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The effectiveness of multi-component goal setting interventions for changing physical activity behaviour: a systematic review and meta-analysis

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ABSTRACT

Drawing from goal setting theory (Latham & Locke, 1991; Locke & Latham, 2002; Locke et al., 1981), the purpose of this study was to conduct a systematic review and meta-analysis of multi-component goal setting interventions for changing physical activity (PA) behaviour. A literature search returned 41,038 potential articles. Included studies consisted of controlled experimental trials wherein participants in the intervention conditions set PA goals and their PA behaviour was compared to participants in a control group who did not set goals. A meta-analysis was ultimately carried out across 45 articles (comprising 52 interventions, 126 effect sizes, $n = 5912$) that met eligibility criteria using a random-effects model. Overall, a medium, positive effect (Cohen's d (SE) = .552(.06), 95% CI = .43–.67, $Z = 9.03$, $p < .001$) of goal setting interventions in relation to PA behaviour was found. Moderator analyses across 20 variables revealed several noteworthy results with regard to features of the study, sample characteristics, PA goal content, and additional goal-related behaviour change techniques. In conclusion, multi-component goal setting interventions represent an effective method of fostering PA across a diverse range of populations and settings. Implications for effective goal setting interventions are discussed.

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It is well established that engaging in regular physical activity (PA) is associated with numerous health benefits including reduced risk of cardiovascular disease, diabetes, stroke, obesity, multiple cancers, as well as improved psychological functioning and quality of life (World Health Organization, 2009). In spite of these physical and mental health benefits, the majority of people across a range of populations currently do not engage in sufficient levels of PA (World Health Organization, 2010). In response to this ongoing public health concern, there have been growing calls to develop efficacious cost-effective PA interventions (World Health Organization, 2007).

A prominent intervention strategy that has been the focus of much research interest is *goal setting*. A goal has been described as the object or aim of an action (Latham & Locke, 1991; Locke & Latham, 2002; Locke, Shaw, Saari, & Latham, 1981). Formulated upon Ryan's (1970) contention that conscious goals influence subsequent action, goal setting theory was originally developed within the context of

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industrial and organisational psychology (Latham & Locke, 1991; Locke et al., 1981; Locke & Latham, 2002, 2006), and over the past four decades has been used to explain and change behaviour across several domains of human functioning (e.g., Kyllo & Landers, 1995; Tubbs, 1986; Zetik & Stuhlmacher, 2002). According to Locke and Latham (2002, 2006), the process of setting goals facilitates behaviour change by guiding individuals' attention and efforts, and increasing persistence towards obtaining a specified level of proficiency.

In their seminal work on goal setting theory, Latham and Locke (1991) and Locke and Latham (2002, 2006) emphasised the importance of several variables that have the potential to moderate the effects of goal setting in achieving a desired set of outcomes. First, they theorised that a series of individual difference variables (on the part of the person setting the goal) might have a substantive effect on goal attainment. Specifically, they contended that greater goal *commitment*, *ability* and *self-efficacy* to perform the tasks related to the goal, perceived *importance* of the goal, and anticipated satisfaction if the goal is attained (i.e., goal *valence*) act as personal variables by which the effects of goal setting can be maximised (Latham & Locke, 1991). Other individual difference factors such as ethnicity, age, and sex (i.e., demographic variables) were theorised to not moderate the effects of goal setting (Latham & Locke, 1991).

Beyond these individual difference variables, Latham and Locke (1991) also point to various 'goal attributes' (p. 213) that may act as moderators. These specifically relate to facets of the goal being set that might either facilitate or debilitate the effects of this intervention. For instance, in terms of the content of goals, they contended that making goals *specific*, *difficult/challenging*, *public* to other individuals, and *positively framed* is advantageous. Other goal content considerations include the person *who prescribes the goal* (i.e., self-set versus set by others), *proximity* of the goal timeframe (i.e., short- versus long-term goals), and task *complexity*. With regard to the former attribute, Latham and Locke (1991) contend that goals are effective regardless of whether they are self-set by an individual, assigned by another person (e.g., an expert or authority figure), or set collaboratively between the two. With regard to timeframe (vis-a-vis proximity), shorter term goals can be beneficial (such as by increasing self-efficacy in performing a task), as can longer term goals (such as by improving behaviour in long-term behaviour change programmes; Latham & Locke, 1991). Finally, goals can be beneficial with simple tasks but also with complex tasks; however, in these latter situations, it is important that individuals incorporate suitable strategies for obtaining the goal (Latham & Locke, 1991).

Within the family of 'goal attributes' specified by Latham and Locke (1991) are several variables that can be considered distinct behaviour change techniques (BCTs; cf. Abraham & Michie, 2008; Kok et al., in press) in their own right. For instance, according to Latham and Locke (1991) the attainment of goals can be enhanced by incorporating *feedback* (i.e., data about recorded behaviour or evaluating performance in relation to a set standard), suitable task *strategies* (i.e., how to perform/attain behaviour), and *rewards* (i.e., contingent incentives that are explicitly linked to the achievement of specified behaviour) (cf. Abraham & Michie, 2008). In fact, Latham and Locke (1991) highlight a process known as the 'high-performance cycle' (p. 233) wherein they hypothesise that combining feedback, task strategies, and rewards with regard to one's goals can maximise individuals' success as opposed to merely setting a goal alone. Moreover, *self-control training* and *subconscious priming* may also increase the likelihood of reaching one's goal (Latham & Locke, 1991; Locke & Latham, 2006).

Finally, in addition to the abovementioned personal variables and goal attributes that might act as moderator variables, Latham and Locke (1991) also highlight the potential for two environmental variables, *situational constraints* and *norms*, to moderate the effects of goal setting. First, when situational constraints are high, individuals are theorised to be less likely to achieve their goals compared to when these constraints are low (Latham & Locke, 1991). Second, being made aware of the average/normal performance of others (i.e., norms) can impact the goal one chooses to set (e.g., individuals may make their previously set goal more difficult if they feel they are too easy compared to others' goals and/or behaviour; Latham & Locke, 1991).

A number of studies within the field of behavioural medicine have pointed to the benefits of goal setting in fostering PA behaviour. Positive relationships derived from goal setting interventions have been found within multiple settings, such as in primary care centres (e.g., Trinh, Wilson, Williams, Sum, & Naylor, 2012), grade school classrooms (e.g., Wang, 2004), workplaces (e.g., Dishman, Vandenberg, Motl, Wilson, & DeJoy, 2010), and faith-based organisations (e.g., Penn, 2010). Goal setting interventions have also been beneficial in relation to PA with a variety of populations, including males (e.g., Moy, Weston, Wilson, Hess, & Richardson, 2012) and females (e.g., Sidman, Corbin, & Le Masurier, 2013), across a range of ages from children (e.g., Horne, Hardman, Lowe, & Rowlands, 2009) to older adults (e.g., Strath et al., 2011), as well as in persons with chronic conditions such as chronic obstructive pulmonary disease (e.g., Altenburg et al., 2015), osteoarthritis (e.g., Talbot, Gaines, Huynh, & Metter, 2003), intellectual impairments (e.g., Tilley, 2011), and cancer survivors (e.g., Matthews et al., 2007). Furthermore, positive relationships with PA have been shown in goal setting interventions of several durations from one week (e.g., Gardiner, Eakin, Healy, & Owen, 2011) to over one year (e.g., Narayan & Mazzola, 2014), as well as in interventions guided by an array of theories including social cognitive theory (e.g., Croteau, 2004), goal setting theory (e.g., Booth, Nowson, & Matters, 2008), the transtheoretical model (e.g., Fitzsimons, Baker, Gray, Nimmo, & Mutrie, 2012), self-regulation theory (e.g., Moy et al., 2010), and the theory of planned behaviour (e.g., Heron, Tully, McKinley, & Cupples, 2013).

Despite the collection of research pointing to the benefits of goal setting interventions on PA behaviour, a systematic review and quantitative synthesis of these effects has yet to be conducted. With this in mind, the first purpose of this study was to conduct a meta-analysis to assess the overall averaged effect of goal setting interventions in relation to individual PA behaviour. We hypothesised that positive, significant effects of goal setting interventions in relation to PA behaviour would emerge from this analysis. We also sought to examine whether variability in the size of this effect can be explained by moderator variables related to characteristics of the study, sample characteristics, and goal attributes (see Methods section for an overview of these moderators). When taken together, such a meta-analytic synthesis is not only a particularly timely endeavour, but also has the potential to substantively inform PA health-promotion interventions in a variety of settings and involving diverse populations.

Methods

Literature search and eligibility criteria

Searches for possible research articles were conducted in the following databases: *PubMed*, *PsycInfo*, *PsycArticles*, *Medline*, *Cochrane Central Register of Controlled Trials*, *ISI Web of Science*, *SportDiscus*, and *ProQuest Dissertations and Theses*. These searches were conducted in January 2015. In each database search, we used the following combinations of search terms: (1) *goal**, with (2) *physical activity*, *physically active*, *exercis**, *walkin*g. Potential articles were then reviewed for eligibility by the first author and a second co-author. Each article was first subjected to title elimination, then abstract elimination, and finally full-text elimination. We also searched the reference sections of the articles that met our inclusion criteria in order to determine if any additional articles could be retrieved (see Figure 1).

