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Anxiety Outcomes after Physical Activity Interventions: Meta-Analysis Findings

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Abstract

Background—Although numerous primary studies have documented the mental health benefits of physical activity (PA), no previous quantitative synthesis has examined anxiety outcomes of interventions to increase PA.

Objectives—This meta-analysis integrates extant research about anxiety outcomes from interventions to increase PA among healthy adults.

Method—Extensive literature searching located published and unpublished PA intervention studies with anxiety outcomes. Eligible studies reported findings from interventions designed to increase PA delivered to healthy adults without anxiety disorders. Data were coded from primary studies. Random-effects meta-analytic procedures were completed. Exploratory moderator analyses using meta-analysis ANOVA and regression analogues were conducted to determine if report, methods, sample, or intervention characteristics were associated with differences in anxiety outcomes.

Results—Data were synthesized across 3,289 subjects from 19 eligible reports. The overall mean anxiety effect size (d-index) for two-group comparisons was 0.22 with significant heterogeneity (Q = 32.15). Exploratory moderator analyses found larger anxiety improvement effect sizes among studies that included larger samples, used random allocation of subjects to treatment and control conditions, targeted only PA behavior instead of multiple health behaviors, included supervised exercise (vs. home-based PA), used moderate or high-intensity instead of low-intensity PA, and suggested subjects exercise at a fitness facility (vs. home) following interventions.

Discussion—These findings document that some interventions can decrease anxiety symptoms among healthy adults. Exploratory moderator analyses suggest possible directions for future primary research to compare interventions in randomized trials to confirm causal relationships.

Health benefits of increased physical activity (PA) have been documented extensively. Most primary research and quantitative syntheses have focused on physical health benefits. Mental health benefits may include reduced anxiety. Some anxiety (a mental state or feeling of uneasiness, apprehension, tension, fear, worry, and/or concern) is common among adults without anxiety disorders. Such anxiety can be unpleasant or may be linked to physical health consequences (Deslandes et al., 2009; Tsatsoulis & Fountoulakis, 2006). Although many reviews have addressed psychological treatments for anxiety (Martin et al., 2009; Ruotsalainen et al., 2008), far fewer have examined PA interventions. This project synthesized extant research testing the effects of PA interventions on anxiety outcomes among healthy adults.

Previous meta-analyses of anxiety outcomes from PA trials included samples with diagnosed anxiety disorders or elevated anxiety (Dunn, Trivedi, & O'Neal, 2001; Long & van Stavel, 1995; Martinsen, 2008; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991;

Strohle, 2009), focused on subjects with both mental and physical health problems (Wipfli et al., 2008), included mental health interventions (Long & van Stavel), lumped diverse mental health outcomes together such as depression and anxiety (Arent, Landers, & Etnier, 2000; Penedo & Dahn, 2005), focused on older adults (Arent et al.), or limited the synthesis to studies with specific PA characteristics (Long & van Stavel). Syntheses of PA intervention primary studies focused on subjects with clinical anxiety disorders have reported standardized mean difference effect sizes of .36 to .48 (Long & van Stavel; Petruzzello et al.; Wipfli et al.). The only synthesis comparing subjects with and without anxiety disorders included studies that combined stress management and PA interventions (Long & van Stavel). No synthesis evidence is available regarding the anxiolytic effects of PA interventions separate from psychological treatments in adults free of anxiety disorders (Salmon, 2001).

