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Dyadic Interventions to Promote Physical Activity and Reduce Sedentary Behaviour: Systematic Review and Meta-Analysis

Carr, R.M[1]., Prestwich, A[2]., Kwasnicka, D[1]., Thøgersen-Ntoumani, C[1]., Gucciardi, D.F[1]., Quested, E[1]., Hall, L.H[2]., & Ntoumanis, N[1].

[1]Curtin University, Perth, Western Australia

[2]University of Leeds, UK

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Abstract

Several interventions have targeted dyads to promote physical activity (PA) or reduce sedentary behaviour (SB), but the evidence has not been synthesised. Sixty-nine studies were identified from MEDLINE, PsycINFO, and Web of Science, and 59 were included in the main meta-analyses (providing 72 independent tests). Intervention details, type of dyadic goal, participant characteristics, and methodological quality were extracted and their impact on the overall effect size was examined. Sensitivity analyses tested effect robustness to (a) the effects of other statistically significant moderators; (b) outliers; (c) data included for participants who were not the main target of the intervention. Dyadic interventions had a small positive, highly heterogeneous, effect on PA g = .203, 95% CI [0.123–0.282], compared to comparison conditions including equivalent interventions targeting individuals. Shared target-oriented goals (where both dyad members hold the same PA goal for the main target of the intervention) and peer/friend dyads were associated with larger effect sizes across most analyses. Dyadic interventions produced a small homogeneous reduction in SB. Given dyadic interventions promote PA over-and-above equivalent interventions targeting individuals, these interventions should be more widespread. However, moderating factors such as the types of PA goal and dyad need to be considered to maximise effects.

Keywords: Randomised control trials, Dyads, Transactive Goal Dynamics Theory, Interventions; Systematic Review; Meta-Analyses

Regular Physical Activity (PA) is associated with reductions in the risk of chronic diseases (e.g., diabetes, overweight and obesity, bone and joint diseases, certain types of cancer) and improvements in mood and well-being (Craft & Perma, 2004; Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010; Warburton, Nicol, & Bredin, 2006). There is also a positive association between Sedentary Behaviour (SB) (defined as sitting or lying down, except when sleeping; Department of Health, 2017b) and the risk of chronic disease and obesity (Department of Health, 2017a). Current public health recommendations specify that adults should achieve 150 minutes of moderate (e.g., walking) or 75 minutes of vigorous PA (e.g., running) per week (World Health Organization, 2010). SB guidelines suggest minimizing the amount of time in prolonged sitting and breaking up long periods of sitting as often as possible (Department of Health, 2017b). However, worldwide 31.3% of adults have been classified as physically inactive (Hallal et al., 2012). Furthermore, 2 in 3 children and 5-17 year olds have 2 or more hours of screen-based entertainment every day (Department of Health, 2017a). The National Health Survey found that watching television was the most prevalent SB and, on average, adults watch close to 13 hours of television per week, peaking at 19 or more hours per week for people aged 75 and over (Department of Health, 2017a). Interventions aimed at fostering and sustaining adequate levels of PA, as well as reducing SB, are thus key public health priorities.

Individuals often attempt to change their health behaviours, such as PA and SB (or refrain from doing so), while being embedded in social networks comprising, amongst others, friends, romantic partners, and family (Scholz & Berli, 2014). However, interventions to promote PA and/or reduce SB are typically focused on individuals or groups. Given that there is both theoretical (e.g., Lewis et al., 2006) and empirical evidence (e.g., Arden-Close & McGrath, 2017) highlighting the

role of others in influencing an individual's behaviour, including their level of PA, there is a need to consider, systematically, the potential impact of dyadic interventions to promote PA and reduce SB.

Dyads are defined as two individuals (such as husband and wife, or two friends) maintaining a socially significant relationship ("Dyad," n.d.). Although there are several group-based interventions to promote PA (e.g., Leahey et al., 2010; Leahey, Kumar, Weinberg, & Wing, 2012), only a subset of these target dyads. There has been some evidence suggesting that interventions targeting the promotion of PA through dyads can be effective (e.g., Castro, Pruitt, Buman, & King, 2011; Prestwich et al., 2012; Winters-Stone et al., 2016). However, other randomised controlled trials indicate that dyadic-based interventions have little influence on PA (Boutelle, Norman, Rock, Rhee, Crow, 2013; Brown et al., 2015; Burke et al., 1999). One potential reason for the inconsistency of these findings is that the nature of the dyadic intervention, and in particular the goals held by each member of the dyad, can vary across interventions. Our review addresses this possibility by systematically categorising and synthesising the different types of PA goals and their effects on PA levels. In addition, studies have flagged the impact that dyadic relations can have on sedentariness. For example, data from 431 parent child dyads shows that parents can have a significant influence on the amount of television viewed by their children (Jago et al., 2011) and that mother's SB is strongly associated with father's SB (Wood, Jago, Sebire, Zahra, & Thompson, 2015). This has led to calls for and applications of dyadic interventions to reduce SB (e.g. Ostbye et al., 2012), but there has been no synthesis of the available empirical evidence. There is some evidence from two family-based treatments that targeting dyads can be effective in reducing SB (Epstein, Paluch, Kilanowski, & Raynor, 2004). However, there was little effect on SB from a randomised controlled trial (see Ostbye et al., 2012).

Transactive Goal Dynamics Theory

Numerous theoretical approaches have been applied to dyadic interventions (see Table A1, Supplementary Materials 1). However, none of the applied theoretical approaches were developed explicitly for dyads. In this review we use the Transactive Goal Dynamics theory (TGD), which; Fitzsimons, Finkel, and vanDellen (2015), applied specifically to dyads. Alas, this theory can be used to explain the types and processes by which PA and SB goals in dyad members are set and pursued. As such, it provides a useful framework within which to synthesise the existing literature.

TGD theory adopts a relational perspective on "self-regulation". Rather than conceptualizing a given pair of individuals as two independent self-regulating agents, the theory identifies the dyad as the regulating unit, with the partners as subunits of a single system of goal dynamics, a system in which resources are shared. According to TGD, dyadic goal pursuit should become more effective with increasing levels of transactive density (the extent to which the dyad members' goals, pursuits and outcomes are linked) as long as there is sufficient goal coordination (the extent to which the dyad members' goal pursuits facilitate each other). For example, if one dyad member is aiming to run a marathon and their partner wants to lose weight, these goals are linked (thus they have high transactive density) and the dyad members can run together to fulfil both their goals (good goal coordination). Fitzsimons et al. (2015) identified seven types of dyadic goals: 1) shared system-oriented goals (both members have the same goal for their own and for their partner's outcomes; for example, if the goal is to increase PA, both dyad members want for themselves and for each other to increase their PA); 2) shared target-oriented goals (both dyad members have the same goal for one person in the dyad); 3) system-oriented goals (one dyad member has the same goal for their own and their partner's outcomes); 4) parallel self-oriented goals (both dyad members have the same goal for themselves); 5) parallel partner-oriented goals (both dyad members have the same goal for

their partner's outcomes); 6) partner-oriented goals (one dyad member has a goal for their partner, their partner does not have a goal for themselves); 7) self-oriented goals (one dyad member has a goal for themselves).

According to the TGD theory, dyads sharing goals for the same target dyad member (shared system-oriented and shared target-oriented goals) should have a smooth division of goal-related effort, because both dyad members should be motivated to maximise goal-related outcomes, and thus, they are more likely to effectively divide goal-related effort. Coordination is easier when dyads agree about the desired outcomes for each partner. In line with TGD theory, interventions that encourage dyads to create shared system-oriented and shared target-oriented type-goals should be more effective in increasing PA than interventions that encourage dyads to create parallel self-oriented, parallel partner-oriented, system-oriented, partner-oriented, or self-oriented type-goals.

TGD theory also indicates that the extent to which dyads are dedicated to the relationship can also influence goal coordination, with stronger dedication enhancing goal coordination. Given that under high levels of goal coordination transactive density improves goal outcomes (Fitzsimons et al., 2015), stronger relationship dedication should also increase goal outcomes. According to the TGD theory, a dense transactive system (e.g., developed after many years of marriage), results in the dyad's goals and pursuits being interdependent. In such a system, there are diverse, frequent, and strong effects of dyads on each individual's goals, pursuits, and outcomes. Thus, interventions that target dyads with a strong bond, that is a dense transactive system (e.g., close family members, very close friends), are more likely to be effective than dyads with a weaker bond (e.g., work colleagues), as long as goal coordination is sufficient. In corroboration of this hypothesis, there is evidence suggesting that a person's PA is associated with close others (i.e. their romantic partners and best friend's) PA though this relation may vary depending on perceived support (Darlow & Xu,

2011). Such evidence is in line with research showing that health behaviours are concordant across couples (Arden-Close & McGrath, 2017) and if a partner adopts a healthier behaviour, the other partner is more likely to make a positive health behaviour change (Jackson, Steptoe, & Wardle, 2015).

The Present Review

The overarching goal of this study was to conduct the first systematic review and meta-analysis of dyadic interventions aiming to increase PA via a randomised controlled trial design on PA and SB outcomes. We tested the effect of dyadic interventions against different types of control conditions including, importantly, interventions utilising the same behaviour change techniques (Michie et al., 2011) but focusing on individuals as opposed to dyads. We also examined the type of goals manipulated within the intervention (using TGD theory to categorise such goals) as well as the type of relationship between the dyad members. In keeping with the basic tenets of TGD, we hypothesised that: 1) dyadic interventions would increase PA and reduce SB more than non-dyadic interventions; 2) dyadic interventions will be most effective if dyads have the same goal for the same target dyad member (shared system-oriented and shared target-oriented goals); and 3) dyadic interventions targeting dyads with a close bond (e.g., long-term partners, close friends) would yield larger effects than interventions targeting dyads with weaker bonds (e.g., participants assigned a role model). There is a risk that the effects of seemingly important moderators may be confounded (Peters, de Bruin, & Crutzen, 2015), thus we adopted an approach used in recent reviews (e.g., Caperon et al., in press; Prestwich et al., 2014, 2016) to address this issue. Specifically, the robustness of these moderator effects was examined via a series of sensitivity analyses which a) controlled for the effect of any other moderator significantly influencing the overall effect size; b)

removed study outliers; and c) combined the effect sizes for the participants who were the main target of the intervention with the effect sizes for their study partner (if available).

Method

We conducted a systematic search across three databases MEDLINE, PsycINFO, and Web of Science (limited to studies published from 1996 onwards as that was the earliest date available in the Medline database). The review protocol was published in the International Prospective Register of Systematic Reviews, and can be accessed from http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016038231.

Inclusion and Exclusion Criteria

Patient, population or problem. Studies were included if they tested a dyadic intervention to increase PA. Studies were excluded if one member of the dyad was a health professional instructing the other member. There were no restrictions on the age of the participants, setting, or location of the study.

Intervention or exposure. Studies were included if they randomised participants to an experimental group or a control group. Systematic reviews of randomised trials are the 'gold standard' for judging whether a treatment does more good than harm (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996).

Comparison. The only restriction was that the comparison could not be an equivalent dyadic intervention aimed at PA promotion. Dyadic interventions in which the comparison group(s) were allocated to another dyadic intervention (not focused on PA) were included.

Outcome. Studies were included if they assessed PA post-intervention. Studies which measured SB in addition to PA were also included. Studies were excluded if relevant PA outcome data were not reported for the target individuals in the dyad and corresponding

authors did not respond to two requests for further information. If studies did report outcome data but did not report relevant statistical information to calculate effect sizes, they were included in the qualitative synthesis but not in the meta-analysis. The included studies had to have a quantitative methodology.

Studies were only included if they were published in the English language.

