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Original citation & hyperlink:
Ashford, S. , Edmunds, J. and French, D.P. (2010) What is the best way to change self-efficacy to promote lifestyle and recreational physical activity? A systematic review with meta-analysis. British Journal of Health Psychology, volume 15 (2): 265-288.
http://dx.doi.org/10.1348/135910709X461752

Running head: Interventions for physical activity self-efficacy

What is the best way to change self-efficacy to promote lifestyle and recreational physical activity? A systematic review with meta-analysis

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Abstract

Purpose

Increasing self-efficacy is an effective method to increase physical activity. Despite this, the evidence concerning the most effective techniques to increase self-efficacy in physical activity interventions has not been systematically reviewed. This meta-analysis aims to fill this gap by systematically gathering intervention studies which aimed to increase self-efficacy for physical activity.

Methods

A systematic database search was conducted for papers reporting lifestyle or recreational physical activity interventions. Published intervention studies explicitly targeting self-efficacy in order to change physical activity behaviour in 'healthy' adults were eligible for inclusion. Meta-analysis was used to quantify the impact of the interventions on physical activity self-efficacy.

Results

The search strategy identified 27 unique physical activity intervention studies. A significant, yet small, relationship between the interventions and changes in self-efficacy was found (mean d= 0.16, $p<0.001$). Due to heterogeneity, moderator analyses were conducted, examining the association of changes in self-efficacy with whether or not specific intervention techniques were used. Tailoring, vicarious experience, feedback, performing the behaviour during intervention sessions and goal setting by the interventionist were associated with higher levels of self-efficacy. Persuasion, graded mastery and barrier identification were associated with lower levels of self-efficacy.

Conclusions

This meta-analysis forms an evidence base for which psychological techniques are most effective in increasing self-efficacy for physical activity. The results are presented in terms of recommendations for interventionists and directions for future research. Examples of strategies to inform future physical activity interventions addressing self efficacy are provided.

Introduction

Self-efficacy is a key construct within several popular health psychology theories. These include Social Cognitive Theory (Bandura, 1997), Protection Motivation Theory (Rogers, 1975), Transtheoretical Model (Prochaska & DiClemente, 1982), Health Action Process Approach (Schwarzer, 1992) and as perceived behavioural control in the Theory of Planned Behaviour (TPB: Ajzen, 1991). It has been defined as 'the belief in one's capabilities to organise and execute the courses of action required to produce given attainments' (Bandura, 1997).

Self-efficacy has been demonstrated to be an important predictor of a number of different health behaviours, including reducing alcohol consumption (Oei & Burrow, 2000), smoking cessation (Baldwin et al., 2006) and condom use (Hendriksen, Pettifor, Lee, Coates & Rees, 2007). Self-efficacy has been repeatedly shown to predict physical activity behaviour in healthy adults (e.g. Kaewthummanukul & Brown, 2006; Rovniak, Anderson, Winett & Stephens, 2002; Sharma et al, 2005) and is predictive of both the adoption, and the maintenance, of physical activity (Sallis, Haskell, Fortmann, Vranizan, Taylor, Soloman, 1986; Sallis, Hovell, Hofstetter, 1992; Strachan, Woodgate, Brawley & Tse, 2005).

Although self-efficacy is an important determinant of a number of behaviours, there still remains a deficit in our knowledge regarding *how* to change this psychological construct. This knowledge gap is important as researchers attempt to develop interventions without evidence of which intervention techniques are effective and which are ineffective. Whilst sources of self-efficacy information have been proposed (Bandura, 1977) there is still a need to disentangle how these can be best operationalised in behaviour change interventions. Bandura (1977) has proposed that self-efficacy for any particular behaviour is the consequence of four sources of information: enactive mastery experience, vicarious experience, verbal persuasion and physiological or affective states. Enactive mastery experience refers to successful performance of the target behaviour, which should enhance

perception of efficacy, while failure to perform the behaviour successfully undermines it. Vicarious experience, refers to seeing a 'similar other' successfully perform the behaviour and appraising one's own performance against the performance of that similar other. Verbal persuasion, in which others express faith in the individual's capabilities is the third source of self-efficacy information, although it has often been argued that the effects of this technique are unlikely to be long lasting (Bandura, 1997). Reducing negative emotional states and correcting misinterpretations of bodily states is the fourth way that Bandura (1977) proposed can enhance self-efficacy perceptions.