Previous meta-analyses of anxiety outcomes following PA interventions have reported heterogeneous effect sizes (Long & van Stavel, 1995; Petruzzello et al., 1991; Wipfli et al., 2008). Heterogeneity is expected in behavioral sciences meta-analyses. Exploratory moderator analyses may help explain heterogeneity. Sample characteristics linked with better anxiety outcomes in previous meta-analyses include gender distribution, sample age, and baseline anxiety levels (Long & van Stavel; Petruzzello et al.; Wipfli et al.). Design characteristics which have been explored in moderator analyses include subject allocation, two-group versus one-group pre-post design, and sample attrition (Long & van Stavel; Petruzzello et al.). Limited anxiety outcome moderator analyses have addressed PA intervention characteristics in samples with physical or mental health problems. Inconsistent findings have been reported for exercise form, intensity, and dose (Long & van Stavel; Petruzzello et al.; Wipfli et al.). Although many interventions addressing multiple behaviors (e.g. diet plus PA) have been reported, none of the previous meta-analyses have compared interventions which target PA behavior exclusively with those that aim to change multiple health behaviors. Previous behavior change syntheses suggest interventions emphasizing one behavior more effectively change outcomes than those which encourage changing multiple behaviors (Conn et al., 2008; Conn, Hafdahl, Cooper, Ruppar et al., 2009; Conn, Valentine, & Cooper, 2002). No previous moderator analyses have examined sample, design, and intervention characteristics among primary studies targeting healthy adults.

This meta-analysis synthesized anxiety outcomes in studies designed to increase PA among healthy adults because many people without diagnosed anxiety experience anxiety symptoms. The research questions were: (1) What are the overall effects of interventions to increase PA on anxiety outcomes? (2) Do intervention effects on anxiety outcomes vary depending on intervention, sample, or methodology characteristics?

Methods

Sample

Inclusion criteria—English-language reports of interventions designed to increase PA among healthy subjects aged 18 years and older were eligible. Studies of subjects who had anxiety disorders or who scored above a criterion value on an anxiety measure indicating significant anxiety were excluded. Only primary studies which excluded adults with emotional, mental, or physical illnesses were included in the meta-analysis. Diverse interventions designed to increase PA were included (e.g. supervised exercise sessions, educational or motivational sessions to encourage increased PA). Studies with anxiety measured immediately after acute exercise sessions were excluded. Since the focus was on PA interventions, studies were excluded if they used interventions designed to directly alter anxiety such as relaxation training, stress management sessions, and the like.

Both published and unpublished studies were included because the most consistent difference between published and unpublished research is the statistical significance of the findings (Conn, Valentine, Cooper, & Rantz, 2003; Rothstein & Hopewell, 2009). Meta-analyses limited to published research may over-estimate effect sizes (ESs) or report distorted moderator analyses (Conn, Valentine et al., 2003; Rothstein & Hopewell). Inclusion criteria based primary study quality measure scores were not used because existing scales lack validity evidence, mix study quality with report quality, and contain items not applicable to these studies. Primary study quality was addressed by examining specific quality features in the moderator analyses.

Small sample studies were included because although they may lack statistical power to detect treatment effects, they can contribute to synthesis findings across studies. ESs were weighted so larger sample studies had proportionally more impact in ES calculations. The project focused on two-group comparisons between treatment and control groups because these provide the most valid estimates of ES. Single-group pre-post comparison ESs for both treatment and control subjects were calculated to supplement two-group findings and should be interpreted very cautiously given potential confounding variables in these designs.

Primary study search strategies—Comprehensive extensive search strategies were employed to avoid bias and move beyond previous reviews (Conn, Isaramalai et al., 2003). An experienced health sciences reference librarian used broad search terms in 11 computerized databases (e.g. MEDLINE, EMBASE). Several research registers were searched, such as the National Institutes of Health Computer Retrieval of Information on Scientific Projects and mRCT which includes 14 active registers and 16 archived registers. Computerized authors searches were completed for principal investigators located through research registers and for the first three authors of all eligible studies. Hand searches of 114 journals were conducted. Ancestry searches of all eligible studies and previous review papers were completed. These diverse comprehensive search strategies are essential because no single search mechanism locates most studies and because different mechanisms exhibit varied patterns of bias.

Data Coding and Analysis

Data coding—A coding frame to assess characteristics of sources, participants, methods, and interventions as well as primary study results was developed from previous meta-analyses, reviews of extant primary studies, and experts in both meta-analysis and content. The coding frame was pilot tested with 20 primary studies and revised to ensure comprehensive replicable coding. Code revisions generally focused on providing more definitions, examples, and non-examples of when specific values should be recorded.