Search Strategy

A search strategy was developed, with three groups of search terms based around a) randomised controlled trials (Baker, Francis, Soares, Weightman, & Foster, 2015); b) dyads (Brandão, Schulz, & Matos, 2014; Park, Tudiver, & Campbell, 2012); and c) PA (Baker et al., 2015); see Supplementary Material 2. The search was conducted by the lead author between May 26th 2016-June 2nd 2016 and updated on December 7th 2017. Additional studies were identified via searches of reference lists of included studies and from reading journal articles. The 'grey' literature search included contacting the corresponding authors of included studies for any unpublished data on the same topic (no additional studies were identified) and through locating full texts of dissertation abstracts listed in the databases (six additional studies were found).

Data Extraction

The type of dyad for each study was coded into 6 different types – parent and child, peers/friends, romantic couples, participant and any significant other (i.e., no set criteria for who that significant other had to be), participant and a personal carer, or participant and a confederate. The types of goals were coded according to the TGD theory. As none of the goals reported in the studies were explicitly categorised using the TGD framework, two coders reached a consensus on which types of goals were employed based on the information

presented in the text. For instance, when the text suggested that both dyad members had the same goal but they were not interdependent and each partner was not requested to support the other, the type of goal was coded as 'parallel self-oriented'. Both the type of dyad and type of goals analyses were pre-specified in the review protocol. The major theory underpinning each study, the type of control group, duration of intervention delivery and follow-up, type of PA – strength, walking, bike or any activity (i.e., no mention of a specific PA), were coded for each study. Some samples engaged in more than one type of exercise (e.g. aerobic-strength) and were allocated into a 'combined PA' group. Measures of physical functioning (e.g., difficulties in bathing/showering), mobility (e.g., gait), fitness (e.g., $\dot{V}O_{2max}$) and light PA were not coded. SB (e.g., time spent watching screens/sitting) was included as a secondary outcome measure.

Two raters judged the methodological quality of the included studies as either high/unclear (1) or low bias (2) on seven dimensions of bias (Higgins et al., 2011; see Figure A1, Supplementary Materials 3). Studies rated as having 'high' or 'unclear' bias were combined into one category and then compared with the 'low' category, as described in the Cochrane Collaboration guidelines (Higgins & Green, 2011). A random number generator was utilized to select 40% of the studies (24 studies) from the initial search for double coding for the risk of bias (non-blind). Following the example of Kwasnicka, Presseau, White and Sniehotta (2013), the first 20% of coding was deemed appropriate as a test round to operationalise and check consistency in applying the criteria. Following the test round, agreement between two coders on the next 20% of studies was almost perfect (Cohen's Kappa = .82). With regard to the coding of moderators, the moderators of the type of goal and type of dyad were double-coded by a second reviewer (who was not blinded to the first author's

judgements), as we had specific hypotheses for those and they were of central focus to the study. All other moderators were coded by one reviewer.

Meta-Analysis Strategy

Effect sizes (Hedges's *g*) for a random-effects model were calculated for each study using the Comprehensive Meta-Analysis Software (Version 3, Borenstein, Hedges, Higgins, & Rothstein, 2015). Wherever possible, the effect sizes were calculated based on the post-baseline means and standard deviations rather than scores reflecting change from baseline to follow-up, as the latter are not independent of each other (Cuijpers, Weitz, Cristea, & Twisk, 2017). When authors did not report analyses accounting for clustering either within the dyad or within larger clusters (i.e., within cluster randomised controlled trials), corrections were applied by calculating effective sample sizes (when effect sizes were based on means and standard deviations or proportions) or inflating standard errors of the effect sizes (e.g., when effect sizes were based on *p*-values) based on the larger cluster (see Higgins & Green, 2011). The moderator analyses were conducted using meta-regression in STATA (Version 13.1, Statacorp, 2013). The I^2 statistic was used to describe the percentage of variation across studies attributable to heterogeneity rather than chance.

Dealing with multiple intervention groups. If studies included multiple dyadic interventions for PA, all such interventions were included in the analysis. To ensure independence of participants, the number of intervention group participants was divided by the number of interventions (Borenstein, Hedges, Higgins, & Rothstein 2009). This method was also applied when two comparison groups (e.g., an individual-level intervention and a standard control group) were included in the same study.

Sensitivity Analyses. Sensitivity analyses were conducted to establish the degree to which the key findings were robust when (a) significant moderators were co-varied; (b) outliers were removed; and (c) data were included for participants who were not the main target of the intervention. The Sample-Adjusted Meta-analysis Deviance (SAMD) statistic (Huffcut & Arthur, 1995) was calculated to produce a scree plot which was used to detect outlier studies. Egger, Smith, Schneider, and Minder's (1997) test of funnel plot asymmetry and trim and fill analyses assessed publication bias.

Results

In total, 14,532 studies were identified via the search terms, of which 413 were full-text screened. Of these, 69 studies were eligible, with 65 studies initially included in the meta-analysis (k = 82 comparisons, see Figure 1). Throughout this paper k refers to the number of comparisons. The studies by Boutelle et al. (2013), Holthoff et al. (2015) and Tymms et al. (2016) were not meta-analyzed, as they did not provide sufficient statistical information to allow their inclusion. The study by Gunnarsdottir, Sigurdardottir, Njardvik, Olafsdottir, and Bjarnason (2011) was not meta-analyzed as the authors pooled data from two independent groups to increase statistical power and we did not have the data from each group.

Of the 65 included studies, 16 targeted participants with a current or previous health issue, such as significant cardiac event (Sher et al., 2014), osteoarthritic knee pain (Keefe et al., 2004), breast cancer (Demark-Wahnefried et al., 2014), stroke (Kim, Lee, & Kim, 2013) or any type of cancer except squamous or basal cell skin cancers (Kamen et al., 2016); the other 49 studies targeted participants without any history of significant illness. Forty-four studies targeted healthy weight participants and 21 studies recruited overweight or obese participants. The majority of comparisons (k = 38) targeted parent-child dyads and were conducted in the USA (k = 54). The most common type of comparison group comprised of

no-intervention or minimal intervention (e.g. received a book/newsletter; $k = 26$). The median intervention duration of the 65 studies was 84 days, hence, intervention duration of 84 days or longer was classified as "longer", whereas duration of less than 84 days was deemed as "shorter". The majority of studies had low risk of bias relating to random sequence generation (62%) and incomplete outcome data (83%). Most studies had high or unclear risk of bias pertaining to lack of: allocation concealment (72%), blinding of participants and personnel (97%), blinding of outcome assessors (68%), selective outcome reporting (71%), and other risks of bias (60%) (see Figure A1, Supplementary Materials 3).

Effects of Dyadic Interventions on PA and SB

Comparisons that included a confederate within the dyad for the experimental group (an actor playing the role of an exercise partner) ($k = 10$, $g = 1.05$) produced much larger effect sizes than comparisons that did not use a confederate in the experimental group ($k = 72$, $g = 0.20$), $B = 0.84$, $SE = 0.13$, $t = 6.53$, $p < .001$. The confederate and non-confederate studies were fundamentally different with 5 out of 6 (representing 9 of 10 comparisons) of the former being lab-based studies, and all 6 testing the Köhler effect (i.e., how the presence of a superior partner may increase motivation to exercise). Given the confederate studies also yielded generally homogeneous effect sizes $I^2 = 31.8\%$, $\chi^2(9) = 13.19$, $p = .15$, the 10 confederate comparisons were excluded from all the analyses henceforth.

Following removal of the confederate studies, dyadic interventions were found to have a small positive effect on PA, relative to control groups, $g = 0.20$, 95% CI [0.12 – 0.28], $K = 72$ comparisons (see Figure 2). However, there was significant heterogeneity, $I^2 = 61.5\%$, $\chi^2(71) = 184.20$, $p < .001$, which was further examined (see moderator analyses).

Dyadic interventions targeting PA outperformed comparison conditions which: a) comprised the same intervention techniques but targeted individuals, $g = .17$, $k = 13$, $p = .01$, or b) reflected usual care, $g = .32$, $k = 26$, $p < .001$. Dyadic interventions targeting PA performed marginally better (but the effect was not statistically significant) than comparison groups which were dyadic but not directed at PA, $g = .13$, $k = 14$, $p = .09$. This effect was similar when an extra comparison was added (Spouse assisted pain coping skills training + exercise vs. Spouse assisted pain coping skills training from Keefe et al. 2004, which was omitted from the main analyses because it only reported sufficient statistics to accurately calculate effect sizes for 2 out of 3 outcomes; the effect size for the third outcome was conservatively estimated as $g = 0$), $g = .15$, $k = 15$, $p = .05$. Dyadic interventions were not meaningfully different from waiting list, $g = .09$, $k = 16$, $p = .17$, or miscellaneous, $g = .06$, $k = 3$, $p = .61$, comparison conditions.

Dyadic interventions also had a small positive effect, relative to comparison conditions, on reducing SB (total SB and TV viewing), $g = .19$, 95% CI [0.10 - 0.28], $k = 20$. Dyadic interventions outperformed waiting list, $g = .22$, $k = 7$, $p = .049$, and usual care, $g = .16$, $k = 8$, $p = .006$, comparison groups. Dyadic interventions did not outperform dyadic interventions not directed at PA, $g = .22$, $k = 4$, $p = .17$ or equivalent interventions targeting individuals, $g = .23$, $k = 1$, $p = .17$, but the number of datasets for such comparisons was small. As a consequence, such findings should be interpreted with caution and require more studies for a more precise estimate of the effect sizes. Given the overall effect of dyadic interventions on SB was homogeneous, $I^2 = 19.4\%$, $\chi^2(19) = 23.56$, $p = .21$, no further moderator analyses were conducted for this outcome.

Moderator Analyses

Type of goals. As shown in Table 1, shared target-oriented goals were associated with significantly larger PA effect sizes than studies which manipulated other types of goals. Goals which were shared system-oriented, system-oriented, partner-oriented or parallel self-oriented, yielded similar effect sizes. Parallel partner-oriented goals and self-oriented goals were not manipulated in any dyadic intervention condition.

Type of dyad. In the main analyses, the effect sizes did not significantly vary depending as a function of the type of dyad. Specifically, comparisons that were based on parents and child dyads, couples, participants and their carer/caregiver, or participants and a significant other yielded similar effect sizes. Utilising Cafri, Kromfey, and Brannick's (2009) SAS macro we estimated the power for the type of dyad comparison to be .94. This gives more reliability to our null findings, as high power reduces the probability of accepting a type II error (i.e. accepting a false negative result). Effect sizes were marginally larger when based on peers/friends and significantly larger in several of the sensitivity analyses.

Other moderators. Studies that targeted clinical samples, conducted outside Australia/New Zealand, UK, Germany, US and Canada (labelled as 'other countries' and comprised of studies conducted in Sri Lanka, Israel, Mexico, Korea and Iran, Switzerland, Sweden, Ireland, Finland and the Netherlands), as well as studies that utilised a usual care control group, were associated with larger effects. Studies that assessed PA using objective measures only were associated with smaller effects, as were studies that had a non-blinded outcome assessor or did not specify if this blinding occurred. None of the other moderators were significantly associated with PA effect sizes (see Table 1).

(Please insert Table 1 here)

Sensitivity Analyses

Controlling for the effect of other significant moderators. Shared target-oriented goals produced marginally larger effects than dyadic interventions using other types of goals from the TGD theory, even after controlling for the effects of other statistically significant moderators in a multivariate meta-regression (see Table A3, Supplementary materials 4). Studies that utilised shared target-oriented goals were more likely to be conducted outside the UK, Germany, Australia, New Zealand, United States, and Canada, $\chi^2(1) = 11.37$, Fisher's $p = .002$, and to be used within a greater proportion of studies targeting clinical populations, $\chi^2(1) = 8.08$, Fisher's $p = .01$. A second multivariate meta-regression that co-varied only these 2 potential confounders resulted in a similar effect. Specifically, studies using shared target-oriented goals produced marginally larger effects than studies that used other types of goals (see Table A4, Supplementary materials 4).