To be included in the meta-analysis, an article needed to meet the following criteria: (1) the study must be a between-subjects controlled experimental study (i.e., include a control group who did not set goals); (2) the study must be an intervention wherein the primary focus involved setting PA goals and assessing PA behaviour. Studies could be included if additional BCTs (e.g., goal-related feedback, rewards) were incorporated into the goal setting intervention (i.e., a multi-component intervention) for the purpose of fostering goal attainment. However, if an intervention's primary focus and/or additional components were *unrelated* to the PA goals (e.g., general stress management and cognitive behaviour therapy), these studies were excluded; (3) the PA goal had to be individually focused and measured (group goal setting interventions were included only if they also involved individuals setting personal PA goals); and (4) the article had to provide appropriate statistics to compute effect sizes. If the requisite statistical information was missing from a given manuscript, we contacted the

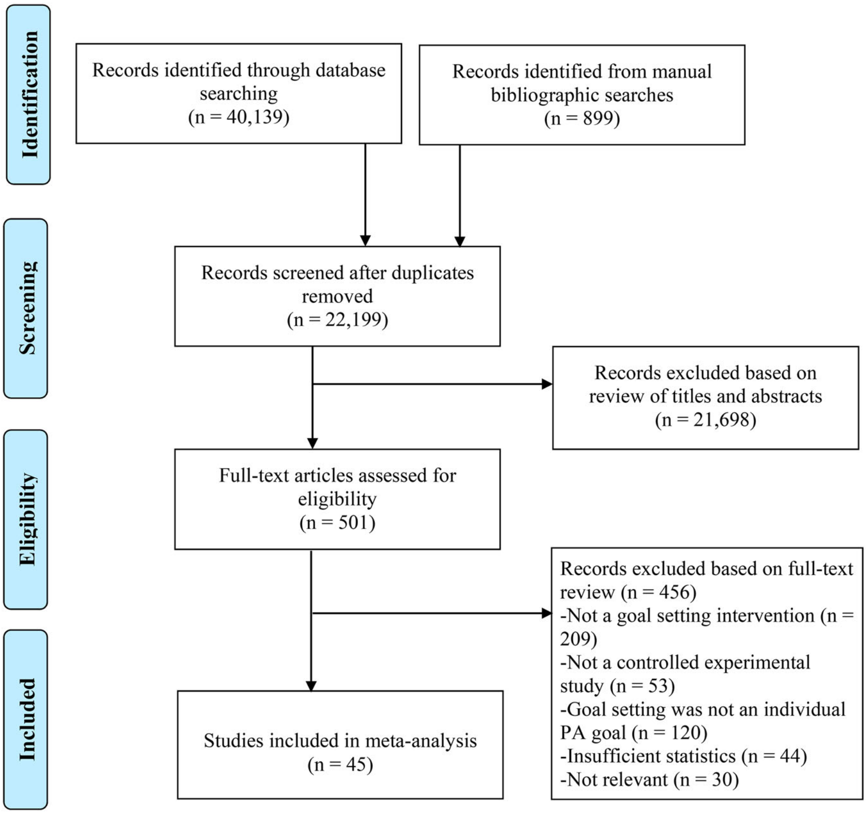


Figure 1. Results of literature search.

corresponding authors for this information. Studies that focused on improving task performance (e.g., improving race times of elite runners, increasing athletes' performance in their sport) were not included.

Data analysis

Articles that met our eligibility criteria were extracted and subsequently reviewed independently by the first author and another co-author with respect to 20 moderator variables and risk of bias (described below). When discrepancies in coding occurred, the authors met to resolve these differences by referring back to the article in question. Data were then analysed as a random-effects model using the software *Comprehensive Meta-Analysis, Version 2* (Borenstein, Hedges, Higgins, & Rothstein, 2005). A random-effects model assumes heterogeneity in the effect sizes from a population of studies, and is the appropriate model to use in social science research (compared to a fixed-effects model which assumes that the average effect size does not vary from study to study; Borenstein, Hedges, Higgins, & Rothstein, 2009; Field & Gillett, 2010).

Where possible, effect sizes for each study were derived from means, standard deviations, and sample sizes at baseline and post-intervention of experimental and control conditions (Borenstein et al., 2009; Decoster & Claypool, 2004). If such statistics were missing, we used *F*-statistics, *t* scores, and *p*-values. Each study was given a relative weight based on its precision, which is determined by the study's sample size, standard error, and confidence interval (i.e., more precise data is given a larger relative weight compared to less precise data; Borenstein et al., 2009). In instances where a study provided more than one effect size (such as when multiple PA outcomes were measured), these effect sizes were combined into one overall effect size statistic for that study, so as to not give greater relative weight to these studies and potentially skew the overall results (Borenstein et al., 2009). The exception to this was when articles reported the effects of multiple interventions (i.e., multiple subgroups), each of which was subject to a unique goal setting protocol. In these cases, an effect size from each intervention was computed; thus, this article contributed multiple effect sizes to the total number of comparisons within the meta-analysis. If studies reporting results from multiple interventions compared PA outcomes for each of the experimental conditions to the same control condition, we corrected for potential unit-of-analysis errors by dividing the sample size of the control condition by the number of within-study comparisons. For example, if three experimental conditions were compared to one control condition (e.g., which had a sample size of 60 participants), we divided *n* of the control condition by 3 (i.e., 60/3 = 20; Higgins & Green, 2008). Cohen's *d* was calculated as the effect size metric to represent the standardised effect (i.e., the average magnitude of effectiveness) of goal setting on PA behaviour (Cohen, 1992). Standard errors and 95% confidence intervals were computed to test for the accuracy of the standardised effects obtained.

Tests of heterogeneity within the meta-analysis were also performed by assessing the variability in the observed effect sizes across studies (*Q* value), as well as the ratio of the true heterogeneity to the total observed variation (I^2). To assess potential publication bias, we calculated the fail-safe *N* statistic, which estimates the number of unpublished studies with null findings that would have to exist to reduce the effect size to zero (Rosenthal, 1979). If this number is sufficiently large – Rosenberg (2005) advises a critical value of $5N+10$ – one can be confident that the chance of such a number of studies existing is low. We also obtained funnel plots to provide a visual depiction of potential publication bias. In addition, we examined risk of bias within the included studies using the Cochrane Collaboration's tool (Higgins et al., 2011) and by following recommendations from Higgins and Green (2008) and de Bruin, McCambridge, and Prins (2015). Finally, sensitivity analyses were conducted by obtaining an effect size when a study is removed from the analysis, thereby assessing the impact of each individual intervention on the overall effect size.

Moderator analyses

In total, we examined 20 potential moderators related to study characteristics, sample characteristics, as well as goal attributes, which included the content of the goal and goal-related BCTs (see Appendix A for a detailed description and coding of moderators). For each moderator variable, we computed an effect size, standard error, 95% confidence interval, *Z*-value, and *p*-value to test for the effects of each category on PA, as well as a *Q* statistic and corresponding *p*-value to assess heterogeneity across these effects (Borenstein et al., 2009). Study characteristics that were examined included *publication source*, whether a *theoretical framework* was used to guide the intervention, *intervention setting, mode of intervention delivery, type of PA* targeted, *PA intensity targeted,* and *PA measure* used to assess PA behaviour; a meta-regression was also conducted to address whether the continuous variable of *intervention duration* (total, in weeks) moderated the effects of goal setting on PA behaviour. Sample characteristics included *age*, *sex*, *baseline weight status* (as sample mean BMI), *baseline PA levels*, and *population targeted* (general or a specific population). Although we sought to also examine additional personal variables (cf. Latham & Locke, 1991; Locke & Latham, 2002, 2006) including *goal commitment, goal-related self-efficacy, goal-related ability, goal valence, perceived importance of the goal,* none of the studies in our meta-analysis assessed these variables. We were also unable to examine *ethnicity* as a potential moderator because all study samples either had a mix of different ethnicities or did not present data on this variable. Goal content moderators – based on goal setting theory (Latham & Locke, 1991; Locke & Latham, 2002, 2006) – that were examined included *goal specificity*, *source of goal prescription*, *goal timeframe*, and *frequency of goal setting/modifications*. Although we sought to also examine *goal difficulty, goal framing, task complexity,* and *whether goals were made public*, none of the studies in our meta-analysis reported data on these goal content variables; therefore, we were unable to include these within our moderator analyses. We also sought to examine the inclusion of the five goal-related BCTs highlighted by Latham and Locke (1991) and

Locke and Latham (2002) – *feedback, strategy planning, rewards, subconscious priming,* and *self-control/management training* – as moderators within the goal setting interventions. None of the included studies operationalised subconscious priming or self-control/management training; therefore, only feedback, strategy planning, and rewards were coded as candidate BCT moderators. Finally, none of the studies operationalised *situational constraints* and *norms*, and so we were unable to examine these environmental variables as potential moderators.