Data extraction included 187 variables in addition to effect size information. Many coded variables were inadequately reported for analysis. Source characteristics coded included publication and funding status as well as dissemination year. Sample mean age and gender distribution were coded as participant characteristics. Subject allocation and the time interval between intervention and outcome assessment were coded as research methods. Intervention features coded included behavior target, social setting, worksite linkages, supervised PA characteristics (i.e. form, intensity, and dose), and location of PA following the intervention. Anxiety outcome data for calculating the *d*-index of ES was extracted from diverse established and investigator-developed anxiety measures. Direction of effect was coded to manage measures where higher or lower scores may represent better anxiety outcomes. Pre- and post-interventions means and measures of variability were coded when available. Other statistics that could be converted to *d*-index were coded when means and measures of variability were not available.

To establish reliable coding, two extensively trained coders independently coded every variable from every study (Orwin & Vevea, 2009). A third doctorally prepared coder verified all ES data. After coding errors were corrected, remaining discrepancies among coders were resolved by the principal investigator or by contacting corresponding authors for clarification.

When multiple papers reporting on the same subjects were available, all reports were used to comprehensively code data for the meta-analysis. Redundant data, from multiple reports about the same subjects, was prevented by careful examination of all studies with even one shared author. Corresponding authors were contacted when necessary to clarify potentially overlapping samples to preserve statistical independence.

Analysis—A standardized mean difference (*d*) was calculated for each comparison (Raudenbush, 2009). For two-group comparisons, this represented the post-intervention difference between treatment and control subjects divided by pooled SD. For single-group pre-post comparisons, the *d* was calculated as the difference between pre- and post-intervention scores divided by pre-intervention SD. Pre-post ES calculations require pre-post correlations not reported in primary studies. These were analyzed under assumptions of no ($\rho_{12} = 0.0$) and high association ($\rho_{12} = 0.8$). All ESs were calculated such that a positive ES indicates a better anxiety outcome. ESs were adjusted for bias. ESs were weighted by the inverse of within-study sampling variance to provide more influence to larger studies. ESs were not weighted by quality scores because existing quality instruments lack accuracy and experts disagree regarding appropriate dimensions of quality. To indicate the range of plausible values for mean ESs and to test if ESs differ significantly from 0, 95% confidence intervals were constructed. Externally standardized residuals and graphical examination were used to detect potential outliers. Plots of ESs against sampling variance were used to assess possible publication bias.

Heterogeneity was assessed with *Q* statistic. *Q* was calculated from weighted sum of squares (chi-squared distribution) to determine whether studies' true ESs were very similar or contain significant differences. I^2 was calculated as a measure of the percentage of total variation among observed ESs that is due to heterogeneity rather than sampling. Heterogeneity was expected because it is common in behavioral sciences and in studies with diverse interventions and methods. Four strategies were used to address heterogeneity. First, a random-effects model was used because it assumes both subject-level sampling error and additional sources of study-level error. Second, both a location parameter and measure of variability were reported. Third, potential sources of heterogeneity were examined via moderator analyses. Lastly, findings were interpreted in light of heterogeneity.

Exploratory moderator analyses were conducted (Wood & Eagly, 2009). Continuous potential moderators were analyzed using unstandardized regression slopes in a meta-analytic analogue of regression. Dichotomous moderators were tested by between-group heterogeneity statistics ($Q_{between}$) using a meta-analytic analogue of ANOVA. Moderator analyses should be considered hypothesis generating. Study quality attributes adequately reported (e.g. random allocation) were considered with moderator analyses to make the relationship between primary study quality and ESs an empirical question (Conn & Rantz, 2003).

Results

Nineteen primary study reports were eligible for inclusion in the meta-analysis (Goodrich, 2004; Hudson, 1991; Kerr & Vos, 1993; Kinmonth et al., 2008; Kubitz & Landers, 1993; Lobitz, Brammell, Stoll, & Niccoli, 1983; Long, 1983; Maloney, Cheney, Spring, &

Kanusky, 1986; McDowell, Black, & Collishaw, 1988; McGlynn, Franklin, Lauro, & McGlynn, 1983; Nelson et al., 1984; Nieman, Custer, Butterworth, Utter, & Henson, 2000; Penny & Rust, 1980; Peterson, 1993; Sherman, Clark, & McEwen, 1989; Steptoe, Edwards, Moses, & Mathews, 1989; Stone, Rothstein, & Showenhair, 1991; Vazquez, Alcon, & Alvarez, 1994; Walker, 1984). The experimental versus control analyses included 15 comparison groups comprised of 2,786 subjects. The treatment group pre-post comparisons from 17 samples included 1,312 subjects. The control subjects' pre-post analyses included 1,279 subjects in 8 comparisons. Further information about two-group comparisons is provided in Table 1.