Outliers. Based on the scree-plot (see Figure 3), there was clearly 1 extreme outlier. However, it was not clear whether there were 0, 1 or 4 additional outliers (i.e., 1, 2 or 5 outliers in total). Thus, we examined the impact of removing outliers under these three scenarios (see Table 1). Across these 3 scenarios, the results were largely unchanged. In particular, shared target-oriented goals significantly increased effect sizes when the single extreme outlier was removed and when 2 outliers were removed (they marginally increased effect sizes when 5 outliers were removed). Studies that targeted peer/friends produced larger effects than studies targeting different types of dyad across all outlier analyses.

Data based on participants not targeted for behaviour change. The original analysis was based on the effect sizes for participants who were the main target of the intervention (in some instances, both members of the dyad were targeted equally). However, ten studies also reported data regarding the participants partners' levels of PA, despite them

not being the main target of the intervention. When the analyses were conducted including these additional data and comparing the new results to the original effect sizes the results from the moderator analyses remained largely unchanged. Aside from dyadic interventions targeting peers/friends now yielding significantly larger effects, the other non-significant moderators remained non-significant and all of the significant moderators remained significant.

Tests for publication bias. A funnel plot was employed to test for publication bias (see Figure 4). The funnel plot appears only somewhat symmetrical on visual inspection, and the effect sizes from studies with larger standard errors appear only slightly more scattered than for studies with more precise estimates of effect size. However, funnel plots can be interpreted differently by different observers (Villar, Piaggio, Carroli, & Donner, 1997). Consequently, Egger et al.'s (1997) test of funnel plot asymmetry was conducted and indicated a modest risk of publication bias, *Intercept B0* = 0.89, 95% CI [0.08 – 1.71], $p = .03$. However, trim and fill analysis suggested that the effect of dyadic interventions on PA remained significant when accounting for 'missing studies', $g = 0.14$, 95% CI [0.04 - 0.23]. In addition, studies reported within dissertations generated similar sized effects compared to studies published in peer reviewed journals $B = 0.02$, $p = .93$.

Discussion

The overarching goal of this study was, for the first time, to systematically review and meta-analyse dyadic randomised controlled interventions aiming to increase PA or reduce SB. Sixty nine randomised controlled trials were eligible, with 59 studies included in the final set of meta-analyses generating 72 comparisons. Drawing from the TGD theory (Fitzsimons et al., 2015), we hypothesised that people allocated to dyadic interventions aiming to improve

PA will increase PA significantly more than participants not in a dyadic intervention, with similar effects on reducing SB. We found some support for these predictions in that dyadic interventions had on average a small positive effect on PA, and a similar sized, but homogeneous, effect in reducing total SB and TV viewing. Importantly, dyadic interventions outperformed interventions that targeted an individual when these conditions were otherwise matched. In addition, studies testing dyadic interventions targeting clinical populations generated larger effect sizes than studies testing dyadic interventions targeting non-clinical populations.

With regard to the type of goal, although it was predicted that shared goals (shared system-oriented and shared target-oriented) would generate larger effects than non-shared goals, only shared target-oriented goals produced larger effect sizes, compared to non-shared target-oriented goals. This comparison remained significant even after controlling for other significant moderators. This finding was surprising as it was anticipated that these types of goals would be equally beneficial. Our expectation was based on the hypothesis that dyads sharing goals for the same target should facilitate smooth division of goal-related effort as both parties should be motivated to maximise outcomes, and thus, would be more likely to divide the task effectively. However, it appears that setting goals for both partners to increase PA may not always be effective. Possible reasons for this finding are that generating these types of goals may reduce the number of appropriate opportunities to act, or there may be more barriers to performing these activities together rather than alone, or the reason (e.g., a medical necessity) for increasing PA may only apply to one partner (see Benyamini, Ashery, & Shiloh, 2011; Burkert, Scholz, Gralla, Roigas, & Knoll, 2011; Knoll et al., 2017).

As well as proposing that the type of goal could influence dyadic outcomes, the TGD theory also indicates that the type of dyad could also be a contributing factor. It has been suggested by Fitzsimons et al. (2015) that dyads which have a close bond/ high transactive density (e.g., couples) have diverse, frequent, and strong effects on each other's goals, pursuits, and outcomes. Whether these strong effects are positive or negative on goal success is dependent on the level of goal coordination, which itself is influenced by the type of goal and goal responsiveness (Fitzsimons & Finkel, in press). Goal responsiveness is higher when partners provide the appropriate level of support (i.e., high support when in need; low support when there is low need) and when the support is not interpreted as pressurising (cf. Fitzsimons & Finkel, in press). Perceptions of being pressured could be more likely in transactively dense relationships, especially if they are asymmetric (e.g., parents-child). On the basis that transactively dense relationships can promote goal success but also be hindering (e.g., in cases where goal responsiveness is inadequate), it is perhaps not surprising that many of the types of dyads produced similar effects. The exception was peer/friend dyads which yielded larger effect sizes than other types of dyad. It may be that peers/friends, at least in the context of PA, combine both the positive effects of relatively high interdependence with high levels of goal responsiveness. Indeed, sociocultural and communication theories suggest people are more receptive to assistance when it is delivered by someone of a similar age and background (see Castro et al., 2011). Nevertheless, further research is needed to directly measure or manipulate all of these constructs (interdependence, goal coordination, type of goal and goal responsiveness) to establish their direct, moderating, and mediating roles in achieving goal success. In the present review, we only measured the type of goal and inferred interdependence (and varying levels of relationship commitment which can influence goal

coordination, see Tenet 4, Fitzsimons et al., 2015) based on the type of dyad. We assumed that opportunity and motivation (the two key determinants of transactive density, Fitzsimons & Finkel, in press), as well as relationship commitment, were likely to be higher for certain dyads (e.g., romantic couples) than others (e.g., work colleagues).

With regard to romantic couples, there was no main effect on effect sizes (i.e., the magnitude of effects of PA interventions targeting couples were similar in size as those targeting other types of dyads). Perhaps in shorter periods of cohabitation, couples pursue more solo activities and/or their goals are less well co-ordinated and thus, benefit equally from individually tailored interventions as they do from dyadic interventions. As only 13 comparisons in the main analysis involved couple dyads, with little variation in their cohabitation history, we did not test this hypothesis as a moderator. Future studies could explore whether length of cohabitation influences the choice and effectiveness of different types of couples-based interventions for PA promotion.

Regarding the larger effect sizes in studies targeting peer and friend dyads than studies targeting different types of dyad, it should be noted that only six studies (yielding 8 comparisons) targeted peers or friends. In a relatively high proportion of these studies, participants were allocated a PA role model/mentor and the participants were in their mid-50s (Pinto, Stein, & Dunsiger, 2015; Ungar, Sieverding, Weidner, Ulrich, & Wiskemann, 2016) or over 50 years old (Castro et al., 2011). It could be that older participants benefit more from being allocated an exercise partner or mentor; however, this hypothesis warrants further investigation. An alternative explanation is that, as 3 out of the 8 comparisons involved participants setting shared target-oriented goals, the beneficial effects of the peer/friend dyad might have been confounded with the finding that shared target-oriented goals are more

effective than non-shared goals. Regarding the larger effect sizes in studies targeting dyads from clinical populations than studies targeting dyads from non-clinical populations, this seems to be consistent with TGD. In such populations, where there is a clinical need for change, one may expect strong commitment to the PA goal for both dyadic members and, hence, strong goal coordination (see Tenet 4 of the TGD, Fitzsimons et al., 2015) which aids goal success.

It should be noted that six comparisons involved a type of goal which did not fit into any of the TGD categories. The related studies involved one dyad member having a goal for their partner to increase PA, while their partner was aiming to increase their own PA, but not the activity of the other dyad member. There were no differences in effect sizes between this discordant type of dyadic goal and the other types of goals.

There are several ethical and methodological issues to consider when designing and testing dyadic interventions. First, several studies in our review involved asymmetric relationships (e.g. parent-child, participants and a carer) raising issues as to whether both dyad members were equally motivated and engaged in the intervention. While ensuring high goal responsiveness is important, in line with TGD (Fitzsimons et al., 2015; Fitzsimons & Finkel, in press), it is also important to promote amongst both members of a dyad self-determined (autonomous) motivation for activity engagement, by fostering the three needs of autonomy (having choice and pursuing activities that suit one's values), competence (being able to achieve mastery) and relatedness (feeling connected to other people) (Ryan & Deci, 2000). Second, dyads are non-independent. Indeed, health behaviours are concordant across couples (Arden-Close & McGrath, 2017; Jackson et al., 2015). Consequently, analysing the PA or SB data of one dyad member should account for this non-independence and also for partner's

activity. The actor-partner interdependence model (Cook & Kenny, 2005) retains the individual scores of participants, while treating them as being nested in a dyad. This allows for the estimation of both individual and dyadic factors, taking into consideration that each person influences the other. Such analysis should be used wherever possible in dyadic research. However, none of the studies in our review use this approach. We attempted to account for clustering following Cochrane guidelines although there appears to be no definitive rule as how to adjust for clustering in dyadic interventions. Thus, there may be alternatives to our approach.

Limitations and Future Research Directions

There are a number of potential limitations that need to be acknowledged. First, there is a possibility that studies that should have been included in the review were omitted. Several attempts were made to minimise this risk, including generating broad search terms based on previous reviews, and utilising multiple databases, including dissertations. Second, there is a risk that there were coding errors. To minimize this risk, key elements of the data extraction (including effect size calculations) were double-checked by second coders. Third, given the results of the Egger et al.'s test and trim and fill analyses, it is not possible for us to rule out the possibility of publication bias. However, while the results of these analyses *estimate* the likelihood of publication bias and its impact, there is some evidence supporting the possibility of no publication bias: 1) there were no differences in effect sizes between studies reported in dissertation versus journal articles; and 2) we contacted all corresponding authors of included studies and none stated that they had any unpublished studies meeting the eligibility criteria. There may be differences (e.g.., in terms of statistical significance or direction of group differences) between the data/studies that authors are willing to share and those studies for

which authors are not willing to share (see Prestwich et al., 2017). Pre-registering of protocols and subsequent publication regardless of result is thus particularly warranted in future research. Fourth, we did not code the behaviour change techniques (Michie et al., 2011) used in the included studies. Future studies should explore whether certain behaviour change techniques e.g., goal-setting (behaviour) are more effective when used amongst different types of dyads who pursue different types of goals. Further research should also directly compare interventions with shared target-oriented goals and interventions with shared system-oriented goals and identify the reasons why such interventions may differ in terms of their impacts on behaviour. While studies have compared dyadic interventions targeting PA against equivalent interventions targeting individuals, we are unaware of any studies that compare dyadic PA interventions against equivalent PA interventions targeting larger groups (i.e, more than 2 members). Finally, only 16 studies provided separate data on SB that could be included in the meta-analysis, thus there is scope for more empirical research in this area. The number of studies for each moderator comparison was small, such findings, particularly those for SB, should be interpreted with caution and require more studies for a more precise estimate of the effect sizes. Our review focused on dyadic interventions that aimed to promote PA, and in some cases, to reduce SB. Future interventions could utilize a dyadic design focusing on SB only and testing the effects of different strategies to reduce it (Manini et al., 2015).

