Davids & Green, gay male sample *	2011	-.13	87	26.28	8.53	MSDMST	.88	Community
Davids & Green, heterosexual sample *	2011	.19	33	23.74	7.08	MSDMST	.88	Community
Downy et al.	2014	.39	134	22.31	6.33	MSDMST	.91	Student
Duggan & McCreary, gay male sample	2004	.31	67	--	--	MSDMST	.91	Community
Duggan & McCreary, heterosexual male sample	2004	-.04	29	--	--	MSDMST	.91	Community
Engeln et al. *	2013	.22	65	20.33	1.30	MSDMSA	--	Student
Galli et al. *	2014	.29	698	19.85	1.39	MSDMSA	.94	Student
Gordon et al.	2010	.26	168	19.80	2.41	MSDMST	.93	Student
Griffiths et al.	2013	.5	91	20.30	4.34	MSDMST	.88	Student
Grossbard et al.	2013	.17	230	--	--	MSDMST	.91	Student
Hallsworth et al.	2005	.35	83	27.69	--	YTDMS	.85	Community
Kelley et al. *	2010	.51	59	18.80	0.94	MSDMST	.89	Student
Kelly et al. *	in press	.1	365	19.64	2.16	MSDMST	--	Student
Maida & Armstrong	2005	.14	106	--	--	MSDMST	--	Community
McCray	2004	.57	65	27.24	7.98	SMAQD	--	Student

McCreary & Sasse	2000	.37	96	18	--	MSDMST	.84	Student
McFarland & Petrie	2012	.27	188	20.30	2.29	MSDMSA	.92	Student
Minnich et al.	2014	.19	302	19.20	1.30	MSDMSA	.89	Student
Mish	2008	.19	24	33.33	9.63	MSDMST	--	Community
Mussap	2008	.23	129	24.38	6.04	MSDMST	.90	Community
Neufeld, grade 4 sample	2009	.57	37	8.97	0.16	MSDMST	.90	Student
Neufeld, grade 7 sample	2009	.14	35	12.06	0.24	MSDMST	.90	Student
Neufeld, grade 10 sample	2009	.57	33	15.33	0.48	MSDMST	.90	Student
Neufeld, college sample	2009	.43	32	18.81	0.74	MSDMST	.90	Student
Petrie et al.	2014	.18	203	20.29	1.64	MSDMSA	.88	Student
Petrie et al., disordered eating asymptomatic sample	2007	.29	164	20.30	1.73	MSDMST	.90	Student
Petrie et al., disordered eating symptomatic sample	2007	.59	35	20.30	1.73	MSDMST	.90	Student
Picot	2004	.32	389	34.00	8.90	MSDMST	.89	Community
Pritchard	2014	.42	84	19.87	2.19	MSDMST	.88	Student
Rodgers et al.	2012	.56	142	16.22	1.04	MSDMST	.91	Student
Shomaker et al.	2010	.13	96	18.00	0.51	PMSD	.75	Community
Sladek et al. *	2014	.22	159	26.62	--	MSDMST	.89	Student
Tantleff-Dunn et al. *	2011	-.06	128	20.50	3.20	SMAQD	--	Student
Tylka et al.	2005	.22	294	19.70	3.00	MSDMSA	.89	Student
Wadeson et al.	2011	.26	169	19.65	1.68	MSDMST	.92	Student
Yean et al., gay male sample	2013	.26	116	21.23	5.56	MSDMST	.90	Community
Yean et al., heterosexual male sample	2013	.40	130	21.23	5.56	MSDMST	.90	Community
Yelland & Tiggemann, heterosexual male sample *	2003	.01	50	33.60	15.40	YTDMS	.87	Community
Yelland & Tiggemann, gay male sample *	2003	.23	51	32.70	15.80	YTDMS	.87	Community

Note: DMQ = Drive for Muscularity Questionnaire, MSDMST = McCreary & Sasse's Drive for Muscularity Questionnaire Total Score, MSDMSA = McCreary & Sasse's Drive for Muscularity Questionnaire Attitudes Score, YTDMS = Yelland & Tiggemann's Drive for Muscularity Scale, SMAQD = Swansea Muscularity Questionnaire Drive for Muscularity Subscale, PMSD = Pursuit of Muscularity Scale Drive Score; * Additional information provided by author

Supplementary Table 5

Characteristics of Studies used in the Meta-Analysis Examining the Drive for Muscularity and Supplement Consumption Relationship

Author	Year	*r*	*n*	Age	Age SD	DMQ	DMQ α	Participant
Chandler et al. *	2009	.28	94	21.75	4.52	MSDMSA	0.91	Student
Chittester & Hausenblas *	2009	.28	113	20.34	1.52	MSDMSA	0.88	Student
Dakanalis, Timko et al. *	2015	.59	655	25.80	9.30	YTDMS	0.93	Community
Dodge et al.	2008	.16	99	--	--	MSDMSA	0.86	Student
Karazsia & Crowther *	2008	.20	210	19.60	2.40	MSDMSA	0.88	Student
Karazsia & Crowther	2010	.37	156	19.34	1.92	MSDMSA	0.88	Student
Karazsia et al.	2013	.14	448	19.54	2.21	MSDMSA	0.88	Student
Litt & Dodge	2008	.21	167	--	--	MSDMSA	0.81	Student
Morrison & Morrison	2006	.39	250	22.30	4.80	SMAQD	0.90	Student
Morrison et al.	2004	.40	304	23.00	5.70	DMAQ	0.82	Student
Neufeld, grade 4 sample	2009	.32	37	8.97	0.16	MSDMST	0.90	Student
Neufeld, grade 7 sample	2009	.52	35	12.06	0.24	MSDMST	0.90	Student
Neufeld, grade 10 sample	2009	.36	33	15.33	0.48	MSDMST	0.90	Student
Neufeld, college sample	2009	.47	32	18.81	0.74	MSDMST	0.90	Student
Thomas et al.	2014	.51	146	22.80	5.00	DMAQ	0.81	Community
Tod et al. b	2012	.45	356	20.24	3.85	YTDMS	0.90	Student