The earliest study was published in 1983, the most recent in 2008. Four dissertations were included, and the other reports were published articles. Ten of the 19 reports indicated some funding for the research. Mean sample ages ranged from 21 to 71 years, with most papers (*s* = 10) reporting mean ages in the third or fourth decade (*s*: number of reports, *k*: number of comparisons). Only two papers reported samples' ethnic or racial composition. Most studies included both women and men, four samples were exclusively female, and two included only men. Only two papers focused on overweight subjects. Theoretical frameworks for interventions were infrequently reported, and evidence of strong implementation of theories in interventions was generally missing.

Effect of Interventions on Anxiety Outcomes

Table 2 shows the effect of PA interventions on anxiety outcomes. The overall effect of PA interventions on anxiety outcomes in two-group studies was .219. Single group pre-post analyses should be viewed cautiously, as ancillary data to two-group findings, given potential significant confounding variables in single group studies. The treatment group pre-versus post-test ESs were .288 (ρ_{12} = 0.8) and .284 (ρ_{12} = 0.0), respectively. The ESs for two-group comparisons and for single-group comparisons under the high association assumption demonstrated significant heterogeneity (*Q* in Table 2). The I^2 also documents significant heterogeneity. Although effects were variable, interventions to increase PA on average resulted in statistically significant improved anxiety outcomes among healthy adults. In contrast, control subjects did not experience improvement as indicated by ESs from .005 to .048, which were not significantly different from 0. *Q* statistics were smaller for control subject pre-post comparisons than for experimental pre-post comparisons or for experimental subjects compared to control subjects.

No studies were excluded as statistical outliers for either two-group or single-group pre-post analyses. One primary study included a significantly larger sample than the other studies. The ESs were calculated excluding the one large sample study to determine the impact of the study on overall findings. Excluding the large-sample study had little impact on findings. The results were similar for both two-group (ES = .272, SE = .102) and pre-post analyses, and subsequent analyses included all studies. Examination of funnel plot symmetry suggested possible publication bias for the two-group comparison and the treatment group pre-post comparison.

Exploratory Moderator Analyses

Tables 3 and 4 display dichotomous and continuous moderator analyses. Both year of publication and sample size were significant predictors of anxiety ESs (Table 3). The magnitude of their effects, reflected in the slope in Table 3, were very modest. Nevertheless, the findings indicate that more recently distributed studies and studies with larger samples reported slightly larger anxiety improvement outcome ESs. The difference in ESs between unpublished reports (−.058) and published papers (.281) did not achieve statistical significance. The anxiety ESs of unfunded and funded studies were similar.

Allocation to treatment and control groups was a statistically significant moderator. Studies with random assignment of subjects reported significantly larger ES (.532) than studies without random assignment (−.071). The difference in ES based on the timing of the anxiety outcome measurement, less than 90 days (.160) versus more than 90 days (.323), was not statistically significant.

Neither sample mean age nor the proportion of women in the sample predicted anxiety outcomes. Other interesting sample characteristics, such as ethnicity and socioeconomic status, could not be analyzed because they were inadequately reported in the primary studies.

Interventions that targeted only PA behavior were significantly more effective in reducing anxiety (.454) than interventions that attempted to change PA plus other behaviors, such as diet (−.011). Interventions delivered to groups were significantly less effective (−.040) than interventions delivered to individuals (.408). There were no differences in anxiety outcomes between worksite-linked interventions and those not associated with workplaces.