Study Implications and Conclusions

We found that dyadic interventions had a small, positive effect on PA, even when compared against equivalent interventions targeting individuals. Given this, and the possibility that positive PA or SB changes in one dyadic member could induce positive changes in the other member, dyadic interventions is a viable intervention strategy. Nevertheless, uptake of

such interventions (relative to those targeting individuals) should be compared, along with their acceptability, to further ascertain the feasibility of such approaches. Shared target-oriented goals produced larger effect sizes than non-shared target-oriented goals. This finding suggests it might be more effective to target one person and encourage their partner to support them to increase PA, ensuring they both hold the same PA goal for the main target. There was also some evidence that dyads comprising peers/friends may be particularly effective but this effect could have been confounded with the effect of shared target-oriented goals. Dyadic interventions produced a small and homogeneous reduction in SB. In conclusion, utilizing a dyadic based approach to behaviour change is a promising research area, thus, we hope that our findings provide useful directions for future intervention research.

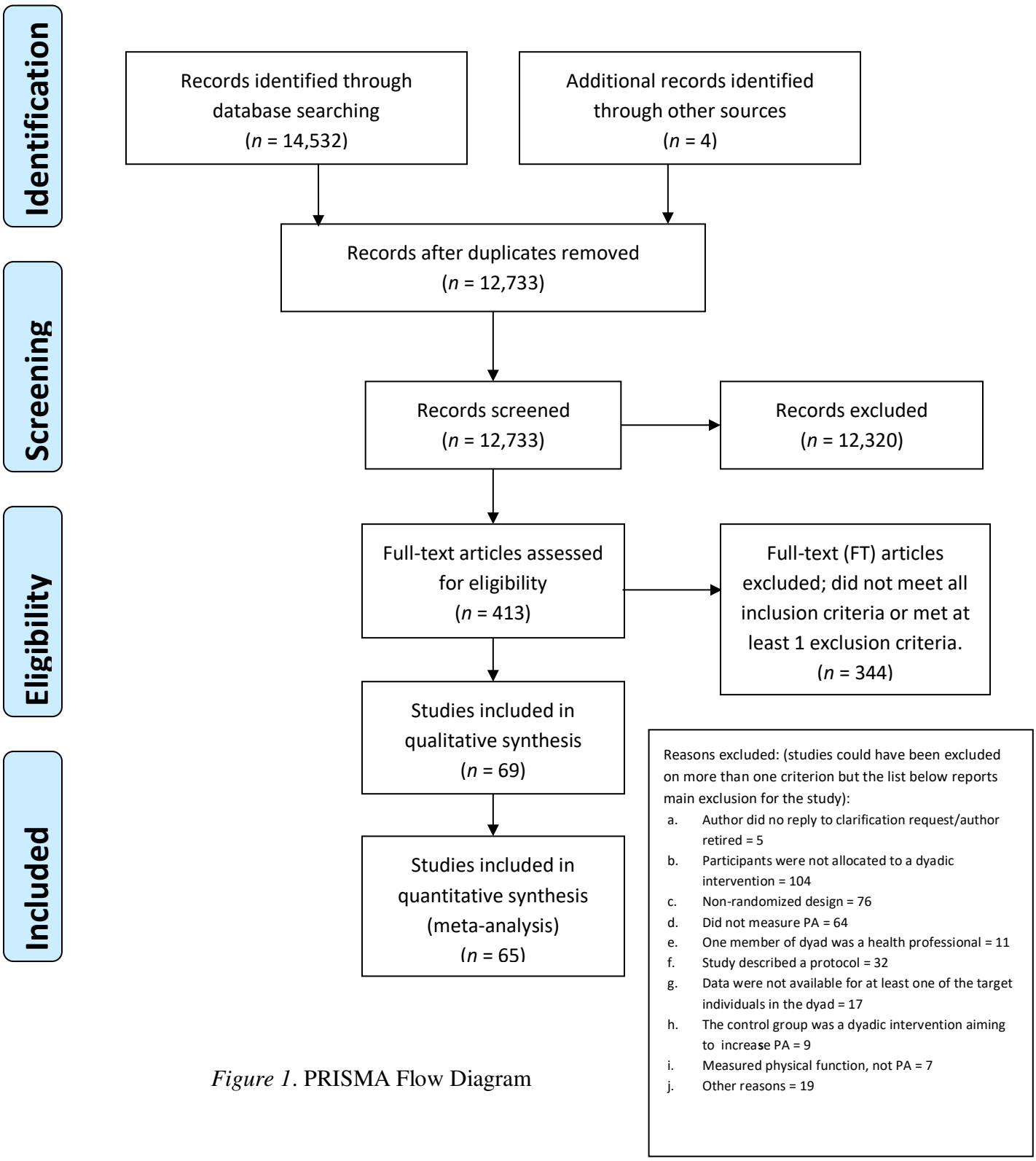

Figure 1. PRISMA Flow Diagram

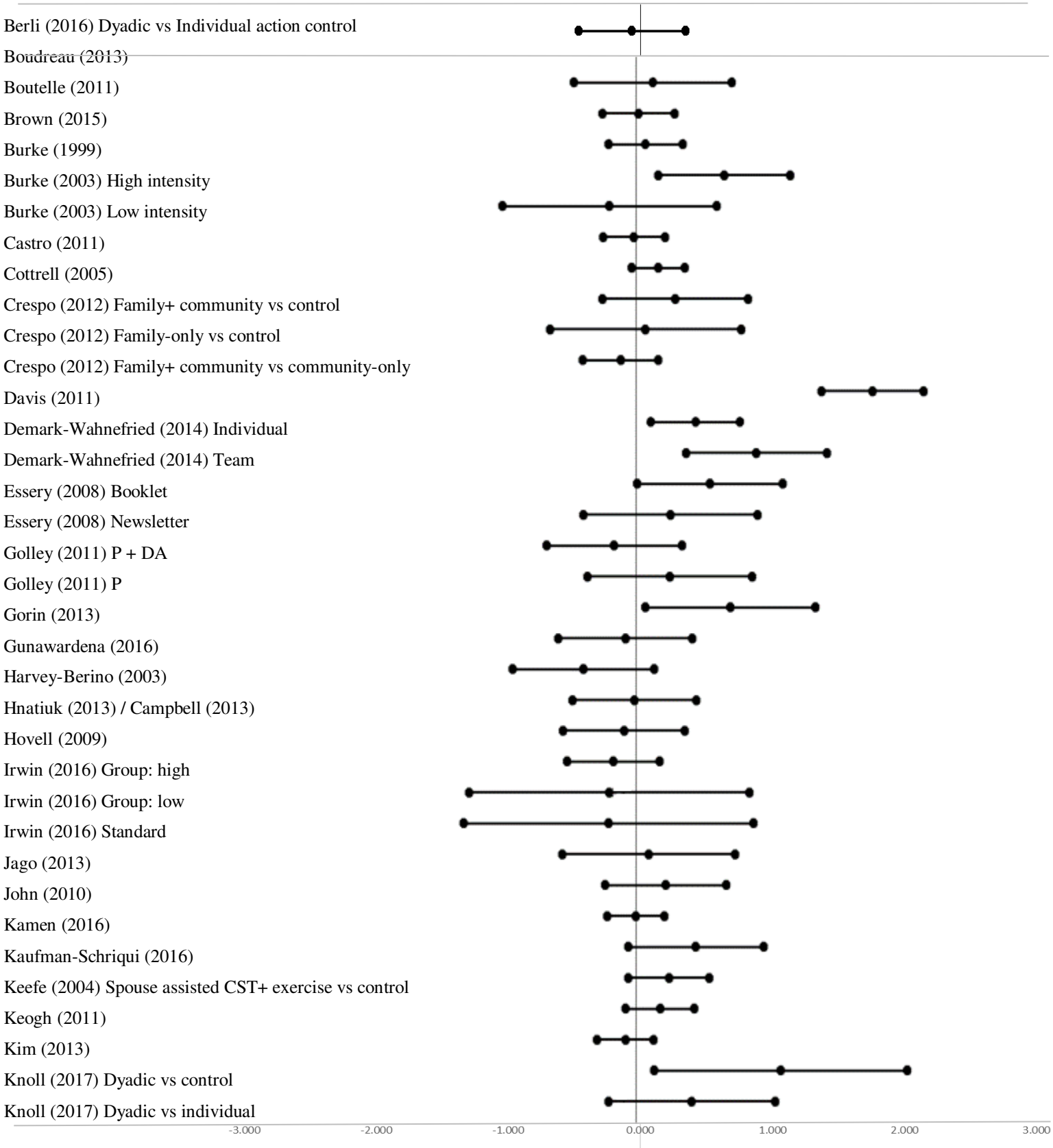

Figure 2. Effect size distribution of dyadic interventions for promoting PA.

II = implementation intentions, MI = motivational interviewing, HV = home visits. P = triple P, CST = pain coping skills training. *Note.* Some studies had more than one type of dyadic comparison condition