With regard to the goal-related BCTs highlighted within Latham and Locke's (1991) framework, we were also interested in whether various *combinations* of feedback, strategy planning, and/or rewards (i.e., multi-component interventions) improve PA behaviour beyond just setting a goal. We, therefore, conducted a method co-occurrence analysis as per recent recommendations by Peters, de Bruin, and Crutzen (2015) to determine 'what works and under what parameters' (p. 7).[1] Hence, in the context of our study, the question is whether interventions that combine multiple goal-related BCTs are more effective than those interventions that do not. Specifically, using BCT absence as a reference category (i.e., when goals were set but feedback, strategy planning, and rewards were not included within the intervention), we dummy coded categories based on the inclusion of one or more of these three BCTs. This provides a means of examining the extent to which goal setting is more effective (in supporting PA behaviour) when it is augmented with each of these attributes (e.g., goal setting alone versus goal setting plus feedback versus goal setting plus feedback and rewards, and so on). This provides an important opportunity to test theoretical assertions of goal setting theory; namely, that the effects of goal setting will be maximised if these BCTs are included as part of the intervention for achieving the set PA goals. Aligning with the propositions of Latham and Locke's (1991) 'high-performance cycle' of goal setting, we hypothesised that goal setting interventions that incorporated a more comprehensive set of goal-related BCTs would be more effective in supporting PA behaviour when compared to those that used fewer (or no) BCTs.

Results

Literature search

The literature searches from the 8 databases returned 40,139 potentially relevant articles. An additional 899 articles were retrieved from the bibliographic sections of manuscripts that originally met our inclusion criteria, which resulted in an initial pool of 41,038 total articles. After removing duplicates, 22,199 articles were subject to title and abstract review. Based on these reviews, 21,698 articles were eliminated, while 501 were full-text reviewed. Ultimately, 45 articles met our eligibility criteria – see Figure 1 for the PRISMA (Moher, Liberati, Tetzlaff, & Altman, 2009) flow diagram. Of these studies, 7 included multiple experimental conditions – each of which was subject to a separate goal setting intervention – which resulted in 52 total comparisons (k), a total sample size (n) of 5912, and 126 individual effect sizes. Inter-coder agreement of moderators and risk of bias assessment was over 90%, kappa (SE) = 0.80 (0.01). Overviews of each study with regard to experimental design, sample characteristics, PA measures utilised, and effect sizes calculated are provided in Table 1.

Summary statistics

Results of the overall goal setting effect along with summary statistics, sensitivity analyses, and forest plots for the included studies are presented in Table 2. Overall, a medium positive effect was found ($d = 0.552$) based on Cohen's (1992) criteria, with study effect sizes ranging from −0.31 (Bycura, 2009) to 1.91 (Duncan & Pozehl, 2003). Sensitivity analyses showed the smallest total effect size was 0.530 when the study by Annesi (2002) was removed, and the largest effect size was 0.569 when the study by Reijonsaari et al. (2012) was removed. Tests of heterogeneity revealed significant variability in the observed effect sizes across interventions, $Q(\text{df}) = 192.62(51)$, $p < 0.001$. The I^2 value was 73.52, indicating that a high proportion (i.e., over 73%) of the observed between-

Table 1. Summary descriptions of studies included in meta-analysis.

Study	Design	Sample characteristics	PA measures	Effect size calculation
Aittasalo et al. (2004)	52-Week RCT (2 experimental conditions, 1 control)	Employees from various industries in Finland (*n*: 155, age: 44 ± 9, 56% female)	Pedometer: daily step count Activity log: LTPA sessions per week; LTPA minutes per week; Kcal expenditure per week; MVPA sessions per week; MVPA minutes per week	6 Effect sizes: 2 experimental conditions merged as 1 in analyses versus control; differences in PA changes between conditions from baseline to 12 months
Aittasalo et al. (2012)	26-Week RCT (1 experimental condition, 1 control)	Employees from various industries in Finland; Control (*n*: 118, age: 45.3 ± 9.1), Intervention (*n*: 123, age: 44.1 ± 9.4)	Pedometer: daily step count Activity log: number of steps in various activities	5 Effect sizes: differences between conditions in PA at baseline and week 26
Altenburg et al. (2015)	12-Week RCT (1 experimental condition, 1 control)	Persons with COPD from the Netherlands (*n*: 155, age: 62, 66% male)	Pedometer: daily step count; daily PA	2 Effect sizes: differences between conditions in PA changes from baseline to week 12
Annesi (2002)	52-Week RCT (1 experimental condition, 1 control)	Members of a northern Italian fitness facility; Control (*n*: 50, age: 39.3 ± 8.7, 70% female), Experimental (*n*: 50, age: 40.7 ± 9.4, 68% female)	Attendance: % of each condition attending fitness facility 3 times per week	1 Effect size: difference in attendance across the 52 weeks
Araiza et al. (2006)	6-Week RCT (1 experimental condition, 1 control)	Individuals with type 2 diabetes mellitus; Control (*n*: 15, age: 51 ± 10), Intervention (*n*: 15, age: 49 ± 11)	Pedometer: daily step count	1 Effect size: differences between conditions in PA at baseline and week 6
Babazono et al. (2007)	52-Week RCT (1 experimental condition, 1 control)	Older adults from Japan; Control (*n*: 41, age: 65.7 ± 7.8, 63% female), Experimental (*n*: 46, age: 65.3 ± 7.6, 54% female)	Pedometer: daily step count	1 Effect size: differences between conditions in PA at baseline and week 52
Baker et al. (2008)	12-Week RCT (1 experimental condition, 1 control)	Scottish community sample not meeting current PA recommendations (*n*: 79, age: 49.2 ± 8.8, 80% female)	Pedometer: daily step count,	1 Effect size: differences between conditions in PA at baseline and week 12
Baker et al. (2011)	4-Week RCT (2 experimental condition, 1 control)	Adults from Scottish University (*n*: 61, age: 42.1 ± 10.6 years, 72% female)	Pedometer: daily step count	2 Effect sizes: differences between conditions in PA at baseline and week 4
Bickmore et al. (2013)	52-Week RCT (1 experimental condition, 1 control)	Older adults from outpatient clinics in Boston, USA; Control (*n*: 131, age: 70.8 ± 5.2, 72% female), Experimental (*n*: 132, age: 71.7 ± 5.6)	Pedometer: daily step count	1 Effect size: difference between conditions in step count changes from baseline to week 52
Butler et al. (2009)	6-Week RCT (1 experimental condition, 1 control)	Cardiac rehabilitation patients from New South Wales, AUS; Control (*n*: 55, age: 64.5 ± 11.2, 82% male), Experimental (*n*: 55, age: 63 ± 10.4, 69% male)	Pedometer: mean and median PA minutes, PA sessions, walking minutes, and walking sessions	8 Effect sizes; differences between conditions in PA changes from baseline to week 6
Bycura (2009)	4-Week RCT (1 experimental condition, 1 control)	Undergraduate students at University in Southwest USA; Control (*n*: 15, age: 19.9), Experimental 1 (*n*: 29, age: 20), Experimental 2 (*n*: 40, age: 19.9)	Questionnaire: days exercised per week	2 Effect sizes; differences between conditions in PA changes at weeks 4 and week 7
Devi et al. (2014)	6-Week RCT (1 experimental condition, 1 control)	Persons with stable angina from a primary care setting in one region of England; Experimental (*n*: 48; age: 66.3 ± 8.4; 71% male), Control (*n*: 46; age: 66.2 ± 10.0; 78% male)	Pedometer: daily step count	1 Effect size: differences between conditions at baseline and week 6
Dishman et al. (2009)	12-Week RCT (1 experimental condition, 1 control)	Employees of 16 worksites across USA and Toronto, CA (*n*: 965)	Questionnaire: moderate PA METS; vigorous PA METS Pedometer: walking METS	3 Effect sizes: differences between conditions in PA at baseline and week 12

(*Continued*)

Table 1. Continued.