Interventions with supervised PA reduced anxiety more effectively (.472) than interventions without supervised PA (−.093). Outcomes were similar between studies that focused exclusively on endurance PA and those that included resistance or flexibility PA. The intensity of supervised PA was important. Studies with moderate or high-intensity PA reported larger anxiety ESs (.452) than studies with lower-intensity exercise (.106). Neither the weekly dose of supervised PA nor the total dose of PA (minutes of supervised PA over the entire intervention) were related to outcomes. Some studies made recommendations regarding PA after the interventions were completed. Studies that recommended PA based at fitness centers reported larger ESs (.472) than studies that encouraged home-based PA (−.093). Too few studies reported recommended PA dose or intensity following interventions to conduct moderator analyses. Moderator findings should be considered cautiously when *k* values were small (Tables 3 & 4).

Discussion

This synthesis documented that interventions to increase PA reduce anxiety in healthy subjects. The magnitude of the effect (.219) may be slightly smaller than the values reported in meta-analyses including subjects with clinical anxiety disorders (.36 to .48; Long & van Stavel, 1995; Petruzzello et al., 1991; Wipfli et al., 2008). Anxiolytic effects may be more pronounced in clinical or subclinical populations (Salmon, 2001). Nevertheless, these findings document that even healthy adults experience reduced anxiety following diverse unsupervised and supervised PA interventions (Table 1). The clinical importance of the ES is difficult to assess given the absence of gold standard measures or criterion values for anxiety.

Heterogeneity was expected given the nature of the phenomenon and because heterogeneity is common in previous meta-analyses of PA and mental health outcomes (Long & van Stavel, 1995). The heterogeneity documents that some interventions are more effective than others (i.e. supervised PA, moderator or high intensity PA, interventions delivered to individuals, recommendations to exercise at a fitness center, interventions that target PA behavior exclusively). The presence of a supervised PA component of the intervention appears important. Supervised PA may provide subjects with explicit guidelines for exercise intensity, duration, and frequency. Supervised PA may also be associated with social affirmation from others exercising at the same time or from research staff supervising the PA. Recommendations to continue exercise at a fitness center may also be effective because they provide social interaction or because participants continue a pattern of exercise behavior established during the intervention. Although exercise dose was unrelated to anxiety ES, PA intensity was important. Low intensity PA may provide insufficient exercise stimulus for anxiety improvements.

Interventions that targeted only PA behavior resulted in better anxiety outcomes than interventions targeting multiple health behaviors. These results are consistent with meta-analyses findings that interventions targeting only one health behavior result in greater changes in that health behavior (Conn et al., 2008; Conn, Hafdahl, Cooper, Ruppar et al., 2009; Conn, Valentine, & Cooper, 2002). It may be easier for individuals to change a single health behavior than to change multiple behaviors simultaneously. Health care providers often suggest that clients work on multiple health behaviors, though sequential efforts to change individual behaviors might be more effective.

The much larger ES among studies with random assignment than in projects using non-random assignment counters common beliefs that studies without random assignment will have inflated ESs due to subject self-selection bias or investigator bias. It is possible that random assignment is a proxy measure of other aspects of interventions or study quality that would result in better outcomes but that were not stated in reports. Many important study quality characteristics, such as treatment fidelity, were too infrequently reported to be analyzed as potential moderators of ESs. When more primary research accumulates, further examination of primary study quality moderators will be possible (Conn & Rantz, 2003).

Identifying whether subject attributes distinguish outcomes is a valuable aspect of meta-analysis. Findings suggest interventions are equally effective across ages and both genders. We were unable to examine important potential moderators, such as ethnicity and economic status, because they were poorly reported. This is the first reported moderator analysis for anxiety outcomes of PA interventions conducted with healthy adults. All of the moderator analysis findings should be viewed as hypothesis-generating, given the small sample size and absence of clear rationale for suggesting findings a priori, and examined in subsequent randomized controlled trials.

Future research testing PA interventions should measure anxiety outcomes. Work testing the independent and combined effects of PA and specific anxiety reduction strategies (e.g. relaxation training, cognitive behavioral training) would be informative (Long & van Stavel, 1995). The neurobiological mechanisms for the effect of PA on anxiety are not known (Arent et al., 2000; Deslandes et al., 2009). Continued research on mental health outcomes is important. Although health care providers emphasize physical health benefits of PA, mental health benefits may provide more motivation to increase PA as well as improved quality of life.