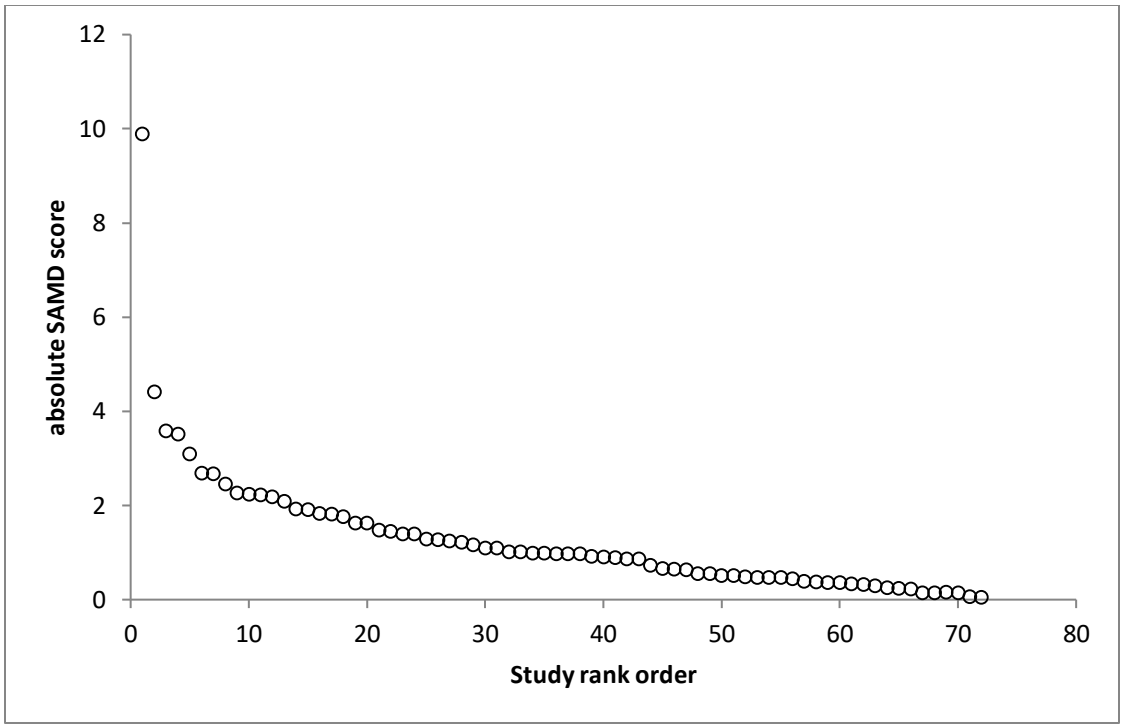

Figure 3. Scree plot indicating study outliers based on the SAMD statistic

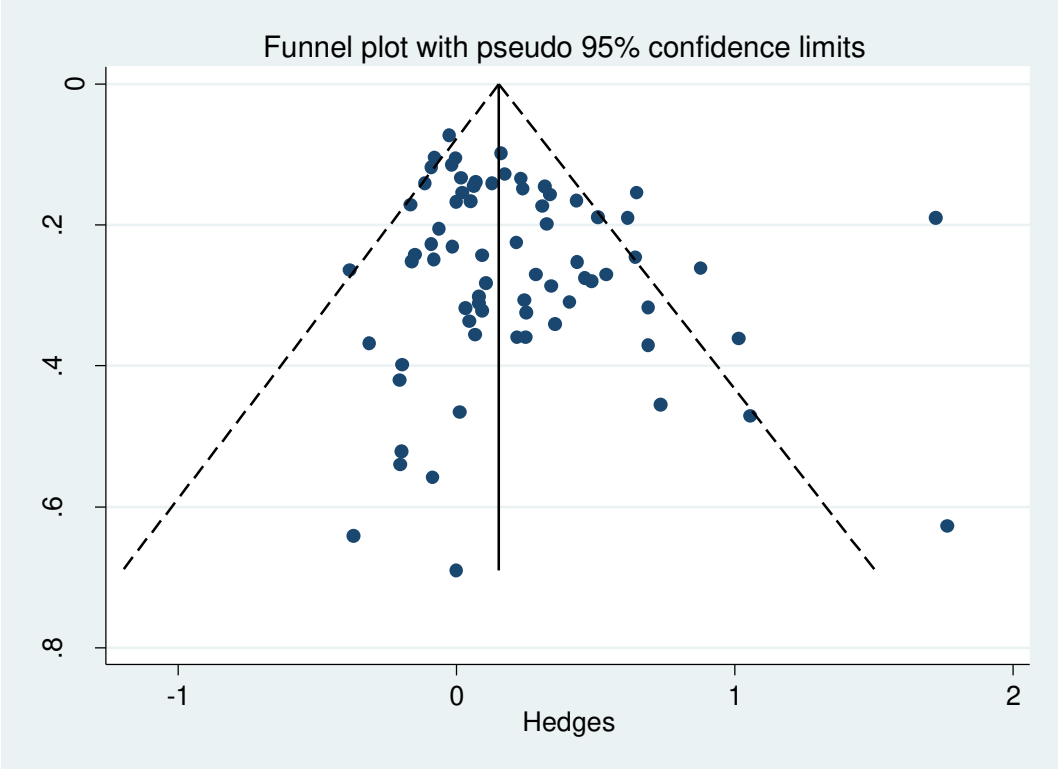

Figure 4. Funnel plot to determine publication bias in the included studies

Table 1
Meta-Regressions Showing Moderators of the Effect of Dyadic Interventions on PA

	Main target (K= 72)[a]			95% CI			Main target & support[b] (K= 72)	OUTLIERS REMOVED 1Extreme (k = 71)	2 removed (k = 70)	5 removed (k = 67)
	k (present)	k (absent)	B	Lower limit	Upper limit	p	p	p-values		
Type of dyad										
Parent and child (38) vs. others (34)	38	34	-0.05	-0.22	0.12	.58	.64	.24	.30	.07
Couples (13) vs. others (59)	13	59	-0.09	-0.30	0.13	.43	.43	.59	.63	.65
Participants and a carer (5) vs others (67)	5	67	0.09	-0.29	0.48	.62	.61	.68	.90	.87
Peers/ friends (8) vs. others (64)	8	64	0.27	-0.01	0.55	.06	.05*	.01**	.004**	p<.001***
Participant + significant other (8) vs. others (64)	8	64	-0.03	-0.30	0.23	.80	.66	.91	.93	.47
Type of goals										
Shared system-oriented (22) vs others (50)	22	50	-0.10	-0.28	0.09	.30	.23	.40	.43	.91
System-oriented (13) vs other (59)	13	59	-0.09	-0.31	0.12	.40	.43	.43	.45	.42
Shared target-oriented (19) vs others (53)	19	53	0.27	0.09	0.45	.003**	.003**	.01*	.01*	.07
Partner-oriented (10) vs others (62)	10	62	-0.11	-0.34	0.13	.38	.37	.43	.45	.42
Parallel self-oriented goals (4) vs others (68)	4	68	-0.02	-0.42	0.38	.92	.95	.89	.86	.83
New type. System and parallel self (6) vs others (66)	6	66	-0.13	-0.46	0.21	.45	.48	.64	.66	.70
Control group										
Other-dyadic (14) vs others (58)	14	58	-0.09	-0.30	0.12	.41	.36	.57	.60	.96
Individual (13) vs others (59)	13	59	-0.06	-0.30	0.17	.58	.63	.96	.99	.89
Waiting list (16) vs others (56)	16	56	-0.10	-0.32	0.13	.39	.30	.48	.50	.64
Usual care (26) vs others (46)	26	46	0.18	0.01	0.35	.04*	.03*	.15	.19	.51
Miscellaneous (3) vs others (69)	3	69	-0.11	-0.48	0.26	.54	.63	.44	.44	.37
Type of PA										
Any (65) vs. specific PA (7)	65	7	-0.19	-0.50	0.12	.22	.57	.15	.14	.14
Strength (4) vs others (68)	4	68	0.35	-0.10	0.80	.13	.12	.06	.05	.04
Walking (1) vs others (71)	1	71	-0.19	-0.79	0.41	.52	.53	.48	.48	.45
Mixed (2) vs others (70)	2	70	0.24	-0.28	0.76	.37	.91	.23	.21	.19
Method of measurement of PA										
Objective (yes= 23; no= 49)	23	49	-0.23	-0.40	-0.05	.01*	.03*	.01**	.01**	.01**
Self-report (yes= 45; no= 27)	45	27	0.13	-0.04	0.31	.14	.17	.16	.17	.18
Both (yes= 4; no= 68)	4	68	0.32	-0.05	0.69	.09	.27	.02*	.02*	.01*
Mode of delivery to the intervention group										
Face-to-face (yes= 53; no= 19)	53	19	-0.02	-0.23	0.18	.82	.85	.69	.88	.92
Written/printed (yes= 36; no= 36)	36	36	-0.11	-0.27	0.06	.21	.19	.29	.32	.54
Telephone (yes= 25; no= 47)	25	47	0.00	-0.17	0.18	.98	.96	.72	.83	.49

Online/PC (yes= 10; no= 62)	10	62	0.00	-0.25	0.26	.97	.99	.97	.78	.76
Video (yes= 10; no= 62)	10	62	-0.06	-0.31	0.20	.66	.84	.32	.17	.34
Duration of delivery										
Longer duration (longer= 41; shorter= 31)	41	31	0.11	-0.06	0.28	.19	.26	.26	.19	.16
Number of sessions										
Multiple session (yes= 59; no= 13)	59	13	-0.00	-0.23	0.23	.999	.93	.91	.87	.90
Assessment periods compared										
From baseline or the start to the follow-ups	n/a	n/a	0.00	-0.00	0.00	.61	.54	.59	.51	.47
From end of intervention to the follow-ups	n/a	n/a	-0.00	-0.00	0.00	.46	.57	.46	.46	.48
Clinical population or non-clinical population										
Clinical (yes= 17; no= 55)	17	55	0.22	0.02	0.42	.04*	.05*	.01**	.01*	.01**
The participants were overweight/obese†										
Overweight/obese (yes= 25; no= 47)	25	47	0.02	-0.16	0.20	.84	.95	.46	.51	.51
ROB: randomization										
High/unclear (25); low (47)	25	47	0.10	-0.08	0.28	.27	.25	.04*	.03*	.12
ROB: allocation concealment										
High/unclear (49); low (23)	49	23	0.07	-0.11	0.25	.45	.46	.63	.67	.80
ROB: blinding of participants and personnel										
High/unclear (70); low (2)	70	2	-0.12	-0.59	0.35	.61	.59	.63	.61	.66
ROB: blinding of outcome assessors										
High/unclear (46); low (26)	46	26	-0.20	-0.37	-0.03	.02*	.03*	.04*	.03*	.01**
ROB: incomplete outcome da										
High/unclear (12); low (60)	12	60	-0.07	-0.32	0.18	.58	.42	.58	.59	.53
ROB: selective outcome reporting										
High/unclear (48); low (24)	48	24	-0.05	-0.23	0.13	.59	.60	.12	.09	.08
ROB: other bias										
High/unclear (41); low (31)	41	31	0.05	-0.12	0.23	.53	.57	.15	.18	.47
Setting of the study										
Australia/New Zealand (yes= 9; no= 63)	9	63	-0.14	-0.40	0.12	.28	.32	.20	.20	.16
UK/ Germany (yes= 9; no= 63)	9	63	-0.12	-0.36	0.13	.34	.43	.37	.38	.36
USA/ Canada (yes= 44; no= 28)	44	28	-0.04	-0.22	0.13	.62	.48	.71	.61	.20
Other (yes= 10; no= 62)	10	62	0.27	0.05	0.48	.02*	.01*	.17	.24	.71

Note. *p<.05, **p<.01, ***p<.001, MOD: Mode of delivery. ROB: Risk of bias † Studies where either one or both dyad members had to be overweight were compared to studies where there were no *apriori* criteria for the dyad members to be overweight [a] Main target = the dyad member who was the focus of the intervention; if both dyad members were targeted equally, both were included as the main target, [b] Including data from the participant's dyad partner who supports them to increase PA. For the new type: System = system-oriented, Parallel self = parallel self-oriented.

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Table A1

Characteristics of Included Studies

First Author	Major Theory	Type of Dyad	Type of goals (Intervention)	PA Measure†	Type of PA	Type of Control	Duration of Delivery	Follow-up Length from Baseline/Start
Berli (2016)	Health action process approach	Couples	Partner-oriented	Objective	Any	Individual	10 texts over 14 days	28 days
Boudreau (2013)	Not stated	Caregiver-child (coded as parent-child)	Shared system "family goal setting"	Objective	Any	Waiting list	Approximately 12 contact days over 6 months	6 months
Boutelle (2011)	Behavioural reinforcement	Parent-child	Shared target	Self-reported	Any	Same BCTs except focused on Individuals not dyads- only parents involved in the intervention	Contact days not stated over 5 months	11 months
Boutelle (2013)[a]	Not stated	Parent-child	System-oriented	Self-reported (parent) Objective (child)	Any	Delayed treatment	12 days over 5 months	11 months
Brown (2015)	Self-determination theory	Family/ friends (56% spouses) Coded as participant + significant other	Shared system	Self-reported	Any	Other- dyadic, Not focused on PA/ skin cancer awareness	8 contact days over 1 year (2 newsletters, 5 phone calls, 1 face-to-face workshop)	1 year / 18 months
Burke (1999)	Not stated	Couples	Parallel self-oriented	Self-reported	Any	Delayed treatment	1 face-to-face, then 6 modules alternating mail with contact sessions over 16 weeks	16 weeks
Burke (2003)	Not stated	Couples	Parallel self-oriented	Self-reported	Any	Waiting list	6 modules over 16 weeks. Low intensity group- mailed the intervention High intensity group- alternating mail and face-to-face	1 year

Castro (2011)	Social cognitive theory and the transtheoretical model	Participant-peer	Shared target	Self-reported	Any	Other- diet. Not focused on PA (staff delivered telephone support for nutrition)	14 days (telephone), 1 day face-to-face and 12 monthly newsletters over 1 year	1 year
Cottrell (2005)	Not stated	Parent-child	System-oriented	Objective (pedometers), however parents inputted this data	Any	Individual- only children received pedometers, not parents	Contact days not stated over 4 weeks	4 weeks
Crespo (2012)	Health belief model, social cognitive theory, structural model of health behaviour	Parent-child	Partner-oriented	Self-reported	Any	Usual care/ Individual	7 face-to-face visits + 4 phone calls over 3 years	3 years
Davis (2011)	Not stated	Mother-child	System-oriented	Self-reported	Any	Usual care- single physician visit	4 days over 8 weeks	14 months
Demark-Wahnefried (2014)	Social cognitive theory, interdependence theory and communal coping	Mother-daughter	Team- Shared system Individual- Parallel self-oriented goals	Objective and self-reported	Any	Usual care- mailed booklets that were not focused on PA	6 days over 1 year	1 year
Essery (2008)	Not stated	Mother-child	Partner-oriented	Self-reported	Any	Delayed treatment	On 12 days received newsletters over 12 weeks Booklet condition- one booklet on first week of intervention	12 weeks