Study	Design	Sample characteristics	PA measures	Effect size calculation
Duncan & Pozehl (2003)	24-Week RCT (1 experimental condition, 1 control)	Patients with heart failure in Nebraska, USA (*n*: 14; age: 66.4; 86% male)	Activity log: exercise sessions completed	1 Effect size: difference between conditions in adherence changes from week 12 to week 24
Fjeldsoe et al. (2010)	12-Week RCT (1 experimental condition, 1 control)	Australian postnatal women (*n*: 88, age: 30 ± 6)	Questionnaire: MVPA and walking frequency	2 Effect sizes: differences between conditions in PA changes from baseline to week 12
Furber et al. (2008)	2-Week RCT (1 experimental condition, 1 control)	Persons with type 2 diabetes or glucose intolerance from an Australian diabetes service; Experimental (*n*: 121; age: 58.3 ± 12.6; 46% female), Control (*n*: 105; age: 61.6 ± 12.3; 48.6% female)	Questionnaire: walking time	1 Effect size: differences between conditions in walking time at baseline and week 2
Furber et al. (2010)	6-Week RCT (1 experimental condition, 1 control)	Australian cardiac patients who did not attend a Cardiac Rehabilitation programme; Experimental (*n*: 104; age: 66.7 ± 10.6; 71% male), Control (*n*: 111; age: 65.4 ± 11.5; 69% male)	Questionnaire: Sessions and minutes of walking and total PA	4 Effect sizes: differences between conditions in PA at baseline and week 6
Hallmark et al. (2005)	6-Week RCT (2 experimental conditions, control)	Adult women (*n*: 38)	Pedometer: daily step count	2 Effect sizes: differences between each experimental condition and control condition in step count at baseline and week 6
Hancock (2005)	3-Week RCT (1 experimental condition, 1 control)	Primary school children in USA (*n*: 163)	Pedometer: daily step count	1 Effect size: difference between conditions in step count at baseline and week 3
Hatchett (2008)	12-Week RCT (1 experimental condition, 1 control)	Women recovering from breast cancer (*n*: 74, age: 53.35)	Questionnaire: total, moderate, and vigorous PA	3 Effect sizes: differences between conditions in PA at baseline and week 12
Havenar (2007)	52-Week RCT (1 experimental condition, 1 control)	Adult community sample (*n*: 41, age: 45.6 ± 12.6, 84% female)	Questionnaire: total minutes of MVPA/week, total energy expenditure	2 Effect sizes: differences between conditions in PA at baseline and week 52
Hawkins et al. (2014)	12-Week RCT (1 experimental condition, 1 control)	Pregnant women at risk for gestational diabetes mellitus in Northeastern USA (*n*: 290, age: 26.5)	Questionnaire: total PA	1 Effect size: difference between conditions in PA at baseline and week 12
Horne et al. (2009)	14-Week RCT (1 experimental condition, 1 control)	Primary school children in Wales; Experimental (Boys – *n*: 15, age: 9.9 ± 0.7; Girls – *n*: 23, age: 10 ± 0.7), Control (Boys – *n*: 28, age: 10.2 ± 0.6; Girls – n: 23, age: 9.9 ± 0.6)	Pedometer: daily step count	2 Effect sizes: differences between conditions in step counts at week 16 for boys and for girls
Hospes et al. (2009)	12-Week RCT (1 experimental condition, 1 control)	Persons with COPD in the Netherlands; Experimental (*n*: 18, age: 63.1 ± 8.3, 56% male), Control (*n*: 17, age: 61.2 ± 9.1, 65% male)	Pedometer: daily step count	1 Effect size: difference between conditions in step count at baseline and week 12
Houle et al. (2011)	12-Month RCT (1 experimental condition, 1 control)	Patients hospitalised for an acute coronary syndrome in Quebec; Experimental (*n*: 32, age: 58 ± 8, 81% male), Control (*n*: 33, age: 59 ± 9, 76% male)	Pedometer: daily step count	1 Effect size: difference between conditions in step count at baseline and week 52
Irvine et al. (2013)	12-Week RCT (1 experimental condition, 1 control)	Sedentary adults from USA (*n*: 368, age: 60.3 ± 4.9; 69% female)	Questionnaire: PA minutes per day in balance, cardiovascular, strengthening, stretching, and total activities Pedometer: daily step count	5 Effect sizes: differences between conditions in PA changes from baseline to week 12

(*Continued*)

Table 1. Continued.

Study	Design	Sample characteristics	PA measures	Effect size calculation
Kaminsky et al. (2013)	8-Week RCT (1 experimental condition, 1 control)	Patients in a maintenance cardiac rehabilitation programme; Experimental (*n*: 10, age: 53.3 ± 8.1, 80% male), Control (*n*: 8, age: 59.4 ± 9.9, 75% male)		1 Effect size: difference between conditions in step count at baseline and week 8
Kovelis et al. (2012)	1-Month RCT (1 experimental condition, 1 control)	Adult smokers in Brazil; Experimental (*n*: 23, age: 51, 35% male), Control (*n*: 17, age: 52, 59% male)	Pedometer: daily step count	2 Effect sizes: differences between conditions in step count changes among active and inactive (at baseline) participants from baseline to week 4
Lombard (1994)	16-Week RCT (1 experimental condition, 1 control)	Community sample near a University in Southeastern USA (*n*: 74, age: 37 ± 10.5, 86% female)	Activity log: number of days active per week; number of minutes active per week; average minutes active per week; active or not (dichotomous variable); meeting ACSM PA guidelines	5 Effect sizes: difference between conditions in PA at baseline and week 16
Martin (1998)	3-Week RCT (1 experimental condition, 1 control)	Female undergraduate students at a university in Eastern USA (*n*: 30, age: 25.8 ± 8.6)	Questionnaire: number of exercise sessions, minutes, and intensity per week	3 Effect sizes: differences between conditions in PA at baseline and week 4
Matthews et al. (2007)	12-Week RCT (1 experimental condition, 1 control)	Breast cancer survivors in Eastern USA; 100% female; Experimental (*n*: 22, age: 51.3 ± 9), Control (*n*: 14, age: 56.9 ± 12.3)	Questionnaire: social activities; household activities; lawn and garden work; non walking exercise; self-reported walking; total activity Accelerometer: activity counts; daily step counts; moderate walking; % of activity at light intensity; and % of activity at moderate-vigorous intensity	11 Effect sizes: differences between conditions in PA at baseline and week 12
Maturi et al. (2011)	12-Week RCT (1 experimental condition, 1 control)	Females in the postpartum period in Iran; Experimental (*n*: 32, age: 25.7 ± 4.6), Control (*n*: 34, age: 24.8 ± 3.7)	Pedometer: energy expenditure, and light, moderate, vigorous PA	4 Effect sizes: differences between conditions in PA at baseline and week 12
Ornes (2006)	4-Week RCT (1 experimental condition, 1 control)	Female university students in Western USA; Experimental (*n*: 60, age: 20.7 ± 2.8), Control (*n*: 61, age: 20.6 ± 3.5)	Pedometer: daily step count	1 Effect size: differences between conditions in step count at baseline and week 4
Petersen et al. (2012)	13-Week RCT (1 experimental condition, 1 control)	Adults from Denmark; Experimental (*n*: 192); Control (*n*: 173)	Questionnaire: total walking time	1 Effect size: difference between conditions in total walking time at week 13
Purath (2002)	6-Week RCT (1 experimental condition, 1 control)	Female university employees from Midwestern USA (*n*: 271)	Questionnaire: minutes walked per week to work, on errands, during work, and for exercise; total minutes walked per week; flights of stairs taken per day; blocks walked per day; hours of weekday and weekend MVPA	9 Effect sizes: differences between conditions in PA at baseline and week 6
Reijonsaari et al. (2012)	52-Week RCT (1 experimental condition, 1 control)	Employees from an insurance company in Finland (*n*: 43, age: 43, 64% female)	Questionnaire: weekly volume of PA	1 Effect size: differences between conditions in PA at baseline and week 52
Ribeiro et al. (2014)	3-Month RCT (2 experimental	Middle-aged women in Brazil; Experimental 1 (*n*: 53, age: 45	Pedometer: total and moderate steps	4 Effect sizes: differences between each

(*Continued*)

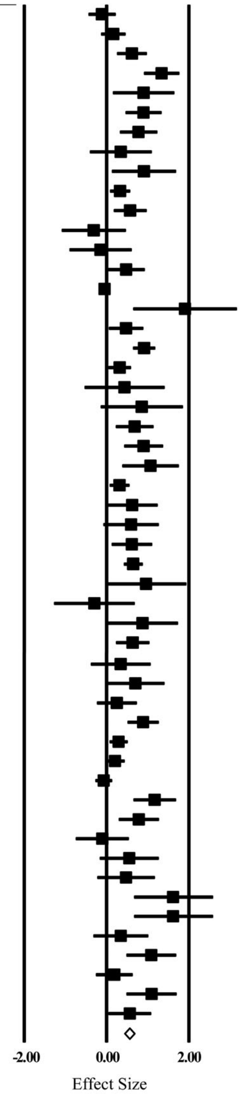
Table 1. Continued.