In summary, the findings reveal that diverse interventions to increase PA among healthy adults result in reduced anxiety. Interventions were most effective when they included supervised PA, were delivered to individuals, used moderate or high intensity PA, recommended fitness center based PA following interventions, and focused exclusively on PA behavior. Discovered heterogeneity documents that intervention variations need further exploration in additional primary research.

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Table 1

Treatment and Control Group Comparison Primary Studies

Report	Sample*	Intervention	Outcome Measurement
Hudson (1991)	44 women between 30 and 62 years of age, mean age 44 years	Brisk walking initially three times per week for 20 minutes progressing to five times per week for 50 minutes over 12 months	State Trait Anxiety Inventory 12 months after starting intervention
Kerr & Vos (1993)	139 white-collar bank employees, mean age 39 years	Employee fitness program with onsite fitness facility using professionally trained physical education staff to increase endurance, strength, & flexibility	General Well-Being Questionnaire 'Uptight' factor to measure anxiety 15 months after starting the intervention
Kubitz & Landers (1993)	24 unfit college students, 60% female, mean age 23 years	Eight week aerobic training on cycle ergometer for 40 minutes three times per week at 60% to 85% heart rate reserve	State Trait Anxiety Inventory measured 8 weeks after beginning exercise
Lobitz, Brammell, Stoll & Niccoli (1983)	11 health sciences center volunteers, 50% female, mean age 37 years	Supervised one hour exercise periods on mechanical devices at 75% to 95% of maximum heart rate thrice weekly for seven weeks	State Trait Anxiety Inventory measured seven weeks after beginning exercise
McDowell, Black & Collishaw (1988)	1820 community volunteers, 76% female, mean age 40 years	Community health center health promotion program including personal goal setting, problem solving mutual support, and information in workshops of 15–20 participants and telephone follow up support	General Health Questionnaire Anxiety/Stress measured 18 months after starting the intervention
McGlynn, Franklin, Lauro & McGlynn (1983)	30 undergraduate students	Fourteen week one hour aerobics class twice weekly with unsupervised once weekly jogging session	State Trait Anxiety Inventory administered 14 weeks after beginning intervention
Nelson, McHugo, Schnurr, Devito, Roberts, Simmons, et al. (1984)	241 community dwelling adults, 80% female	Series of group education sessions focused on skills training, role playing, self-contracting, and health education.	Emotional health stress measured one year after beginning intervention
Nieman, Custer, Butterworth, Utter & Henson (2000)	87 overweight women, mean age 46 years	Twelve weeks of 45 minute walking sessions at 60% to 75% maximum heart rate	Profile of Mood States Tension subscale measured three months after starting exercise
Penny & Rust (1980)	24 middle aged women, mean age 43 years	Fifteen week twice weekly walking-jogging fitness class	Minnesota Multiphasic Personality Inventory Anxiety subscale measured 15 weeks after starting intervention
Peterson (1993)	218 university employees, 62% female, mean age 39 years	Worksite wellness program at major public university including supervised exercise classes	List of 30 physical manifestations of anxiety/stress administered varying lengths of time after starting the intervention
Sherman, Clark & McEwen (1989)	81 employees, 62% female, mean age 34 years	Wellness Council of Tucson information program designed to increase participants' exercise	Six Likert-type questions to measure anxiety & stress three months after completing the intervention
Stone, Rothstein & Shoenhair (1991)	30 male corporate executives, mean age 53 years	Corporate supervised exercise program with individual exercise prescription for 30–60 minutes of aerobic exercise thrice weekly	Psychological profile with anxiety/stress 13 years after starting intervention
Walker (1984)	37 middle-class volunteers between 21 and 45 years of age, mean age 31 years	Eight week thrice weekly aerobic physical fitness program designed to achieve target heart rate	Anxiety/stress physical and emotional symptom checklist measured after completing the supervised exercise sessions