Feltz (2011)	Köhler effect	Participant-confederate	Coactive- parallel self-oriented Additive- shared system Conjunctive- shared target Coded in relation to the goal the participants perceived they had	Objective	Strength	Individual	1 day	1 day
Feltz (2012)	Köhler effect	Participant-confederate	Moderate- shared target Low- shared target High- shared target	Objective	Strength	Individual	1 day	1 day
Forlenza (2015) Our analysis focused on the virtually live partner vs. individual control as the other conditions distorted the confederate to make them less human in appearance	Köhler effect	Participant-confederate	Shared target	Objective	Strength	Individual	1 day	1 day
Golley (2011)	Child development theory and social learning principles	Parent-child	System-oriented- “parent aiming to increase child and family activity”	Self-reported	Any	Waiting list	P + DA- 15 days over 6 months P- 8 days over 8 weeks	1 year
Gorin (2013)	Social ecological models	Participant + household member (coded as participant + significant other)	Shared system	Self-reported	Any	Standard behavioural treatment-miscellaneous	52 days over 18 months	18 months

Gunawardena (2016)	Based on their own previous theory and experience	Mother-child	Shared target-child increasing mother's PA	Self-reported	Any	Usual care	Contact days not stated over 1 year	1 year
Gunnarsdottir (2011)[a]	Not stated	Parent-child	Shared target	Self-reported	Any	Standard care. Dyadic- not focused on PA. Nutrition counselling	22 contact sessions over 4 months/11 weeks	16 months
Harvey-Berino (2003)	Not stated	Mother-child	Partner-oriented-mother changing child's PA	Objective	Any	Other- dyadic, BCTs not focused on PA. Parenting skills training for the mother.	Contact days not stated over 16 weeks	16 weeks
Hnatiuk (2013) / Campbell (2013) Linked to Lioret (2012)	Social cognitive theory. Parenting support theory	Mother-child	System-oriented- mother modelling activity behaviours to increase child's PA	Objective (for the child but self-reported for the mother)	Any	Usual care/booklet not focused on obesity	6 days over 15 months	16 months
Holthoff (2015)[a]	Not stated	Caregiver-person with dementia	Shared target	Objective	Any	Usual care	36 days over 12 weeks	24 weeks
Hovell (2009)	Not stated	Parent-child	System-oriented	Self-reported	Any	Other- dyadic, child safety	8 days over 8 weeks	12 months
Irwin (2012)	Köhler effect	Participant-confederate	Coactive condition Parallel self-oriented Conjunctive condition-Shared target	Objective	Bike	Individual	6 days over 4 weeks	4 weeks
Irwin (2013)a	Köhler effect	Participant-confederate	Partner + encouragement condition**-** Shared target Partner without encouragement-Shared target	Objective	Strength	Individual	1 day	1 day

Irwin (2013)b Dissertation	Köhler effect and the transtheoretical model of behaviour change	Participant-confederate	Conjunctive condition- Shared target Coactive condition- Parallel self-oriented	Objective	Any	Individual	8 days 8 weeks	8 weeks
Irwin (2016)	Carron and Spink's team-building model	Peer-peer	High- shared system Low- shared system Standard- shared system	Objective	Strength	Individual	1 day	1 day
Jago (2013)	Self-determination theory	Mother-child (1 father in the control condition)	System-oriented	Objective	Any	Delayed treatment	8 days over 8 weeks	16 weeks
John (2010)	Family centered care	Parent-child	System-oriented	Self-reported	Any	Delayed treatment	1 day	2 months
Kamen (2016)	Social support and social control theories	Caregiver-cancer survivor	Shared system	Objective	Any	Individual	6 days contacted to check adherence over 6 weeks	6 weeks
Kaufman-Shriqui (2016)	Ecological model	Mother-child	A mixture between system-oriented and parallel self-oriented	Self-reported	Any	Usual care	For children- 10 days of intervention contact over 15 weeks For parents- 13 contact days over 15 weeks	6 months
Keefe (2004)	Gate control theory	Spouses	Shared target	Objective	Strength	Usual care	12 group sessions + 36 exercise sessions over 12 weeks	12 weeks
Keogh (2011)	Self-regulatory model	Participant-family member (Coded as significant other)	Shared target	Self-reported	Any	Usual care	3 days over 3 weeks	6 months

Kim (2013)	Not stated	Caregiver - patient	Shared target	Self-reported	Any	Usual care	Not specified, 9 sessions were flexible manner as long as completed over 9 weeks	3 months
Knoll (2017)	Implementation intentions	Couples	Shared target	Objective	Any	Individual/ Other-dyadic task not focused on PA	1 day	7 weeks
Knowlden (2015) Linked to: Knowlden (2016) Follow-up one year efficacy	Social cognitive theory	Mother-child	System-oriented	Self-reported	Any	Dyadic- child focus. General health knowledge	4 days over 4 weeks	60 weeks
Lowery (2014)	Not stated	Person with dementia-carer	Mixture between system-oriented and parallel self-oriented	Self-reported	Walking	Usual care	Contact days not stated over 12 weeks	26 weeks
Maddison (2014)	Social cognitive theory and behavioural economics theory	Caregiver-child	System-oriented	Self-reported	Any	Delayed treatment	6 days over 20 weeks	24 weeks
Marmo (2013)	Social cognitive theory	Friend-friend	Partner-oriented	Self-reported	Any	Usual care	1 day	1 week
Marquez (2013)	Not stated	Participant-member of social network	Shared system	Self-reported	Any	Individual	12 days over 12 weeks	24 weeks
Martinez-Andrade (2014)	Chronic care model	Parent-child	Partner-oriented	Self-reported	Any	Usual care	6 days over 6 weeks	6 months
Minneboo (2017)	Not stated	Couples	Shared system and Shared target	Self-reported	Any	Usual care	1 year (depending on program)	1 year

Morrison (2013)	Not stated	Parent-child	System-oriented	Objective	Any	Usual care	Approximately 7 days over 10 weeks	11 weeks
O'Connor (2013)	Social cognitive theory and parenting theories	Parent-child	Mixture between system-oriented and parallel self-oriented	Objective	Any	Waiting list	Up to 12 contact days within 7 months completion	7 months
Ostbye (2012)	Social cognitive theory	Mother-child	System-oriented	Objective	Any	Dyadic- not focused on PA, reading	8 days (mailed), 8 days (telephone), 1 semi-structured group session over 10 months	22 months
Pakpour (2015)	Not stated	Mother-adolescent/ child	Shared target	Self-reported	Any	Usual care/ Individual	6 MI contact days over 1 year (extra session for parents in the MI + parent group)	1 year
Pinto (2015)	Transtheoretical model and social cognitive theory	Participant-volunteer/peer	Shared target	Objective and self-reported	Any	Other- dyadic, breast cancer	12 days over 12 weeks	24 weeks
Pisu (2017)	Cognitive interaction and intimacy model	Couples	Shared system	Self-reported	Any	Waiting list	12 sessions over 12 weeks	12 weeks
Prestwich (2012)	Theory of planned behaviour, protection motivation theory, implementation intentions.	Participant + significant other	Collaborative II condition- Shared system Partner without IIs condition- shared target	Self-reported	Any	Individual/ Usual care	1 day	6 months
Samuel-Hodge (2017)	Social interdependence and social support theories	Participant-family member (Coded as significant other)	Shared system	Self-reported	Mixed-Walking and general	Waiting list	20 sessions over 20 weeks	20 weeks
Santos (2014)	Not stated	Young child-Older child	Shared system; “participating in the go move activity together”	Objective	Any	Delayed treatment	Contact days unclear over 10 months	9/10 months

Schneider (2013)	Family systems theory and social cognitive theory	Caregiver-adolescent	Shared system	Objective	Any	Other- dyadic, broad range of health topics	8 days over 8 weeks	8 weeks
Schwinn (2014)	Not stated	Mother-daughter	Shared system	Self-reported	Any	Usual care	3 days over 3 weeks	5 months after receiving the program
Sher (2014)	Cognitive behavioural couples therapy and self-determination theory. Transtheoretical model	Couples	Shared target	Self-reported	Any	Individual	18 days over 24 weeks	18 months
Skouteris (2016)	Learning and social cognitive theory	Parent-child	Partner-oriented	Self-reported	Any	Waiting list	10 face-to-face days and parents received 10 handouts over 10 weeks	12 months post-intervention
Stark (2011)	Social cognitive theory	Parent-child	Mixture of system-oriented and parallel self-oriented goals	Objective	Any	Other- enhanced standard of care, paediatric counselling	18 days over 6 months	1 year
St. George (2014)	Social cognitive theory, self-determination theory, family systems theory	Parent-adolescent	Mixture between system-oriented and parallel self-oriented	Objective	Any	Other- dyadic, one of six general health topics	6 sessions over 6 weeks	6 weeks
Teri (2003)	Not stated	Patient-caregiver	Shared target	Self-reported (by caregiver)	Any	Usual care	12 days over 3 months	2 years
Tuominen (2017)	Not stated	Mother-child	Shared system	Objective	Any	Usual care	1 day (sent video) over 8 weeks	8 weeks
Tymms (2016)[a] PL group not dyadic, focused on the mentoring, combination and control	Self-efficacy and agency	Peer-peer	Shared target	Objective	Any	Waiting list	6 contact days over 6 weeks	6 weeks after the intervention

Ungar (2016)	Health action process approach	Peer-peer	Shared target	Self-reported	Any	Miscellaneous	4 days over 4 weeks	14 weeks
Van Allen (2015)	Behaviour change techniques	Parent-child	System-oriented	Self-reported	Any	Dyadic- weight focused	10 days over 10 weeks	1 year + 10 weeks
Voils (2013) Linked to King (2014)	Social cognitive theory	Couples	Shared target and shared system	Self-reported	Any	Usual care	9 days over 10 months	11 months
Werch (2008)	Prospect theory and stage theory	Parent-adolescent/ child	Partner-oriented	Self-reported	Any	Miscellaneous	3 days over 3 weeks	4 months
Wesson (2013)	Allen's cognitive disabilities model	Person with dementia + carer	Shared target	Self-reported	Any	Usual care	Approximately 14 days over 12 weeks	4 months
Williamson (2005)	Not stated	Mother-daughter	Shared system	Self-reported	Any	Other dyadic-general health education, nutrition	4 face-to-face days over 6 months	6 months
Winters-Stone (2016)	Not stated	Spouses	Shared system	Self-reported /Strength measures-objective	Mixed-Strength and general	Usual care	12 days over 6 months	6 months
Yates (2015)	Social cognitive theory and social support theory	Spouses	Shared system	Objective	Any	Usual care	18 - 36 sessions over 6 - 12 weeks	6 months

Note:

[a] Included in the systematic review but not in the meta-analysis

If explicitly mentioned that there were family goals or role modelling of the mother, then the studies were coded as having shared system-oriented or system-oriented goals

† PA measure - coded in relation to the measures included in the meta-analysis

Shared target = shared target-oriented goals. Shared system = shared system-oriented goals