Note: DMQ = Drive for Muscularity Questionnaire, MSDMST = McCreary & Sasse's Drive for Muscularity Questionnaire Total Score, MSDMSA = McCreary & Sasse's Drive for Muscularity Questionnaire Attitudes Score, YTDMS = Yelland & Tiggemann's Drive for Muscularity Scale, SMAQD = Swansea Muscularity Questionnaire Drive for Muscularity Subscale, DMAQ = Drive for Muscularity Attitudes Questionnaire; * Additional information provided by author

Supplementary Table 6

Characteristics of Studies used in the Meta-Analysis Examining the Drive for Muscularity and Exercise Dependence Relationship

Author	Year	*r*	*n*	Age	Age SD	DMQ α	DMQ	Participant
Chandler et al. *	2009	.00	97	21.75	4.52	.91	MSDMSA	Student
Chittester & Hausenblas *	2009	.35	113	20.34	1.52	.88	MSDMSA	Student
Hale et al.	2010	.32	100	--	--	.95	MSDMSA	Community
Kelly et al. *	in press	.41	365	19.64	2.16	--	MSDMST	Student
Kelley et al. *	2010	.59	60	18.80	0.94	.89	MSDMST	Student
Neufeld, grade 7 sample	2009	.46	35	12.06	0.24	.90	MSDMST	Student
Neufeld, grade 10 sample	2009	.34	33	15.33	0.48	.90	MSDMST	Student
Neufeld, college sample	2009	.73	32	18.81	0.74	.90	MSDMST	Student
Parnell	2011	.59	105	20.75	1.72	.87	MSDMST	Student
Robert et al. *	2009	.41	148	26.89	9.8	.88	MSDMSA	Student
Thomas et al.	2014	.53	146	22.80	5.00	.81	DMAQ	Community

Note: DMQ = Drive for Muscularity Questionnaire, MSDMST = McCreary & Sasse's Drive for Muscularity Questionnaire Total Score, MSDMSA = McCreary & Sasse's Drive for Muscularity Questionnaire Attitudes Score, DMAQ = Drive for Muscularity Attitudes Questionnaire; * Additional information provided by author

Figures (both for the manuscript and as online supplementary material)

Figure 1. Prisma diagram for the current meta-analysis.

Supplementary Figure 1. Forest plot of studies examining the relationship between the drive for muscularity and weight training

Supplementary Figure 2. Funnel plot for the drive for muscularity and weight training relationship.

Supplementary Figure 3. Forest plot of studies examining the relationship between the drive for muscularity and non-weight training exercise

Supplementary Figure 4. Funnel plot for the drive for muscularity and non-weight training exercise relationship.

Supplementary Figure 5. Forest plot of studies examining the relationship between the Drive for Muscularity Scale's Attitudes and Behaviour subscales

Supplementary Figure 6. Funnel plot for the drive for muscularity attitudes and behaviour subscales relationship.

Supplementary Figure 7. Forest plot of studies examining the relationship between the drive for muscularity and disordered eating

Supplementary Figure 8. Funnel plot for the drive for muscularity and disordered eating relationship.

Supplementary Figure 9. Forest plot of studies examining the relationship between the drive for muscularity and supplement consumption

Supplementary Figure 10. Funnel plot for the drive for muscularity and supplement use relationship.

Supplementary Figure 11. Forest plot of studies examining the relationship between the drive for muscularity and exercise dependence

Supplementary Figure 12. Funnel plot for the drive for muscularity and exercise dependence relationship.