* Sample sizes reflect the number of subjects included in the outcome analysis

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Table 2

Random-Effects Anxiety Symptom Outcome Estimates and Tests

Comparison	***k***	**Effect size**	**p (ES)**	**95% Confidence interval**	**Standard error**	I^2	Q	**p (*Q*)**
Treatment vs. control groups at post-test	15	.219	.022	.032, .407	.096	56.457	32.152	.004
Treatment group pre- vs. post-test (.80 correlation)	17	.288	.000	.175, .400	.057	44.791	71.650	.000
Treatment group pre- vs. post-test (0 correlation)	17	.284	.000	.175, .393	.056	14.179	18.644	.288
Control group pre- vs. post-test (.80 correlation)	8	.048	.532	-.102, .197	.076	77.669	14.345	.045
Control group pre- vs. post-test (0 correlation)	8	.005	.926	-.109, .119	.058	51.202	3.137	.872

k denotes number of comparisons, *Q* is a conventional homogeneity statistic, I^2 is the percentage of total variation among studies' observed ES due to heterogeneity

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Table 3

Continuous Moderator Results for Anxiety Symptoms: Treatment vs. Control at Outcome

Moderator	*k*	Slope	Standard Error	Tau^2	Q_{model}	p (slope)
Report and Methods Moderators						
Year of publication	15	.032	.012	.047	6.367	.012
Sample size	15	.000	.000	.047	10.321	.001
Sample Attribute Moderators						
Age	9	−.000	.005	.073	.015	.904
Percent women	11	.005	.004	.048	1.749	.186
Intervention Feature Moderators						
Dose of supervised PA (minutes per session times number of sessions)	9	−.000	.000	.000	.039	.843
Minutes of supervised PA per week	9	.003	.003	.000	.976	.323

k denotes number of comparisons, *Q* is a conventional homogeneity statistic, Tau^2 is the between-study variance

Table 4

Dichotomous Moderator Results for Anxiety Symptoms: Treatment vs. Control at Outcome

Moderator	***k***	**Effect size**	**Standard error**	$Q_{between}$	p ($Q_{between}$)
Report Moderators					
Publication status				2.321	.128
Unpublished (e.g. dissertation, presentation)	2	−.058	.194		
Published article	13	.281	.111		
Presence of funding for research				.095	.758
Unfunded	7	.260	.145		
Funded (any funding reported or acknowledged)	8	.198	.138		
Research Methods Moderators					
Allocation to treatment and control groups				21.229	.000
Random assignment	7	.532	.119		
Not random assignment	8	−.071	.055		
Outcome measure in relationship to supervised PA				.484	.487
Outcome measured > 90 days after intervention completed	4	.323	.208		
Outcome measured < 90 days after intervention completed	10	.160	.107		
Intervention Feature Moderators					
Target behaviors				10.502	.001
Target PA plus other behaviors (e.g. PA + diet)	6	−.011	.092		
Target PA behavior change exclusively	9	.454	.110		
Social setting for intervention delivery				4.841	.028
Delivered to individuals	7	.408	.195		
Delivered to groups	8	−.040	.059		
Worksite interventions				.020	.887
Intervention not linked with subjects workplaces	10	.215	.126		
Worksite intervention	5	.247	.183		
Supervised PA component of intervention				22.588	.000
Intervention did not include supervised PA	5	−.093	.057		
Intervention included research staff supervised PA	10	.472	.105		

Moderator	*k*	Effect size	Standard error	$Q_{between}$	p ($Q_{between}$)
Supervised PA exercise form				.042	.837
Supervised PA included only endurance PA	7	.452	.143		
Supervised PA included both endurance PA plus resistance/flexibility PA	3	.496	.154		
Flexibility exercise component of supervised PA				.042	.837
No flexibility exercise in supervised PA	7	.452	.143		
Flexibility exercise included in supervised PA	3	.496	.154		
Supervised PA intensity				3.905	.048
Low intensity PA	8	.106	.102		
Moderate intensity PA	7	.452	.143		
PA location after intervention completed				22.588	.000
Home based PA	5	−.093	.057		
Fitness center based PA	10	.472	.105		

k denotes number of comparisons, *Q* is a conventional homogeneity statistic