Study	Design	Sample characteristics	PA measures	Effect size calculation
	conditions, 2 control)	± 3), Experimental 2 (n: 48, age: 45 ± 3), Control 1 (*n*: 47, age: 45 ± 3), Control 2 (*n*: 47; age: 45 ± 3)		experimental condition and control condition in PA changes from baseline and week 13
Sawchuk et al. (2011)	6-Week RCT (1 experimental condition, 1 control)	American Indian/Alaska Native elders; Control condition (*n*: 19, age: 61 ± 8.4, 68% female), Experimental condition (*n*: 17, age: 62 ± 9.8, 71% female)	Questionnaire: calorie expenditure (all activities), calorie expenditure (moderate PA); exercise bouts per week, bouts of moderate PA per week Pedometer: daily step count, total steps over 5 weeks; daily step count for 5 weeks	7 Effect sizes: differences between conditions in PA at week 6
Schofield et al. (2005)	12 Week RCT (2 experimental conditions, 1 control)	Adolescent females from Australian high schools; Experimental 1 (*n*: 23, age: 15.9 ± 0.8), Experimental 2 (*n*: 21, age: 15.7 ± 0.8), Control (*n*: 24, age: 15.9 ± 0.8)	Pedometer: daily step count Questionnaire: vigorous and moderate-vigorous PA	6 Effect sizes: differences between each experimental condition and control condition in PA at baseline and week 12
Strath et al. (2011)	12-Week RCT (2 experimental conditions, 1 control)	Older adults from Central USA; Control (*n*: 20, age: 64.9 ± 7.1, 80% female), Experimental 1 (*n*: 20, age: 63.3 ± 5.8, 85% female), Experimental 2 (*n*: 20, age: 63.6 ± 4.2, 86% female)	Pedometer: daily step count	2 Effect sizes: differences between each experimental condition and control condition in step count at week 12
Talbot et al. (2003)	12-Week RCT (1 experimental condition, 1 control)	Older adults from Eastern USA; Experimental (*n*: 17, age: 69.6 ± 6.7, 77% female), Control (*n*: 17, age: 70.8 ± 4.7, 77% female)	Pedometer: daily step count, total vector	2 Effect sizes: differences between conditions in PA at baseline and week 12
Tudor-Locke et al. (2004)	16-Week RCT (1 experimental condition, 1 control)	Adults with type 2 diabetes; Experimental (*n*: 24, age: 52.8 ± 5.2, 50% male), Control (*n*: 23, age: 52.5 ± 4.8, 61% male)	Pedometer: daily step count	1 Effect size: differences between conditions in step count at baseline and week 16
Wadsworth (2005)	6-Week RCT (1 experimental condition, 1 control)	Female university students from Southeastern USA; Experimental (*n*: 45), Control (*n*: 46)	Accelerometer: days and minutes of moderate and vigorous PA	4 Effect sizes: differences between conditions in PA at baseline and week 6
Wang (2004)	6-Week RCT (1 experimental condition, 1 control)	Female middle school students in USA; Experimental (*n*: 24), Control (*n*: 22)	Pedometer: daily step count	1 Effect size: differences between conditions in step count at baseline and week 6
Watson et al. (2012)	12-Week RCT (1 experimental condition, 1 control)	Adults from Boston, USA; Experimental (*n*: 27; age: 44.1; 89% female), Control (*n*: 30; age: 40.6; 80% female)	Pedometer: daily step count	1 Effect size: difference between conditions in step count changes from baseline to week 12

Notes: Although some studies had more experimental conditions than reported here, some of those conditions did not meet eligibility criteria. Therefore, the results given in this meta-analysis only reflect outcomes from the experimental conditions that met our inclusion criteria; RCT = randomised controlled trial; PA = physical activity; MET= metabolic equivalence; LTPA = leisure time physical activity; MVPA = moderate-vigorous physical activity; kcal = kilocalories; NR = not reported.

Table 2. Summary results of studies included in meta-analysis.

Study	Relative Weight	Effect Size (SE)	95% CI (lower, upper)	*Z*-value	*p*-value	ES with study removed
Aittasalo et al. (2004)	2.55	-.111 (.17)	-.45, .22	-0.65	.513	0.568
Aittasalo et al. (2012)	2.65	.163 (.15)	-.14, .46	1.06	.289	0.563
Altenburg et al. (2015)	2.45	.618 (.19)	.25, .99	3.30	.001	0.551
Annesi (2002)	2.24	1.339 (.22)	.91, 1.77	6.05	<.001	0.530
Araiza et al. (2006)	1.41	.902 (.38)	.15, 1.65	2.35	0.019	0.547
Babazano et al. (2007)	2.22	.900 (.23)	.46, 1.34	3.99	<.001	0.544
Baker et al. (2008)	2.17	.779 (.23)	.32, 1.24	3.34	.001	0.547
Baker et al. (2013) A	1.40	.346 (.39)	-0.41, 1.10	0.89	.371	0.555
B	1.34	.909 (.40)	0.12, 1.70	2.27	.023	0.547
Bickmore et al. (2013)	2.79	.328 (.13)	.08, .58	2.58	.010	0.560
Butler et al. (2009)	2.33	.573 (.21)	.17, .98	2.77	.006	0.552
Bycura (2009) A	1.34	-.311 (.40)	-1.10, .48	-0.78	.437	0.563
B	1.40	-.146 (.39)	-.91, .61	-0.38	.707	0.562
Devi et al. (2014)	2.16	.475 (.24)	.02, .94	2.02	.043	0.554
Dishman et al. (2009)	3.03	-.048 (.08)	-.19, .10	-0.65	.517	0.566
Duncan & Pozehl (2003)	0.70	1.908 (.65)	.64, 3.17	2.96	.003	0.542
Fjeldsoe et al. (2010)	2.27	.847 (.22)	.05, .90	2.19	<.029	0.554
Furber et al. (2008)	2.72	.914 (.14)	.64, 1.19	6.52	<.001	0.540
Furber et al. (2010)	2.72	.320 (.14)	.04, .60	2.27	.023	0.560
Hallmark et al. (2005) A	1.02	.437 (.50)	-.54, 1.41	0.88	.381	0.553
B	0.98	.857 (.51)	-.15, 1.86	1.67	.095	0.549
Hancock (2005)	2.16	.683 (.24)	.22, 1.15	2.89	.004	0.549
Hatchett (2008)	2.11	.091 (.24)	.42, 1.38	3.69	<.001	0.544
Havenar (2007)	1.54	1.07 (.35)	.38, .1.76	3.04	.002	0.543
Hawkins et al. (2014)	2.81	.314 (.13)	.07, .56	2.51	.012	0.560
Horne et al. (2009)	1.71	.625 (.32)	.003, 1.25	1.97	.049	0.551
Hospes et al. (2009)	1.58	.596 (.35)	-.08, 1.27	1.75	.085	0.552
Houle el al. (2011)	2.05	.617 (.25)	.12, 1.11	2.43	.015	0.551
Irvine et al. (2013)	2.83	.649 (.12)	.42, .88	5.44	<.001	0.550
Kaminsky et al. (2013)	1.01	.961 (.50)	-.02, 1.94	1.92	.055	0.548
Kovelis (2012) A	1.01	-.297 (.50)	-1.28, .69	-.59	.555	0.560
B	1.20	.878 (.44)	.02, 1.74	1.99	.046	0.548
Lombard (1994)	2.31	.636 (.21)	.23, 1.05	3.03	.002	0.550
Martin (1998)	1.44	.349 (.38)	-.39, 1.09	0.93	.354	0.555
Matthews et al. (2007)	1.48	.710 (.37)	-.01, 1.43	1.94	.053	0.550
Maturi et al. (2011)	2.06	.255 (.25)	-.24, .75	1.01	.313	0.559
Ornes (2006)	2.38	.900 (.20)	.51, 1.29	4.53	<.001	0.543
Petersen et al. (2012)	2.86	.296 (.12)	.07, .52	2.58	.010	0.561
Purath (2002)	2.82	.207 (.12)	-.03, .45	1.68	.093	0.563
Reijonsaari et al. (2012)	2.90	-.068 (.11)	-.28, .14	-0.64	.525	0.569
Ribeiro et al. (2014) A	1.97	1.184 (.27)	.66, 1.71	4.40	<.001	0.538
B	2.05	.793 (.25)	.30, 1.29	3.12	.002	0.547
Sawchuk et al. (2011)	1.62	-.104 (.34)	-.76, .55	-0.31	.755	0.563
Schofield et al. (2005) A	1.46	.559 (.37)	-.17, 1.29	1.51	.132	0.552
B	1.50	.479 (.36)	-.23, 1.91	1.32	.187	0.553
Strath et al. (2011) A	1.04	1.636 (.49)	.67, 2.60	3.32	.001	0.540
B	1.04	1.636 (.49)	.67, 2.60	3.32	.001	0.540
Talbot et al. (2003)	1.57	.350 (.35)	-.33, 1.03	1.01	.312	0.556
Tudor-Locke et al. (2004)	1.73	1.102 (.31)	.49, 1.72	3.52	<.001	0.542
Wadsworth (2005)	2.17	.191 (.23)	-.27, .65	0.82	.414	0.560
Wang (2004)	1.71	1.108 (.32)	.49, 1.73	3.50	<.001	0.542
Watson et al. (2012)	1.96	.572 (.27)	.04, 1.10	2.11	.034	0.552
OVERALL	**100**	**.552 (0.06)**	**0.43, 0.67**	**9.03**	**<.001**	



Note: A and B = experimental groups within study; SE = standard error; CI = confidence interval; ES = effect size

study variance reflects true differences in the effect sizes (Higgins, Thompson, Deeks, & Altman, 2003). Regarding potential publication bias, the fail-safe N was 3354, which is sufficiently large (cf. Rosenberg, 2005). A funnel plot is provided in Appendix B. With regard to potential risk of bias (Higgins et al., 2011), there were no significant differences ($Q(\text{df}) = 0.701(2)$, $p = 0.704$) in effect sizes between interventions coded as being at a low ($k = 9$, $d = 0.471$, $p = 0.002$), high ($k = 9$, $d = 0.497$, $p = 0.001$), or unclear ($k = 34$, $d = 0.592$, $p < 0.001$) risk (see Appendix C for the table describing these results).