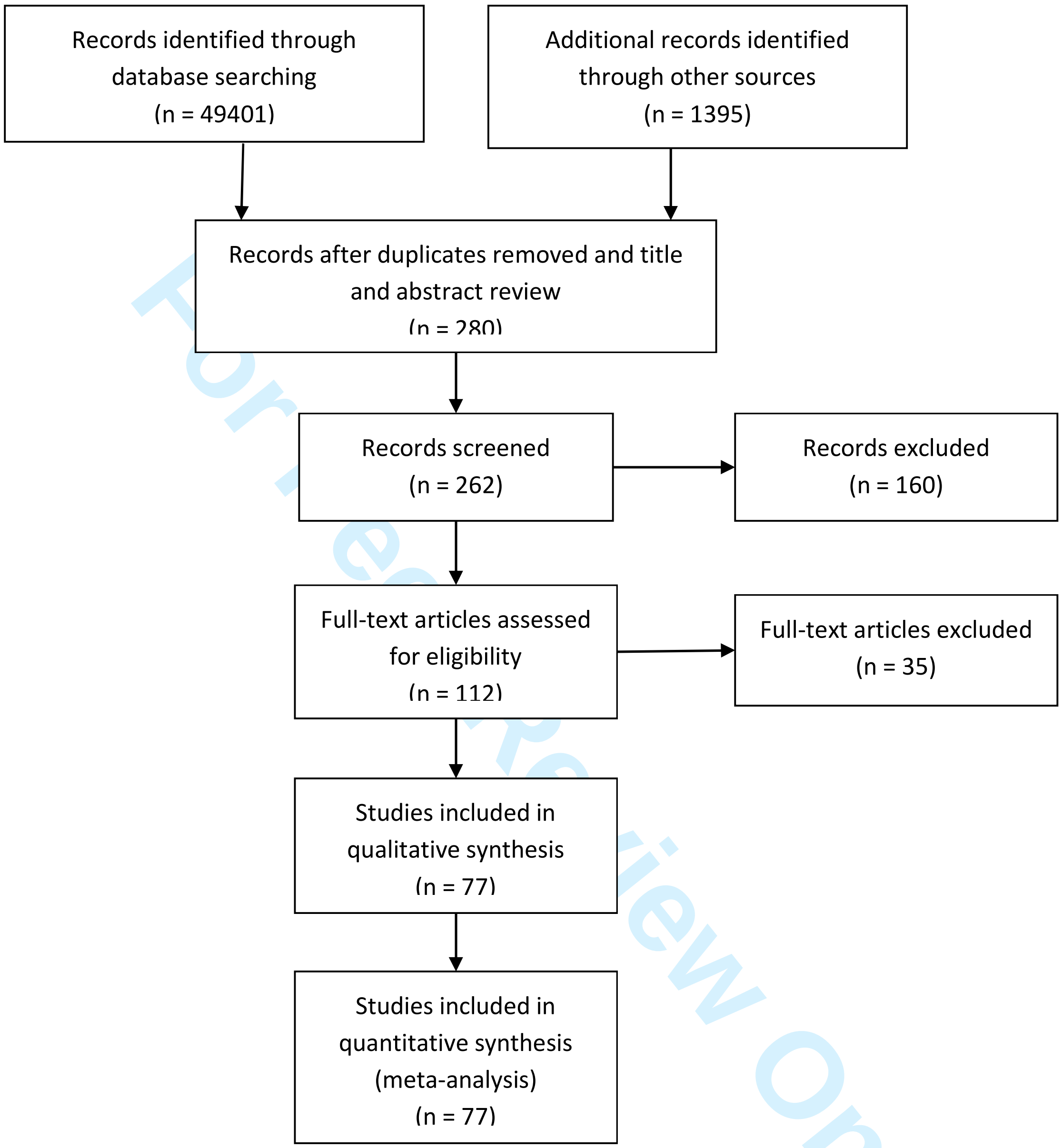
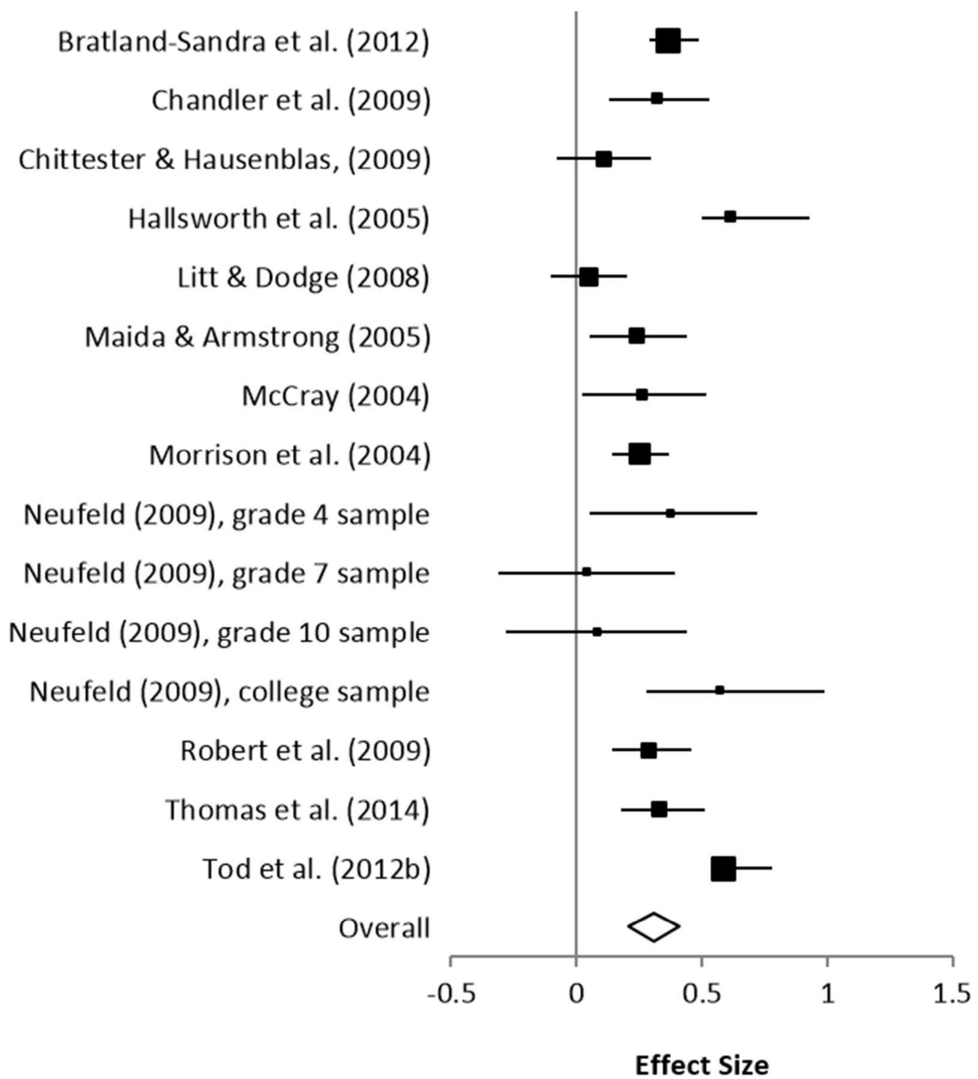
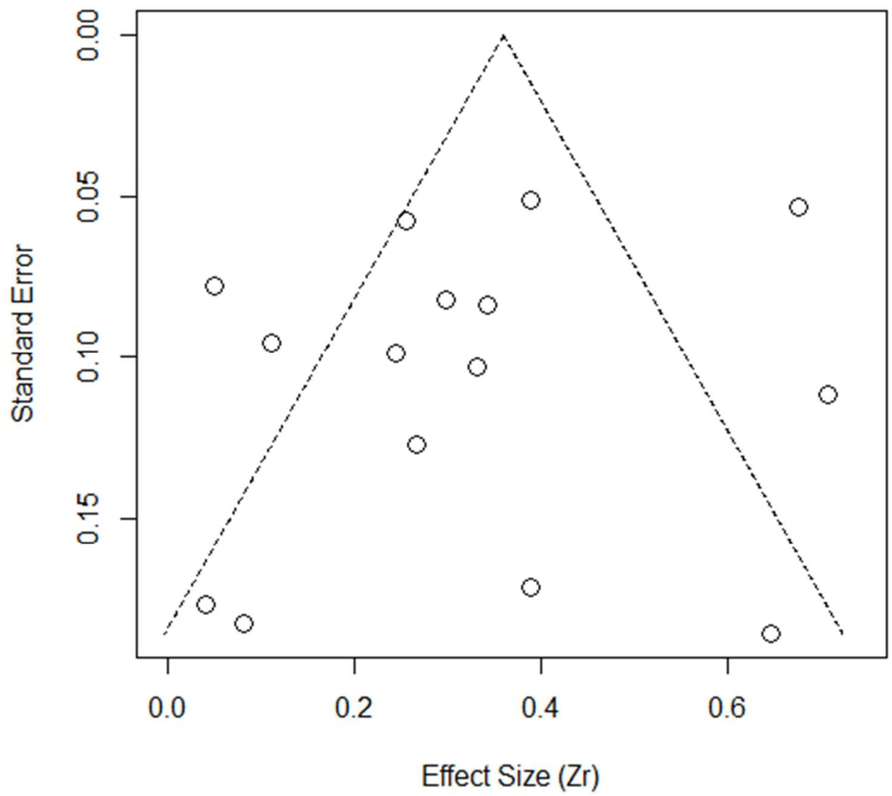