Table A2

Search Terms

Psycinfo	Medline	Web of Science - Social Sciences Citation Index only
(fathers and their child).mp.	(fathers and their child).mp.	TS=(fathers and their child)
(mothers and their child).mp.	(mothers and their child).mp.	TS=(mothers and their child)
(parents and their child).mp.	(parents and their child).mp.	TS=(parents and their child)
(women and their boyfriend).mp.	(women and their boyfriend).mp.	TS=(women and their boyfriend)
(boyfriend and girlfriend).mp.	(boyfriend and girlfriend).mp.	TS=(boyfriend and girlfriend)
sibling$.mp.	sibling$.mp.	TS=sibling$
(husband and wives).mp.	(husband and wives).mp.	TS=(husband and wives)
dyad$.mp.	dyad$.mp.	TS=dyad*
couple$.mp.	couple$.mp.	TS=couple$
partner$.mp.	partner$.mp.	TS=partner$
colleague$.mp.	colleague$.mp.	TS=colleague$
friend$.mp.	friend$.mp.	TS=friend$
(women and their partner$).mp.	(women and their partner$).mp.	TS=(women and their partner$)
(women and their husband$).mp.	(women and their husband$).mp.	TS=(women and their husband$)
spouse$.mp.	spouse$.mp.	TS=spouse$
mother-child.mp.	mother-child.mp.	TS=mother-child
family.mp.	family.mp.	TS=family
families.mp.	families.mp.	TS=families
marriage.mp.	marriage.mp.	TS=marriage
sexual partner.mp.	sexual partner.mp.	TS=sexual partner

Psycinfo	Medline	Web of Science - Social Sciences Citation Index only

Psycinfo	Medline	Web of Science - Social Sciences Citation Index only
buddy.mp.	buddy.mp.	TS=buddy
cohabitee.mp.	cohabitee.mp.	TS=cohabitee
coworker.mp.	coworker.mp.	TS=coworker
caregiv*.mp.	caregiv*.mp.	TS=caregiv*
pair*.mp.	pair*.mp.	TS=pair*
father-child.mp.	father-child.mp.	TS=father-child
(children* adj10 father*).ab.	(children* adj10 father*).ab.	TS=(children* and mother*)
(children* adj10 mother*).ab.	(children* adj10 mother*).ab.	TS=(children* and father*)
exp DYADS/	Parent-Child Relations/	
exp exercise/ or exp physical activity/	exp exercise/ or exp physical activity/	TS=(bicycl* OR bike* OR biking OR swim* OR swimming OR aerobic* exercise* OR rollerblading OR rollerskating OR skating OR exertion* OR ”strength training“ OR ”resilience training“ OR ”weight lifting“ OR travel mode*)
running/	running/	TS=((cycle OR cycling) AND (school* OR work OR workplace OR commut* OR travel* OR equipment OR facilit* OR rack* OR store* OR storing OR park* OR friendly OR infrastructure))
walking/	walking/	TS=(sport* OR walk* OR running OR jogging OR pilates OR yoga)
physical fitness/	physical fitness/	TS=((decreas* OR reduc* OR discourag*) AND (sedentary OR deskbound OR ”physical* inactiv*“))

swimming/	swimming/	TS=((promot* OR uptak* OR encourag* OR increas* OR start* OR adher* OR sustain* OR maintain*) AND (exercis* OR exertion OR keep fit OR fitness class OR yoga OR aerobic*))
(fitness adj class*).ti,ab.	(fitness adj class*).ti,ab.	TS=((promot* OR uptak* OR encourag* OR increas* OR start* OR adher* OR sustain* OR maintain*) AND (circuit* OR aqua*))
gardening/	gardening/	TS=((promot* OR uptak* OR encourag* OR increas* OR start* OR adher* OR sustain* OR maintain*) AND physical activ*)
exp SPORTS/	exp SPORTS/	TS=((promot* OR uptak* OR encourag* OR increas* OR start* OR adher* OR sustain* OR maintain*) AND gym*)
exp YOGA/	exp YOGA/	TS=((leisure OR fitness) AND (centre* OR center* OR facilit*))
recreation/	recreation/	TS=(exercis* AND (fit* OR train* OR activ* OR endur*))
(fitness adj (regime* or program*)).ti,ab.	(fitness adj (regime* or program*)).ti,ab.	TS=(physical AND (fit* OR train* OR activ* OR endur*))
(led walk* or health walk*).ti,ab.	(led walk* or health walk*).ti,ab.	TS=(led walk* OR health walk*)
((moderate or vigorous*) adj activ*).ti,ab.	((moderate or vigorous*) adj activ*).ti,ab.	TS=((moderate OR vigorous*) AND activ*)
cardiorespiratory fitness.ti,ab.	cardiorespiratory fitness.ti,ab.	TS=(cardiorespiratory fitness OR aerobic capacity)
aerobic capacity.ti,ab.	aerobic capacity.ti,ab.	TS=(fitness AND (regime* OR program*))
(physical adj5 (fit* or train* or activ* or endur*)).ti,ab.	(physical adj5 (fit* or train* or activ* or endur*)).ti,ab.	TS=(exercise OR physical fitness OR sport* OR fitness class*)

Psycinfo	Medline	Web of Science - Social Sciences Citation Index only

(multimodal transportation or alternative transport* or alternative travel*).ti,ab.	(multimodal transportation or alternative transport* or alternative travel*).ti,ab.	TS=(multimodal transportation OR alternative transport* OR alternative travel* OR recreation* OR pedestrianis* OR pedestrianiz*)
("use" adj3 stair*).ti,ab.	("use" adj3 stair*).ti,ab.	TS=(use AND stair*)
BMI.mp.	BMI.mp.	TS=BMI
weigh*.mp.	weigh*.mp.	TS=Weigh*
(exercis* adj5 (fit* or train* or activ* or endur*)).ti,ab.	(exercis* adj5 (fit* or train* or activ* or endur*)).ti,ab.	
((leisure or fitness) adj5 (centre* or center* or facilit*)).ti,ab.	((leisure or fitness) adj5 (centre* or center* or facilit*)).ti,ab.	
((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 gym*).ti,ab.	((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 gym*).ti,ab.	
((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 physical activ*).ti,ab.	((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 physical activ*).ti,ab.	
((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 (circuit* or aqua*)).ti,ab.	((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 (circuit* or aqua*)).ti,ab.	
((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 (exercis* or exertion or keep fit or fitness class or yoga or aerobic*)).ti,ab.	((promot* or uptak* or encourag* or increas* or start* or adher* or sustain* or maintain*) adj5 (exercis* or exertion or keep fit or fitness class or yoga or aerobic*)).ti,ab.	

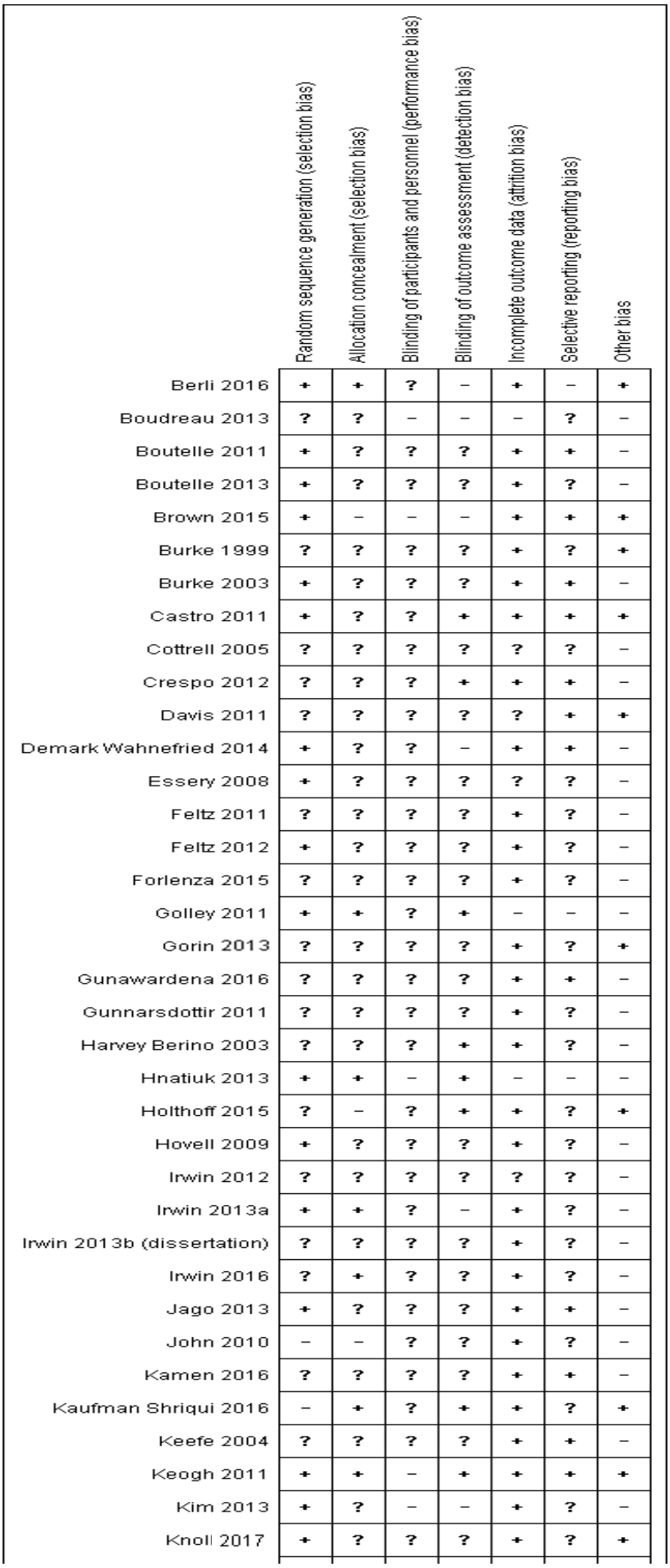
Psycinfo	Medline	Web of Science - Social Sciences Citation Index only

((decreas* or reduc* or discourag*) adj5 (sedentary or deskbound or "physical* inactiv*")).ti,ab.	((decreas* or reduc* or discourag*) adj5 (sedentary or deskbound or "physical* inactiv*")).ti,ab.	
sport*3.ti,ab.	sport*3.ti,ab.	
walk*3.ti,ab.	walk*3.ti,ab.	
running.ti,ab.	running.ti,ab.	
jogging.ti,ab.	jogging.ti,ab.	
pilates.ti,ab.	pilates.ti,ab.	
yoga.ti,ab.	yoga.ti,ab.	
((cycle or cycling) adj5 (school$ or work or workplace or commut$ or travel$ or equipment or facilit$ or rack$1 or store$1 or storing or park$ or friendly or infrastructure)).ti,ab.	((cycle or cycling) adj5 (school$ or work or workplace or commut$ or travel$ or equipment or facilit$ or rack$1 or store$1 or storing or park$ or friendly or infrastructure)).ti,ab.	
bicycl*.ti,ab.	bicycl*.ti,ab.	
(bike*1 or biking).ti,ab.	(bike*1 or biking).ti,ab.	
(swim*1 or swimming).ti,ab.	(swim*1 or swimming).ti,ab.	
(exercis*3 adj5 aerobic*).ti,ab.	(exercis*3 adj5 aerobic*).ti,ab.	
rollerblading.ti,ab.	rollerblading.ti,ab.	
rollerskating.ti,ab.	rollerskating.ti,ab.	
skating.ti,ab.	skating.ti,ab.	
exertion*1.ti,ab.	exertion*1.ti,ab.	