Moderator analyses

The results of the moderator analyses are provided in Table 3.

Table 3. Results of moderator analyses for study, sample, intervention characteristics, and components of the goal setting process.

Moderator	*k*	Effect size (SE)	95% CI	*Z*-value	*p*-Value	*Q* value (df), *p*-value
Study characteristics						
Publication source						0.01(1), $p = 0.933$
Peer-reviewed journal	39	0.555 (0.07)	0.42, 0.69	7.90	<0.001	
Other (thesis or conference)	13	0.543 (0.13)	0.29, 0.79	4.27	<0.001	
Theoretical framework						1.67(3), $p = 0.433$
Atheoretical/not specified	21	0.487 (0.10)	0.29, 0.68	4.83	<0.001	
Theoretical	31	0.593 (0.08)	0.44, 0.75	7.54	<0.001	
Single theory	19	0.541 (0.09)	0.36, 0.73	5.73	<0.001	
Multiple theories	12	0.709 (0.14)	0.43, 0.99	5.03	<0.001	
Intervention setting						17.12(6), $p = 0.009$
Workplace	7	0.211 (0.11)	−0.01, 0.43	1.89	0.059	
Medical/rehabilitation/primary care centre	9	0.653 (0.12)	0.43, 0.88	5.62	<0.001	
University	5	0.434 (0.17)	0.10, 0.77	2.51	0.012	
Grade school	3	0.792 (0.22)	0.36, 1.22	3.61	<0.001	
Fitness facility	1	1.339 (0.33)	0.69, 1.99	4.02	<0.001	
Home	7	0.566 (0.13)	0.32, 0.82	4.45	<0.001	
Not specified	20	0.574 (0.09)	0.39, 0.75	6.43	<0.001	
Mode of intervention delivery						2.41(3), $p = 0.492$
In person	22	0.622 (0.09)	0.44, 0.80	6.68	<0.001	
Technology	10	0.421 (0.12)	0.18, 0.66	3.46	0.001	
Multiple methods	11	0.627 (0.13)	0.36, 0.89	4.68	<0.001	
Unclear	9	0.457 (0.16)	0.15, 0.76	2.91	0.004	
Type of PA						15.60(2), $p < 0.001$
Aerobic activity	35	0.635 (0.06)	0.51, 0.76	9.95	<0.001	
Any/multiple types	10	0.607 (0.11)	0.39, 0.82	5.49	<0.001	
Not specified	7	0.142 (0.11)	−0.07, 0.36	1.29	0.196	
PA intensity prescribed						2.30(3), $p = 0.513$
Moderate	7	0.709 (0.17)	0.39, 1.03	4.29	<0.001	
Moderate-vigorous	5	0.323 (0.20)	−0.07, 0.72	1.60	0.109	
Any	4	0.494 (0.19)	0.12, 0.87	2.60	0.009	
Not specified	36	0.562 (0.08)	0.41, 0.71	7.41	<0.001	
PA measure						16.85(4), $p = 0.002$
Technology	20	0.671 (0.09)	0.49, 0.85	7.25	<0.001	
Pedometer	18	0.717 (0.09)	0.54, 0.90	7.69	<0.001	
Accelerometer	2	0.333 (0.25)	−0.15, 0.82	1.34	0.179	
Self-report	18	0.525 (0.09)	0.35, 0.70	5.83	<0.001	
PA questionnaire	16	0.449 (0.09)	0.28, 0.62	5.15	<0.001	
Activity log/diary	2	1.450 (0.31)	0.85, 2.05	4.73	<0.001	
Multiple	18	0.525 (0.11)	0.19, 0.61	3.77	<0.001	
Sample characteristics						
Age						3.15(4), $p = 0.534$
Children	2	0.657 (0.31)	0.04, 1.27	2.10	0.036	
Youth	3	0.735 (0.29)	0.18, 1.29	2.58	0.010	
Adults	36	0.523 (0.07)	0.38, 0.67	7.17	<0.001	
Older adults	5	0.417 (0.18)	0.06, 0.77	2.31	0.021	
Adults and older adults	6	0.849 (0.22)	0.43, 1.27	3.95	<0.001	
Sex						0.05(1), $p = 0.831$
Female only	16	0.573 (0.11)	0.35, 0.79	5.11	<0.001	
Both males and females	36	0.544 (0.07)	0.40, 0.69	7.37	<0.001	
Baseline weight status (sample mean BMI)						1.49(3), $p = 0.684$
Healthy	5	0.488 (0.23)	0.03, 0.95	2.09	0.037	
Overweight	26	0.567 (0.09)	0.40, 0.73	6.68	<0.001	
Obese	3	0.843 (0.27)	0.31, 1.38	3.10	0.002	
Not specified	18	0.502 (0.10)	0.30, 0.70	4.88	<0.001	
Baseline activity levels (sample mean)						0.14(1), $p = 0.712$
Does not meet PA guidelines at baseline	46	0.561 (0.07)	0.43, 0.69	8.51	<0.001	
Meets PA guidelines at baseline	6	0.491 (0.18)	0.14, 0.84	2.74	0.006	
Population type						0.63(1), $p = 0.428$
General population	31	0.512 (0.08)	0.36, 0.66	6.61	<0.001	
Special population	21	0.609 (0.10)	0.42, 0.80	6.38	<0.001	
Goal content						
Goal specificity						2.13(3), $p = 0.545$
Specific	31	0.589 (0.08)	0.43, 0.75	7.01	<0.001	

(*Continued*)

Table 3. Continued.

Moderator	k	Effect size (SE)	95% CI	Z-value	p-Value	Q value (df), p-value
Absolute	7	0.447 (0.22)	0.03, 0.87	2.08	0.038	
Relative	19	0.673 (0.11)	0.47, 0.88	6.34	<0.001	
Absolute and relative	5	0.422 (0.20)	0.03, 0.82	2.08	0.037	
Vague/unclear	21	0.511 (0.10)	0.33, 0.70	5.36	<0.001	
Source of goal prescription						0.76(3), $p = 0.860$
Participant	9	0.625 (0.14)	0.36, 0.90	4.54	<0.001	
Interventionist	23	0.583 (0.11)	0.38, 0.79	5.56	<0.001	
Collaborative	9	0.473 (0.14)	0.20, 0.75	3.38	0.001	
Unclear	11	0.517 (0.14)	0.25, 0.78	3.81	<0.001	
Goal timeframe						9.89(3), $p = 0.020$
Daily	28	0.600 (0.08)	0.44, 0.76	7.48	<0.001	
Weekly	7	0.152 (0.15)	−0.14, 0.45	1.02	0.310	
Daily and weekly	2	0.947 (0.26)	0.45, 1.45	3.71	<0.001	
Unclear/other	15	0.562 (0.09)	0.38, 0.75	6.02	<0.001	
Frequency of goal setting/modifications						1.55(4), $p = 0.819$
At baseline only	6	0.568 (0.20)	0.17, 0.97	2.79	0.005	
Daily	1	0.328 (0.36)	−0.38, 1.04	0.91	0.366	
Weekly	16	0.641 (0.11)	0.42, 0.86	5.70	<0.001	
Bi-weekly	5	0.634 (0.23)	0.19, 1.08	2.78	0.005	
Any time	24	0.499 (0.08)	0.33, 0.66	5.92	<0.001	
Goal-related BCTs						
Feedback						0.16(1), $p = 0.693$
No	3	0.646 (0.24)	0.17, 1.12	2.66	0.008	
Yes	49	0.547 (0.06)	0.42, 0.68	8.50	<0.001	
Strategy planning						0.50(1), $p = 0.480$
No	21	0.498 (0.10)	0.30, 0.70	4.95	<0.001	
Yes	31	0.588 (0.08)	0.43, 0.74	7.41	<0.001	
Rewards						0.46(1), $p = 0.499$
No	44	0.570 (0.07)	0.44, 0.70	8.52	<0.001	
Yes	8	0.462 (0.15)	0.18, 0.75	3.15	0.002	
Method co-occurrence effects						3.42(5), $p = 0.635$
Goal setting only	1	0.207 (0.37)	−0.52, 0.93	0.56	0.575	
Partial application – goal setting plus:	45	0.582 (0.07)	0.45, 0.71	8.70	<0.001	
Feedback	18	0.517 (0.11)	0.30, 0.73	4.72	<0.001	
Strategies	2	0.970 (0.32)	0.35, 1.59	3.05	0.002	
Feedback and strategy planning	23	0.600 (0.09)	0.42, 0.78	6.48	<0.001	
Feedback and rewards	2	0.541 (0.31)	−0.07, 1.16	1.73	0.084	
Complete application – goal setting plus all three of feedback, strategy planning, and rewards	6	0.440 (0.17)	0.11, 0.77	2.61	0.009	