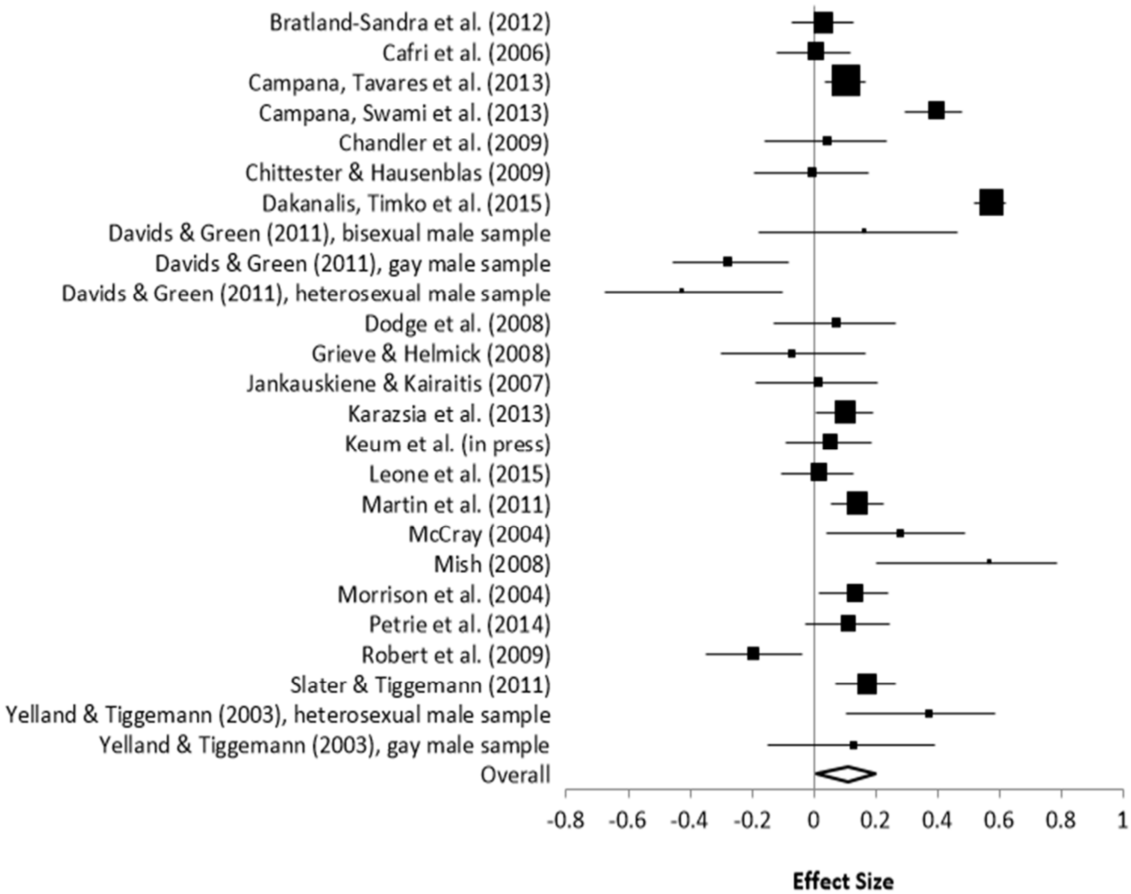
Figure 1. Prisma diagram for the current meta-analysis.



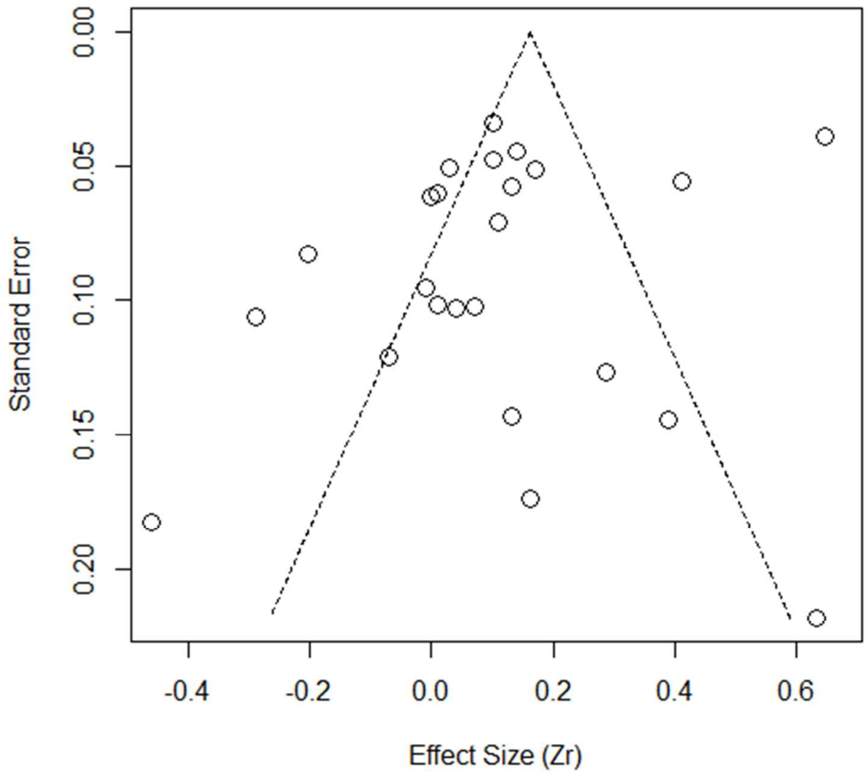
Supplementary Figure 1. Forest plot of studies examining the relationship between the drive for muscularity and weight training