Psycinfo	Medline	Web of Science - Social Sciences Citation Index only
strength training.ti,ab.	strength training.ti,ab.	

resilience training.ti,ab.	resilience training.ti,ab.	
weight lifting.tw.	weight lifting.tw.	
travel mode*1.tw.	travel mode*1.tw.	
(active adj (travel*4 or transport* or commut$)).tw.	(active adj (travel*4 or transport* or commut$)).tw.	
recreation*1.ti,ab.	recreation*1.ti,ab.	
(pedestrianis* or pedestrianiz*).ti,ab.	(pedestrianis* or pedestrianiz*).ti,ab.	
(randomized or randomised or placebo or randomly or trial).ab.	randomized controlled trial.pt.	TS=(randomized controlled trial* OR randomised controlled trial* OR RCT OR controlled trial* OR interrupted time series OR controlled before)
Random allocation/ or clinical trial/ or single-blind method/ or double-blind method/ or control groups/	controlled clinical trial.pt.	
program evaluation/ or evaluation/	(randomized or randomised or placebo or randomly or trial).ab.	
quasi-experiment$.ti,ab.	random allocation/ or clinical trial/ or single-blind method/ or double-blind method/ or control groups/	
(pre test or pretest or (posttest or post test)).ti,ab.	evaluation studies/	
trial.ti.	program evaluation/	
(time adj series).ti,ab.	Comparative study.pt.	

Psycinfo	Medline	Web of Science - Social Sciences Citation Index only
((evaluat$ or intervention or interventional) adj8 (control or controlled or study or program$ or comparison or "before and after" or comparative)).ti,ab.	quasi-experiment$.ti,ab.	
((intervention or interventional) adj8 (effect* or evaluat* or outcome*)).ti,ab.	(pre test or pretest or (posttest or post test)).ti,ab.	
((process or program*) adj3 (effect* or evaluat*)).ti,ab.	trial.ti.	
(controlled before or "before and after stud$" or follow up assessment).ti,ab.	(time adj series).ti,ab.	
	((evaluat$ or intervention or interventional) adj8 (control or controlled or study or program$ or comparison or "before and after" or comparative)).ti,ab.	
	((intervention or interventional) adj8 (effect* or evaluat* or outcome*)).ti,ab.	
	((process or program*) adj3 (effect* or evaluat*)).ti,ab.	
	(controlled before or "before and after stud$" or follow up assessment).ti,ab.	
	Clinical Trial/	
No limit	English language and Full Text	English language and Article
Limit to 1996	Medline 1996-	Limit to 1996



	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Berli 2016	+	+	?	–	+	–	+
Boudreau 2013	?	?	–	–	–	?	–
Boutelle 2011	+	?	?	?	+	+	–
Boutelle 2013	+	?	?	?	+	?	–
Brown 2015	+	–	–	–	+	+	+
Burke 1999	?	?	?	?	+	?	+
Burke 2003	+	?	?	?	+	+	–
Castro 2011	+	?	?	+	+	+	+
Cottrell 2005	?	?	?	?	?	?	–
Crespo 2012	?	?	?	+	+	+	–
Davis 2011	?	?	?	?	?	+	+
Demark Wahnefried 2014	+	?	?	–	+	+	–
Essery 2008	+	?	?	?	?	?	–
Feltz 2011	?	?	?	?	+	?	–
Feltz 2012	+	?	?	?	+	?	–
Forlenza 2015	?	?	?	?	+	?	–
Golley 2011	+	+	?	+	–	–	–
Gorin 2013	?	?	?	?	+	?	+
Gunawardena 2016	?	?	?	?	+	+	–
Gunnarsdottir 2011	?	?	?	?	+	?	–
Harvey Berino 2003	?	?	?	+	+	?	–
Hnatiuk 2013	+	+	–	+	–	–	–
Holthoff 2015	?	–	?	+	+	?	+
Hovell 2009	+	?	?	?	+	?	–
Irwin 2012	?	?	?	?	?	?	–
Irwin 2013a	+	+	?	–	+	?	–
Irwin 2013b (dissertation)	?	?	?	?	+	?	–
Irwin 2016	?	+	?	?	+	?	–
Jago 2013	+	?	?	?	+	+	–
John 2010	–	–	?	?	+	?	–
Kamen 2016	?	?	?	?	+	+	–
Kaufman Shriqui 2016	–	+	?	+	+	?	+
Keefe 2004	?	?	?	?	+	+	–
Keogh 2011	+	+	–	+	+	+	+
Kim 2013	+	?	–	–	+	?	–
Knoll 2017	+	?	?	?	+	?	+

Figure A1. Risk of Bias Summary for Each Study

Knowlden 2015	+	+	?	?	+	+	+
Lowery 2014	+	-	?	+	+	-	-
Maddison 2014	+	+	-	-	?	+	-
Marmo 2013	?	?	?	?	-	?	-
Marquez 2013	?	?	?	?	+	?	-
Martinez Andrade 2014	+	+	+	-	+	?	+
Minneboo 2017	+	-	-	-	+	+	-
Morrison 2013	+	+	?	+	+	-	-
O'Connor 2013	+	?	-	-	+	?	-
Ostbye 2012	+	?	?	?	?	?	+
Pakpour 2015	+	-	?	+	+	?	+
Pinto 2015	+	?	+	+	+	?	+
Pisu 2017	?	?	?	+	+	?	-
Prestwich 2012	+	+	?	-	+	?	+
Samuel Hodge 2017	+	?	?	+	?	?	-
Santos 2014	+	+	?	+	+	?	+
Schneider 2013	+	-	?	?	+	?	-
Schwinn 2014	?	?	?	?	+	?	-
Sher 2014	+	?	?	?	+	?	+
Skouteris 2016	+	-	?	?	+	?	+
Stark 2011	+	+	?	+	+	+	+
St George 2014	+	?	?	+	+	?	+
Teri 2003	?	?	?	+	+	+	+
Tuominen 2017	+	+	-	-	+	-	+
Tymms 2016	+	+	?	?	?	+	+
Ungar 2016	?	?	?	?	+	+	-
VanAllen 2015	+	?	?	?	+	?	+
Voils 2013	+	+	?	+	+	+	+
Werch 2008	?	?	?	?	+	?	-
Wesson 2013	+	+	?	+	+	?	-
Williamson 2005	?	?	-	-	+	?	-
Winters Stone 2016	+	+	?	+	+	-	+
Yates 2015	+	?	?	+	+	?	+

Table A3

Multivariate Meta-Regression Controlling for All Other Study Characteristics which were Associated with Effect Sizes

Moderator	*B*	Lower limit 95% CI	Upper limit 95% CI	*P*
Shared target-oriented goals	0.17	-0.02	0.35	.07
Objective PA only	-0.17	-0.34	-0.00	.04*
Control- usual care	0.01	-0.17	0.19	.94
Other country	0.16	-0.07	0.39	.16
ROB: Blind outcome assessor (high/unclear)	-0.16	-0.32	0.00	.06
Clinical	0.07	-0.13	0.27	.49

Note: PA= Physical Activity, ROB: risk of bias. Clinical= studies targeting clinical populations compared to studies targeting non-clinical populations

Table A4

Multivariate Meta-Regression for Significant Predictors that were confounded with Shared

Moderator	*B*	Lower limit 95% CI	Upper limit 95% CI	*P*
Shared target-oriented goals	0.17	-0.02	0.37	.09
Other country	0.18	-0.04	0.41	.10
Clinical	0.15	-0.05	0.36	.13

Target-Oriented goals

Appendix B

Studies Included in the Review

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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
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	7
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.	8
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.	8
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
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary materials 2
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).	8-9
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.	9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	10
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.	10
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	11
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.	11

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).	Supplementary materials 3
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	11-12
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.	25
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.	Supplementary materials 1
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).	Supplementary materials 3
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.	26-27
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	13
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	13
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	16-17 & 30-31
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).	17
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).	22
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	23
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.	1

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

OVERALL EFFECTS

ssc install metan

metan Hedges Standard_error, random lcols(Studyname)
metan Hedges Standard_error, random by(participant_confederate)
metan Hedges Standard_error, random by(control_type)

*Additional analysis to check the impact of including an extra comparison from Keefe (Spouse-Assisted CST+exercise vs. Spouse Assisted CST). This was omitted from the main analysis as the paper only reports data for 2 out of the 3 outcomes (for the 3rd DV, the ES was estimated, conservatively, as ES=0 for the Hedges2 variable).
metan Hedges2 Standard_error2, random by(control_type)

PUBLICATION BIAS
ssc install metabias
metabias Hedges Standard_error, egger

ssc install metafunnel
metafunnel Hedges Standard_error

ssc install metatrim
metatrim Hedges Standard_error

PREDICTORS OF EFFECT SIZE

ssc install metareg

metareg Hedges participant_confederate, wsse(Standard_error)
metareg Hedges dissertation, wsse(Standard_error)

metareg Hedges study_period, wsse(Standard_error)
metareg Hedges followup_period, wsse(Standard_error)
metareg Hedges face2face, wsse(Standard_error)
metareg Hedges print, wsse(Standard_error)
metareg Hedges computer, wsse(Standard_error)
metareg Hedges telephone, wsse(Standard_error)
metareg Hedges video, wsse(Standard_error)
metareg Hedges multi_session, wsse(Standard_error)
metareg Hedges long_duration, wsse(Standard_error)
metareg Hedges parent_child, wsse(Standard_error)
metareg Hedges peers_friends, wsse(Standard_error)
metareg Hedges participant_carer, wsse(Standard_error)

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metareg Hedges participant_sigother, wsse(Standard_error)
metareg Hedges participant_confederate, wsse(Standard_error)
metareg Hedges couples, wsse(Standard_error)
metareg Hedges objective_only, wsse(Standard_error)
metareg Hedges selfreport_only, wsse(Standard_error)
metareg Hedges both_objective_selfreport, wsse(Standard_error)
metareg Hedges anytypePA, wsse(Standard_error)
metareg Hedges strengthPA, wsse(Standard_error)
metareg Hedges walking, wsse(Standard_error)
metareg Hedges bike, wsse(Standard_error)
metareg Hedges mixed_type, wsse(Standard_error)
metareg Hedges control_other_dyad, wsse(Standard_error)
metareg Hedges control_individual, wsse(Standard_error)
metareg Hedges control_waitlist, wsse(Standard_error)
metareg Hedges control_usualcare, wsse(Standard_error)
metareg Hedges control_misc, wsse(Standard_error)
metareg Hedges sharedsystem, wsse(Standard_error)
metareg Hedges system, wsse(Standard_error)
metareg Hedges sharedtarget, wsse(Standard_error)
metareg Hedges partner, wsse(Standard_error)
metareg Hedges parallel, wsse(Standard_error)
metareg Hedges system_parallel_self, wsse(Standard_error)

metareg Hedges UK_Germany, wsse(Standard_error)
metareg Hedges AustraliaNZ, wsse(Standard_error)
metareg Hedges USA_Canada, wsse(Standard_error)
metareg Hedges other_country, wsse(Standard_error)
metareg Hedges random_highunclear, wsse(Standard_error)
metareg Hedges allocation_highunclear, wsse(Standard_error)
metareg Hedges blind_ps_highunclear, wsse(Standard_error)
metareg Hedges blind_assess_highunclear, wsse(Standard_error)
metareg Hedges selective_highunclear, wsse(Standard_error)
metareg Hedges incomplete_highunclear, wsse(Standard_error)
metareg Hedges otherbias, wsse(Standard_error)
metareg Hedges clinical, wsse(Standard_error)
metareg Hedges overweight, wsse(Standard_error)

***MULTIVARIATE META-REGRESSIONS***

metareg Hedges sharedtarget objective_only control_usualcare other_country
blind_assess_highunclear clinical, wsse(Standard_error)

metareg Hedges sharedtarget other_country clinical, wsse(Standard_error)

**TO IDENTIFY IMPACT OF INDIVIDUAL STUDIES ON OVERALL ES (NEEDED FOR SAMD OUTLIER
STATISTICS)***

ssc install metaninf
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metaninf Hedges Standard_error, random label(namevar= Studyname)

**SEDENTARY BEHAVIOUR**
metan Hedges_sed Std_Err_sed, random lcols(Studyname)
metan Hedges_sed Std_Err_sed, random by(control_type)
```