Study characteristics

Significant positive effects of goal setting on PA behaviour were shown for both peer-reviewed journal articles and other publications (i.e., conference abstracts or dissertations; $ds \geq 0.54$), as well as for atheoretical interventions and those guided by theory ($ds \geq 0.48$). Significant effects also emerged across all intervention settings ($ds \geq 0.43$) except for workplace settings whose effect size ($d = 0.21$) approached significance. Significant effects were also shown regardless of the mode of delivery ($ds \geq 0.42$). In terms of type of PA, we found significant effects when aerobic activity was targeted or when participants could perform any type of activity they desired ($ds \geq 0.60$); however, null effects emerged when the type of activity targeted was not specified ($d = 0.14$). Significant effects were shown when the goal targeted moderate-intensity PA or when participants were free to be active at any intensity they desired as well as when this information was not specified ($ds \geq 0.49$). Non-significant effects were found when the targeted activity was specified to be of moderate-vigorous intensity ($d = 0.32$). With regard to the PA measures used, significant effects were evident regardless of whether objective (i.e., technology) or subjective (i.e., self-report) methods were used ($ds \geq 0.44$). The exception to this was for those two studies that used accelerometers only ($d = 0.33$).

Finally, the results of the meta-regression indicated that the length of the intervention did not moderate the relationship between the goal setting intervention and PA (a visual depiction of this meta-regression is provided in Appendix D). Specifically, the intercept of this regression was statistically significant, Cohen's d(SE) = 0.58(0.08), 95% confidence interval (0.41, 0.74), $Z = 6.98$, $p < .00001$, while the slope of this regression was not, Cohen's d(SE) = −0.002(0.004), 95% confidence interval (−0.01, 0.005), $Z = -0.51$, $p = 0.61$. In other words, goal setting interventions had a medium positive effect on PA regardless of the length of the intervention.

Sample characteristics

Significant positive effects were evident across all age ranges ($ds \geq 0.41$), in both female only and female plus male samples ($ds \geq 0.54$), for all weight statuses ($ds \geq 0.48$), with both insufficiently and sufficiently active (at baseline) samples ($ds \geq 0.49$), as well as for samples consisting of the general population and a specific population ($ds \geq 0.51$).

Goal attributes

Significant effects were evident regardless of the specificity of the goal ($ds \geq 0.42$) or the individual who prescribed the goal ($ds \geq 0.47$). In terms of goal timeframe, significant effect sizes were shown in interventions targeting daily PA as well as a combination of daily and weekly PA ($ds \geq 0.56$), but not weekly PA alone. With regard to the frequency of goal setting/modification, significant positive effects were shown when goals were set at baseline only, modified on a weekly or bi-weekly basis, and when modifications could be made at any time as per the participant's discretion ($ds \geq 0.49$).

With regard to the three goal-related BCTs emphasised within goal setting theory, we first analysed each individually by comparing interventions in which the BCT was present versus those in which the BCT was absent (summaries for each study with regard to the inclusion of the three goal-related BCTs are provided in Appendix E). Significant positive effects were found in interventions that included the respective BCT as well as in those that did not ($ds \geq 0.46$). Specifically, no significant differences emerged between studies that did or did not include (a) feedback related to the goal (Q(df) = 0.16(1), $p = 0.693$), (b) strategy planning for attaining the goal (Q(df) = 0.50(1), $p = 0.480$), and (c) rewards for goal progress (Q(df) = 0.46(1), $p = 0.499$). We also examined whether differential effects were evident across interventions that included various combinations of these BCTs to go along with setting goals (i.e., co-occurrence effects; Peters et al., 2015). Only one intervention fell into the category in which goal setting was done without also including any of the three BCTs – the effect size of this study was not statistically significant ($d = .20$). Most interventions ($k = 45$) employed one or two BCTs alongside goal setting with significant effects emerging in these interventions ($d = 0.58$). Specifically, there were significant effects in goal setting interventions that included feedback and strategy planning alone or in combination with each other ($ds \geq 0.51$). When rewards were combined with feedback and incorporated into the goal setting intervention, a comparable but non-significant effect size was obtained ($d = 0.58$); however, only two studies fell into this category. When all three BCTs were incorporated into the goal setting intervention ($k = 6$), significant effects emerged ($d = 0.44$).

Discussion

The purpose of this systematic review was to conduct a meta-analysis of the effects of multi-component goal setting interventions in relation to PA behaviour. Overall, a medium-sized positive effect was found, which suggests that these interventions are effective for improving PA. Subsequent moderator analyses revealed a number of noteworthy findings.

With regard to study characteristics, significant and comparable effects of goal setting interventions on PA behaviour were observed regardless of the source from which a study was obtained (i.e., published journal article versus conference/thesis). Similarly, the effects of these interventions were significant regardless of whether theory was used to guide the intervention or not (i.e., atheoretical). Significant effects were also seen across all intervention settings, except in workplace locations; however, conclusions on the latter setting should be tempered given that the effect approached statistical significance ($d = 0.211$, $p = .059$). In terms of delivery mode, interventions were effective irrespective of whether the intervention was delivered in person, via technology, or using a combination of the two. This is an encouraging finding as it suggests that interventions utilising websites or text messaging, for example, as the mode of delivery are just as effective as those conducted face-to-face. These technology-based goal setting interventions also have the added benefit of improving the reach of these interventions beyond that which can be done in person (cf. Fanning, Mullen, & McAuley, 2012). Moreover, the result of the meta-regression for duration of interventions is noteworthy as we found that duration did not moderate the intervention – PA effects. In other words, for improving individuals' PA behaviour, it does not seem to matter whether interventions utilise brief protocols (e.g., one week) or prolonged programmes (e.g., year-long). Altogether, these are important and encouraging findings as they seem to suggest that the utility of goal setting interventions is not limited to the use of theory (versus atheoretical frameworks), particular research settings, modes of delivery, or lengths of programme durations; positive, significant effects on PA seem to emerge regardless.

With regard to the PA goal that was set, significant intervention effects were found when aerobic activity or any type of activity was prescribed. On the one hand, these findings are encouraging as they suggest marked improvements in PA behaviour can be incurred when participants set goals specifically for aerobic activities or more generally for any type of activity an individual wishes to undertake. On the other hand, it is unclear whether these findings extend to other specific activities. For instance, many PA guidelines suggest incorporating bone and muscle strengthening activities into individuals' weekly PA regimens (e.g., Tremblay et al., 2011). It would therefore be prudent for future researchers to assess the effects of goal setting specifically for these types of health-enhancing activities to determine the generalisability of these meta-analytic findings to other types of PA. In terms of the type of measure that was used to assess PA, the results revealed moderate effects irrespective of whether objective (using technology) or subjective (using self-report) forms of assessment were used. Specifically, pedometer, PA questionnaire, and activity log measures all yielded significant effects. In contrast, it should be noted that the effects for accelerometer (only) assessments was non-significant; however, caution should be exercised in interpreting these findings as only two studies used this form of assessment.

With regard to intensity, goal setting interventions were effective when the goals targeted PA of any intensity or of moderate intensity. However, when goals were directed towards higher (i.e., moderate-vigorous) intensity PA, the intervention effects were not significant. As one potential explanation for these latter null findings, it is worth noting that the majority of the interventions included in this meta-analysis fell into the category in which intensity was not specified. It is therefore unclear at what intensity participants in these studies were actually exercising. On the one hand, participants in some of these studies may have exercised at higher intensities, and, therefore, benefitted from using goal setting to increase their moderate and/or moderate-to-vigorous PA. On the other hand, it is certainly possible that participants in these 'not specified' studies indeed restricted their PA participation to moderate (or low) intensity PA. Regardless, based on the effect sizes reported, it appears as though goal setting interventions may display stronger effects when directed towards achieving moderate-intensity PA, rather than high-intensity PA. Further to this point, there may be reasons why goal setting interventions appear to be less effective when higher intensity PA is targeted. For instance, it has been suggested that at high intensities (i.e., above one's ventilatory threshold), individuals' affective responses to exercise (i.e., enjoyment) are more strongly influenced by interoceptive/physiological cues (e.g., muscular and respiratory) than by psychological ones (e.g., goals) which play a much greater role at lower intensities (Ekkekakis, 2003). Some studies have also found that adherence is higher when lower intensity activities are prescribed compared to higher intensity activities (cf. Perri et al., 2002). This may be due to reasons such as a perceived increased risk of injury (Dishman & Buckworth, 1997) and decreased positive affect (Ekkekakis, Parfitt, & Petruzzello, 2011) at higher intensities. It should be reiterated that the majority of the participants in the studies within this meta-analysis were insufficiently active at baseline (i.e., not meeting PA guidelines) and, as such, it is possible that moderate-intensity PA goals were better suited than higher intensity goals for such individuals. In any case, future research is necessary to determine whether (and how) goal setting interventions are effective for enhancing higher intensity PA.