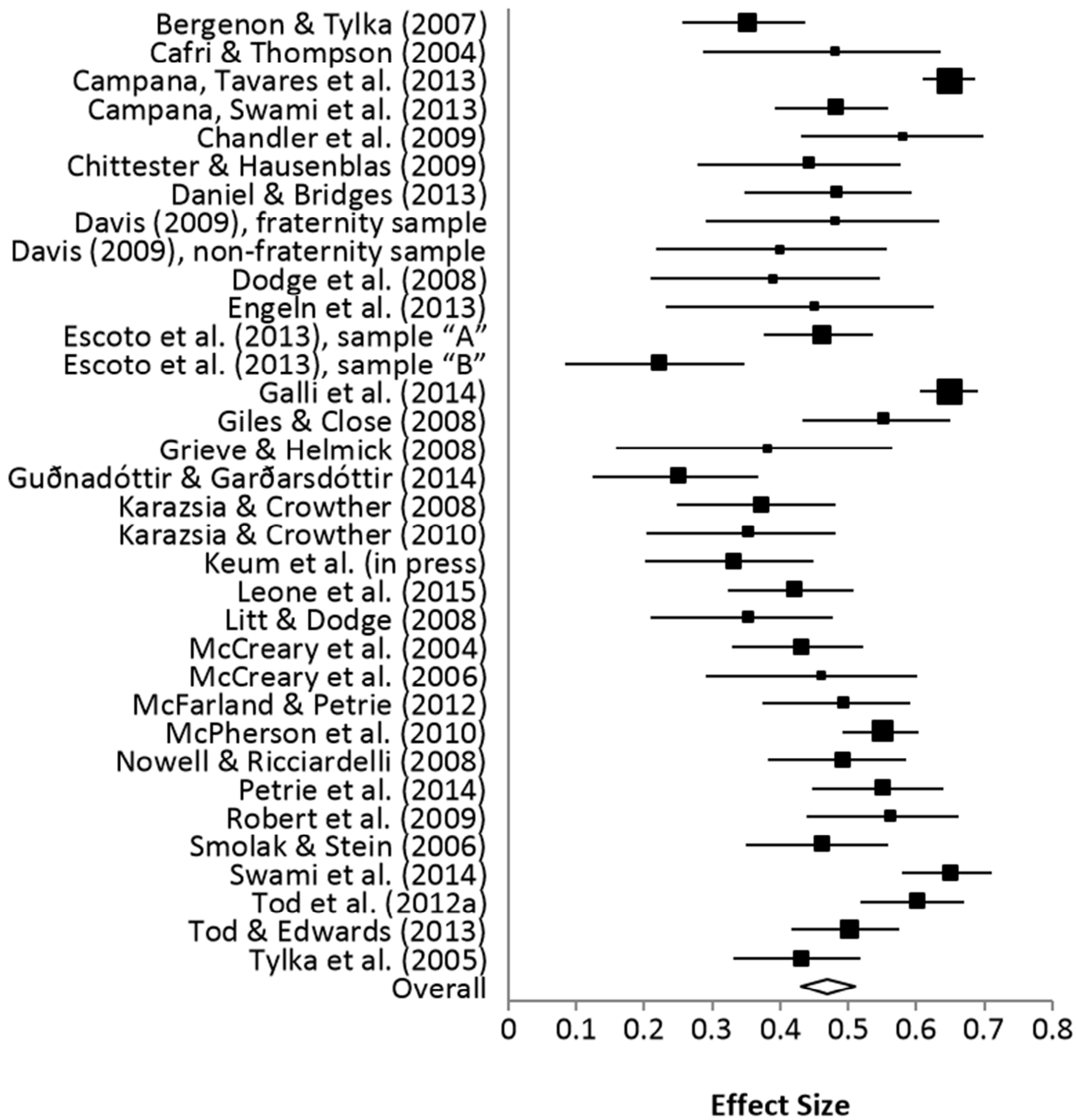
Supplementary Figure 2. Funnel plot for the drive for muscularity and weight training relationship.



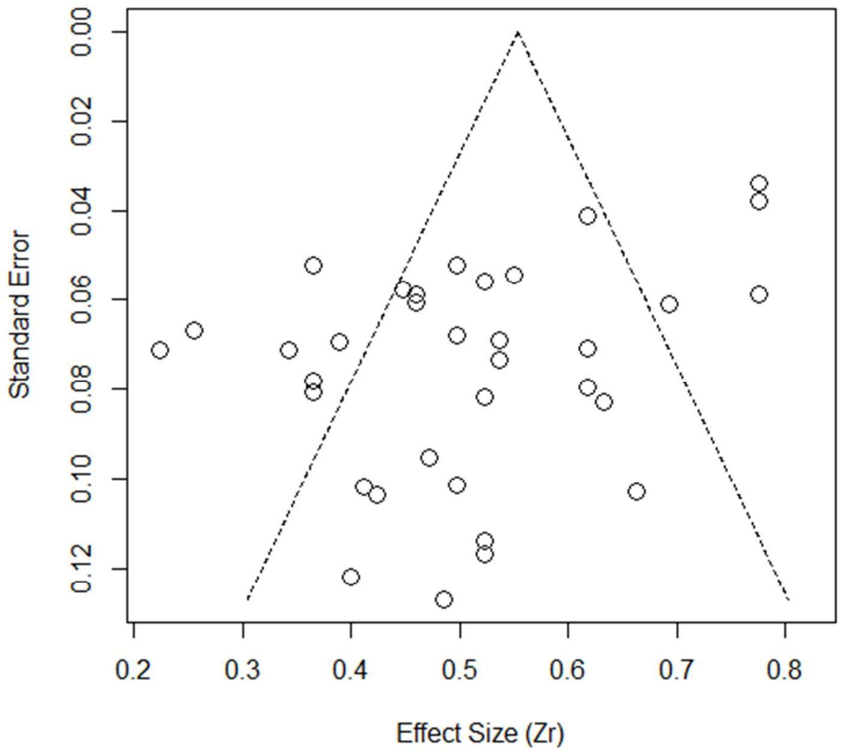
Supplementary Figure 3. Forest plot of studies examining the relationship between the drive for muscularity and non-weight training exercise