With regard to sample characteristics, goal setting interventions were effective irrespective of a study sample's age, baseline weight and activity status (prior to the intervention), and sex. No controlled intervention studies focused on males only; however, given that comparable effects were found for both females only and those studies that sampled males and females, goal setting interventions are likely beneficial across sexes. In addition, the findings that interventions derived significant effects across the age-span (from children to older adults), involving inactive and active participants, as well as healthy weight and overweight/obese participants points to the pervasive utility of goal setting interventions. With regard to population type, the results revealed that the interventions derived comparable effects for specific populations (e.g., persons with cardiac issues, diabetes, and cancer) as well as the general population. Taken together, goal setting interventions appear to be effective for a wide variety of populations.

With regard to goal attributes, a number of noteworthy findings emerged. First, significant effects were found regardless of goal specificity. That is, goal setting interventions had a medium effect on the targeted PA behaviour when the goal identified an absolute level of PA behaviour (e.g., to obtain 10,000 steps per day), PA increases relative to one's current PA levels (e.g., to increase PA time by 20% from baseline), and even when the goal was vaguely defined (e.g., to be more active). Although this may be surprising as it is commonly assumed that specific goals are superior to vague ones, Latham and Locke (1991) note that 'trying for specific, challenging goals may actually hurt performance in certain circumstances' such as 'in the early stages of learning a new, complex task' (p. 229). It is important to note that the majority of the samples included in the meta-analysis consisted of participants who were insufficiently active at baseline and, as such, it is possible that vague goals were advantageous for these participants who were in the early stages of learning to be physically active. This idea should be tested in further research.

Second, significant intervention effects were evident regardless of the individual(s) who prescribed the goal. That is, goal setting interventions had a significant effect on PA behaviour when the goal was set by the participants themselves, by an interventionist, or when participants and interventionists collaborated to determine an appropriate PA goal together. These results corroborate Locke and Latham's theorising that goals are just as effective whether they are 'assigned, self-set, or set participatively' (2002, p. 714).

Third, goal setting interventions appeared to be most effective when goals were set in relation to daily PA or a combination of daily and weekly PA. By contrast, when goals were set only in relation to weekly PA, these significant effects dissipated. This is an intriguing finding that warrants future attention as many health-promotion organisations around the world advise obtaining a certain amount of PA *per week* rather than *per day* (e.g., World Health Organization, 2010). It is possible that recommending PA behaviour on a weekly timeframe undermines the potential benefits that can be derived from setting PA goals. Thus, to increase the likelihood of getting people sufficiently active, perhaps there should be a greater emphasis on *daily* PA behaviour rather than – or at least in addition to – *weekly* PA.

Fourth, in terms of the frequency of goal setting, significant effects were shown for PA goals set at baseline only, on a weekly or bi-weekly basis, or when they could be modified whenever the participant felt it was appropriate. By contrast, goals modified on a daily basis did not have a significant effect on PA, although it is worth noting that only one study had participants set and revisit their goals on a daily basis. Therefore, it may be premature to conclude that adjusting goals on a daily basis is ineffective for improving subsequent PA behaviour. Nevertheless, at present, the results seem to suggest that individuals can derive significant benefits in PA behaviour if they set their goals at baseline only (i.e., prior to the programme of intervention) and/or if they are able to modify them on a weekly or bi-weekly basis or as they otherwise deem necessary.

With regard to the BCTs that are theorised as important components of the goal setting process (Latham & Locke, 1991), the initial moderator results revealed that the interventions were comparably effective regardless of whether or not participants were provided with feedback on their goals, planned strategies to help them achieve their goals, or received rewards based on progress to or attainment of their goals. However, in light of the fact that nearly every intervention included in this meta-analysis incorporated one or more goal-related BCTs in addition to goal setting itself, we sought to examine method co-occurrence using procedures outlined by Peters et al. (2015). Only one study did not explicitly include at least one of the three goal-related BCTs, which did not significantly benefit subsequent PA behaviour. By contrast, significant effects emerged when, in addition to setting PA goals, participants received feedback on their PA goals and/or engaged in strategy planning for how they would reach their goals. Despite yielding a comparable effect size, the combination of feedback and rewards for being physically active at a certain level alongside goal setting did not reach statistical significance; however, caution should be exercised in interpreting this latter finding as only two interventions fell into this latter category. Furthermore, when all three techniques were incorporated as part of a goal setting intervention, significant effects emerged. In summary, when interventions used one or more goal-related BCTs, the effect sizes were in the medium range. As a final cautionary note, while 18 comparisons involved goal setting with feedback, and 23 comparisons involved goal setting with feedback plus planning, the rest of the comparison categories in the co-occurrence analysis involved a relatively small pool of studies, which makes direct comparisons difficult. Nevertheless, the results seem to point to the utility of the goal-related BCTs highlighted by Latham and Locke (1991); that is, if goals are set without these components they tend to be less effective than if those attributes are included.

Although the results of this meta-analysis provide valuable information on goal setting interventions, the study is not without its limitations. For one, there was a high degree of heterogeneity across the included studies, likely due to differences between studies with regard to variations in the type of PA operationalised, the way in which PA was assessed and quantified, the timepoints at which PA was measured, the settings in which the interventions were delivered, and so forth. Although steps were taken to improve the interpretability of the results (e.g., only including controlled experimental studies, performing sensitivity analyses, assessing risk of bias, and conducting several moderator analyses) and heterogeneity is not uncommon in meta-analyses within the social sciences, it can result in conclusions being more suggestive than indisputable (Higgins & Thompson, 2002). Moreover, the majority of the samples included in the meta-analysis were with adults who were overweight and whose PA goal related to aerobic activity. Thus, further research is needed to ascertain the veracity of the results of the current meta-analysis, especially for individuals of other weight statuses, in other age ranges, and for participation in other types of PA.

Another limitation of this study concerns the coding of moderators. First, some of the moderators required an additional 'unclear' or 'not specified' category (e.g., weight status, goal specificity) when it was not explicit to which category the study belonged (based on the details presented within the respective manuscript). For instance, several interventions were unclear (as opposed to explicitly defined) with regard to goal specificity (i.e., whether the PA goal was absolute or relative). This, therefore, makes comparisons – and subsequent conclusions – related to goal specificity somewhat tentative. Although it may not always be possible for studies to report exactly what participants did with regard to these moderator variables, stronger implications could have been provided if this information were consistently available (cf. Abraham & Michie, 2008; Conn & Groves, 2011). A related point concerns the Cochrane risk of bias assessment. The majority of studies in this analysis were given an overall code of 'unclear' denoting that at least one of the seven potential sources of bias could not be coded as clearly being 'low' risk (see Higgins & Green, 2008). Hence, it is difficult to be certain of (a) whether a risk of bias was present or absent in these studies (i.e., if the authors of a study had indeed made information on each source of bias explicit, would this study have been subsequently coded as having a 'low' or 'high' risk of bias?) and, in turn, (b) the extent to which potential bias influenced the overall effect size of goal setting interventions on PA behaviour. Nevertheless, it is important to note that there were no significant differences between those studies classified as low and high risk of bias (Higgins & Green, 2008), with regard to the effectiveness of goal setting interventions in relation to PA behaviour.

Finally, in spite of the wide range of attributes that Latham and Locke (1991) and Locke and Latham (2002, 2006) purport would maximise the goal setting effects, some of these attributes were not operationalised within any of the included studies (e.g., goal difficulty and subconscious priming); therefore, we were unable to assess the full range of goal setting attributes highlighted by Latham and Locke (1991) and Locke and Latham (2002, 2006). Moreover, despite our efforts to examine method co-occurrence and isolate the effects of individual goal-related BCTs within the interventions in this meta-analysis, no studies examined goal setting plus rewards only, and very few comparisons aligned with some of the other co-occurrence categories (e.g., $k = 2$ for goal setting interventions that included planning only; $k = 2$ for goal setting interventions that involved feedback plus rewards). As such, we were precluded from concluding which specific combination of goal-related BCTs (within goal setting theory) are most likely to maximise the effects of goal setting.

In spite of these limitations, the results of this meta-analysis provide evidence that multi-component goal setting interventions are generally effective in promoting PA behaviour. The benefits of these interventions are present across a diverse range of settings, populations, and intervention characteristics. Furthermore, the incorporation of various goal setting attributes including strategy planning, the use of rewards, and feedback appear to be beneficial in maximising the effects of goals setting interventions in relation to PA behaviour.

Note

1. We thank an anonymous reviewer for the suggestion to test method co-occurrence effects (cf. Peters et al., 2015).

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