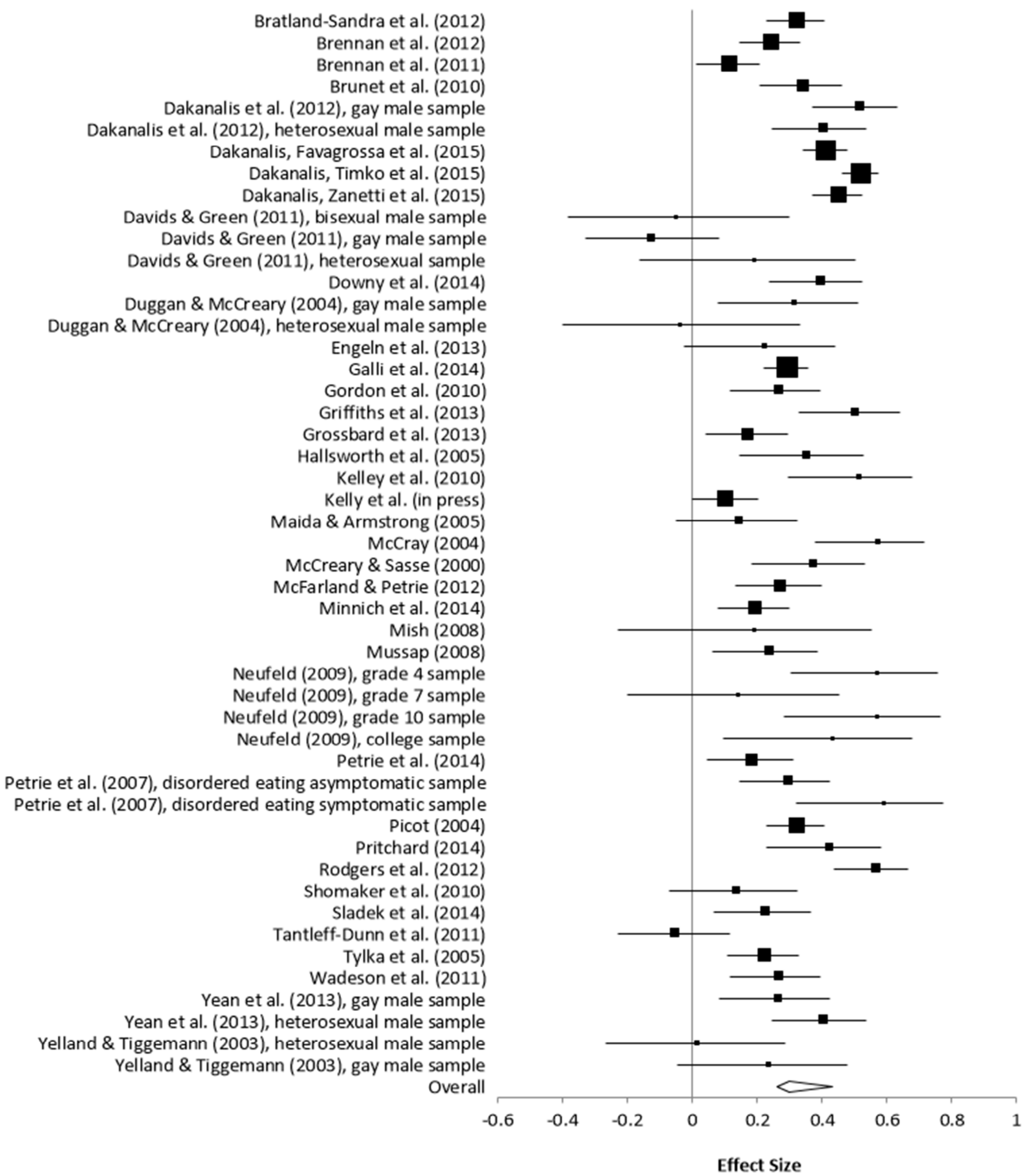
Supplementary Figure 4. Funnel plot for the drive for muscularity and non-weight training exercise relationship.



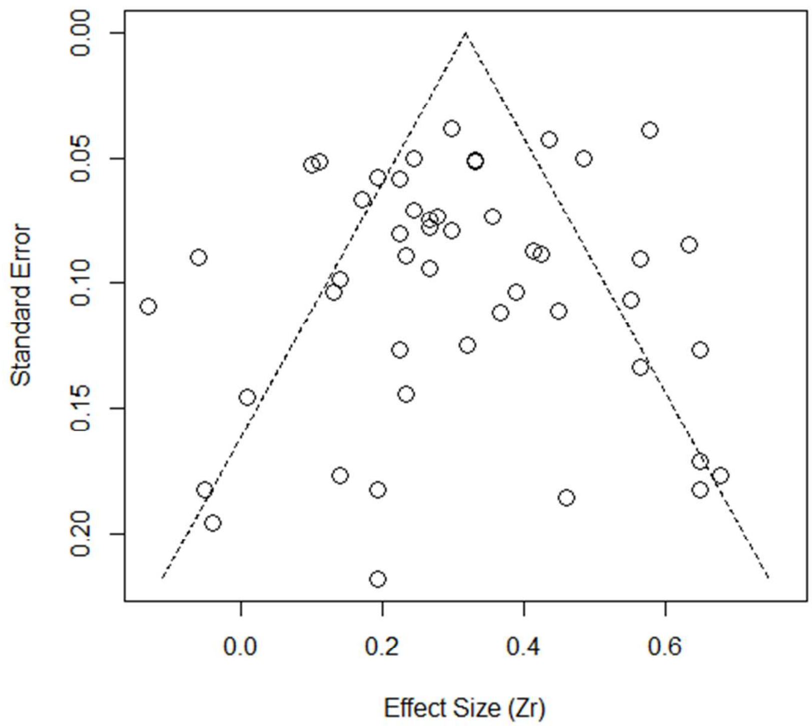
Supplementary Figure 5. Forest plot of studies examining the relationship between the Drive for Muscularity Scale's Attitudes and Behaviour subscales



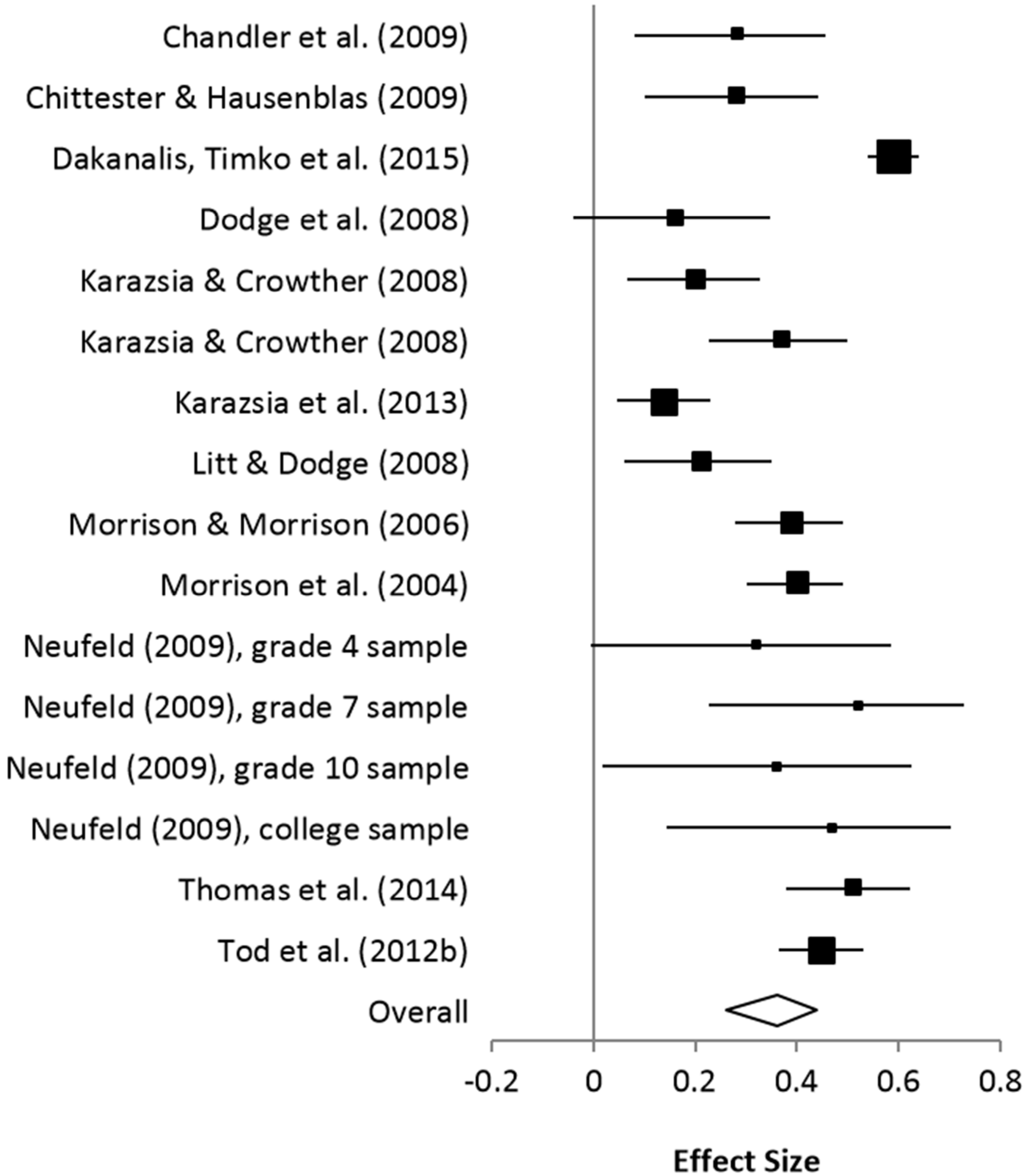
Supplementary Figure 6. Funnel plot for the drive for muscularity attitudes and behaviour subscales relationship.



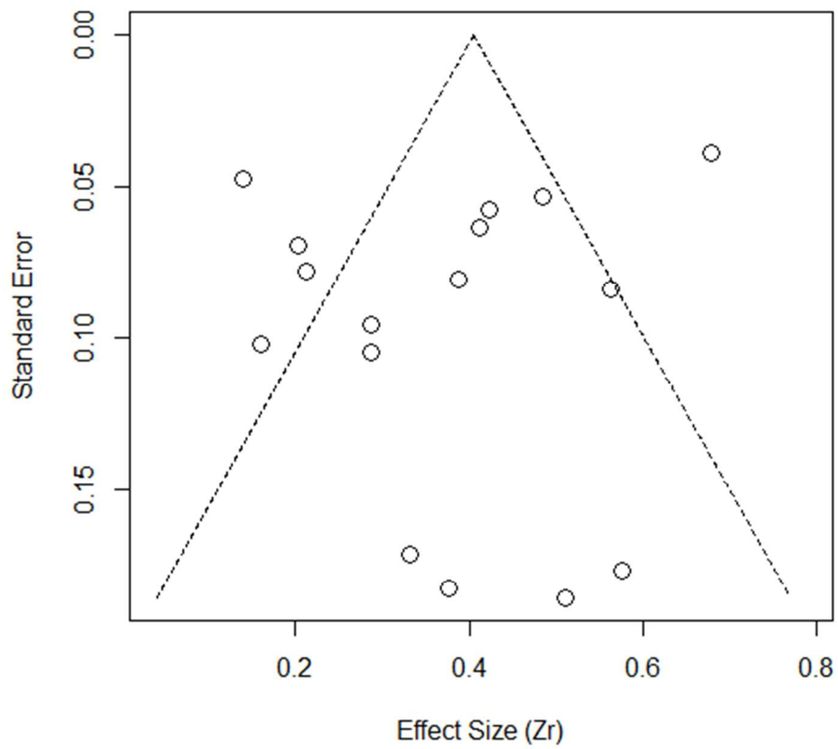
Supplementary Figure 7. Forest plot of studies examining the relationship between the drive for muscularity and disordered eating



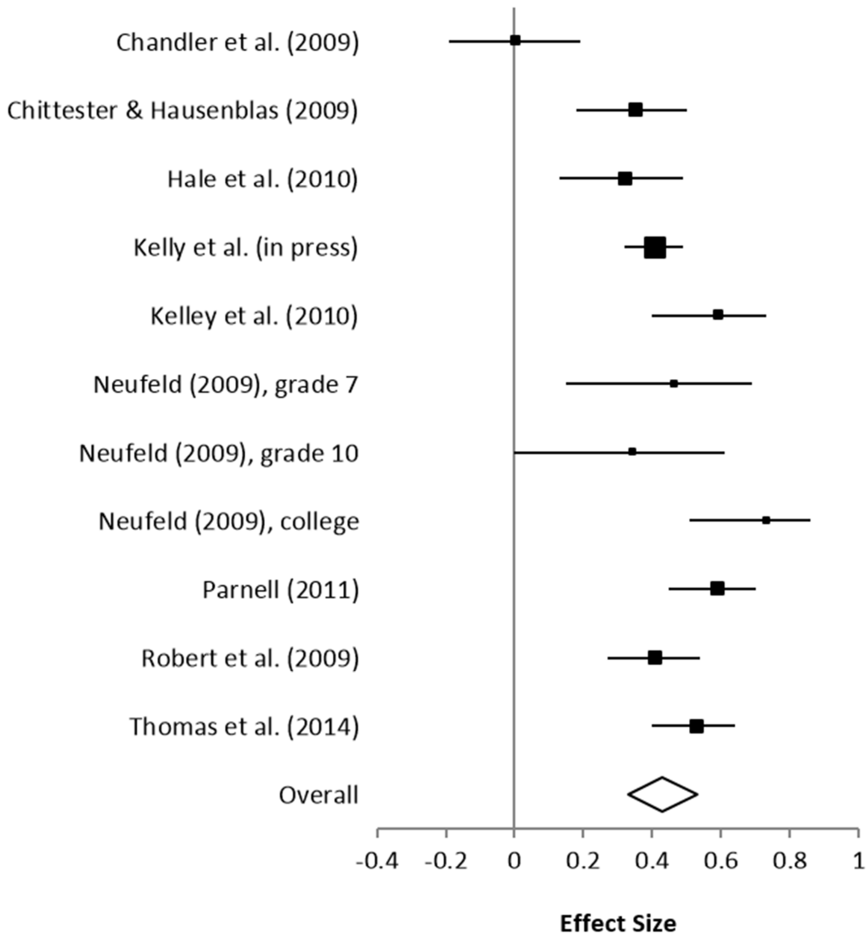
Supplementary Figure 8. Funnel plot for the drive for muscularity and disordered eating relationship.



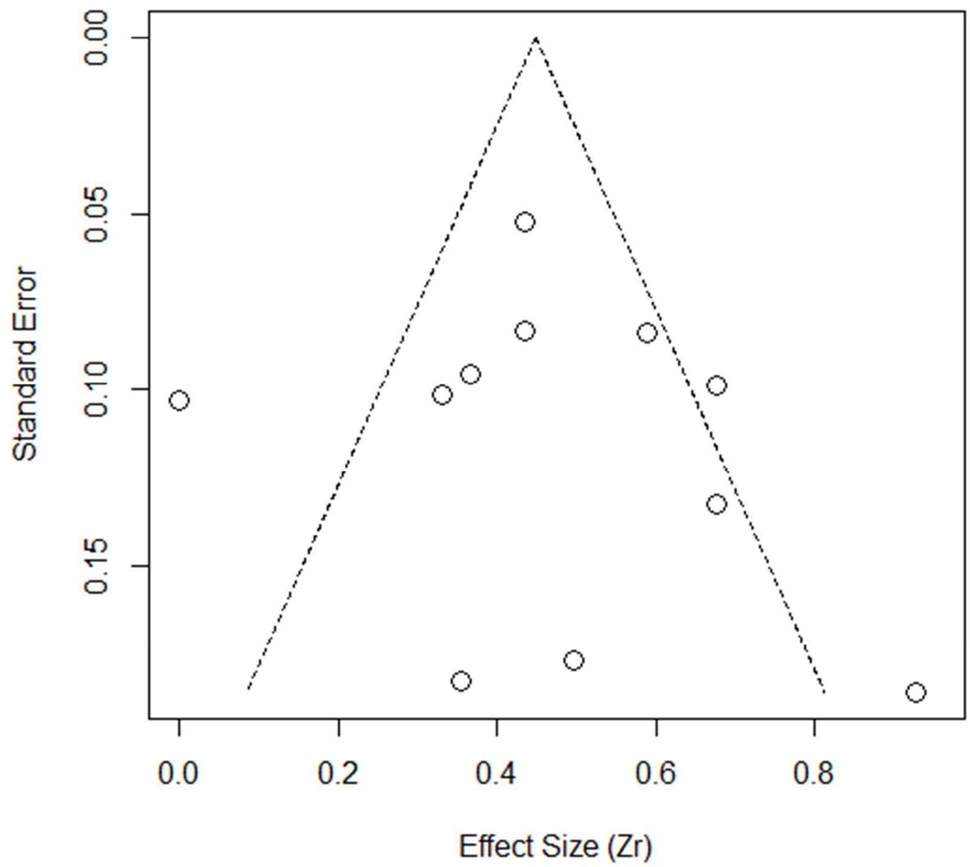
Supplementary Figure 9. Forest plot of studies examining the relationship between the drive for muscularity and supplement consumption



Supplementary Figure 10. Funnel plot for the drive for muscularity and supplement use relationship.



Supplementary Figure 11. Forest plot of studies examining the relationship between the drive for muscularity and exercise dependence



Supplementary Figure 12. Funnel plot for the drive for muscularity and exercise dependence relationship.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-9
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	8-9
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	None existed
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	10-11
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	9-11
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	13
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	10-12
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	10-12
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	11-13
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	13, 7-8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	12
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	12-14

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	13
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	12-13
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	10, Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Online
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13-18, Table 1-2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Online
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	13-18, Table 1-2
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	13-18, Table 1-2
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	13-18, Table 1-2
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16-22
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19-21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16-22
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	None

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