Two narrative reviews have attempted to rectify this lack of an evidence base for physical activity behaviours (Marcus, King, Clark, Pinto & Bock, 1996; Sherwood & Jeffery, 2000). In both reviews, the role of self-efficacy in promoting physical activity was discussed and recommendations of cognitive techniques for promoting self-efficacy were offered. However, as narrative reviews, they did not use rigorous reproducible methodology for searching for articles and synthesising evidence. They therefore are open to bias, and may not constitute a sound evidence base on which to draw conclusions. Further, self-efficacy was one of a number of determinants discussed in both reviews, detracting from the amount of attention that could be given to the self-efficacy construct.

Systematic review methodology has shown a positive effect of behaviour change interventions on physical activity behaviour and on the mediators of physical activity. However few of the intervention studies included in these reviews measured mediating variables (Baranowski, Anderson & Carmack, 1998; Lewis, Marcus, Pate & Dunn, 2002) and of those that did, findings were inconsistent with regard to their impact on self-efficacy (Lewis et al., 2002). Both reviews were heterogeneous with regards to the theoretical and participant characteristics of their included studies: mediators other than self-efficacy and both adult and child studies were included, thus insufficient attention was given to the specific impact of physical activity interventions on self-efficacy in adult populations. Importantly,

neither review attempted a quantitative synthesis of the impact of interventions on the self-efficacy construct in isolation.

Whilst a number of reviews have therefore attempted to synthesise evidence of *what* constructs to target in physical activity interventions, scientific evidence of *how* to alter these constructs as part of physical activity interventions is currently lacking. Thus interventionists lack an evidence base for what they should include in physical activity interventions in order to successfully impact on self-efficacy.

Two recent systematic reviews have summarised the effectiveness of interventions on self-efficacy for two different behaviours: refraining from substance use and engaging in HIV prevention behaviours (Hyde, Hankins, Deale & Marteau, 2008; Mize, Robinson, Bockting & Scheltema, 2002). Interventions were found to successfully change self-efficacy regarding substance use behaviours in seven out of ten studies but findings were less consistent for HIV prevention behaviours. However both reviews included a relatively small number of studies that measured self-efficacy as an independent outcome and only one of these reviews attempted a quantitative synthesis of their findings (Mize et al., 2002). In addition, due to the behavioural content of both reviews the findings are of questionable relevance to physical activity behaviour interventions. Further, neither of the reviews linked the specific behaviour change techniques included within interventions with changes in self-efficacy, thus they did not shed light on the mechanisms underlying successful self-efficacy change.

In sum, there is still a lack of systematically analysed scientific evidence on which to base interventions to increase self-efficacy for lifestyle and recreational physical activity. We report a systematic review with the following aims:

1) To describe the contents of physical activity interventions for healthy adults that aim to increase self-efficacy, to provide a resource to other researchers and intervention developers.

2) To conduct a meta-analysis of the effectiveness of interventions to alter self-efficacy for physical activity, including moderator analyses to assess what intervention components are included in the most or least successful physical activity interventions.
3) To quantify the relationship between changes in physical activity self-efficacy and changes in physical activity behaviour, as a consequence of the inclusion of particular intervention components.

Methods

Selection Criteria

Published intervention studies explicitly targeting self-efficacy in order to change physical activity behaviour in 'healthy' adults were eligible for inclusion. Studies that employed randomised experimental, non-randomised experimental, quasi-experimental or pre and post intervention designs were eligible for inclusion. Studies that used self-efficacy only to predict physical activity behaviour were excluded, as were qualitative studies, surveys, case-control designs, cross sectional studies, case reports and prospective cohort studies.

Studies that specifically targeted clinically defined populations, for example those recruiting participants on the basis of having a pre-existing chronic medical condition or obese individuals as part of a weight management programme, were not eligible for inclusion. We did not include studies of children, student populations and athletes, or studies that specified recruiting older adults or where the mean age of participants in a study was 60 years or over.

Lifestyle and recreational physical activity interventions that aimed to increase physical activity self-efficacy formed the basis of this review. Papers were not included if the intervention targeted more than one behaviour (e.g. physical activity and diet). Sport or lab-

based studies that did not aim to increase the amount of physical activity but instead focused on competitive sports or fitness were also excluded.

Intervention studies that mentioned self-efficacy or Social Cognitive Theory in their rationale for intervention development were included if self-efficacy was also an outcome measure. When self-efficacy or Social Cognitive Theory was mentioned alongside other theoretical models such as the Transtheoretical Model in the development or evaluation of an intervention these studies were included, on the condition that physical activity self-efficacy was measured as an independent outcome.

To be included in this review the relevant information needed to calculate effect sizes for self-efficacy change should have been available. Thus self-efficacy should have been measured either pre and post intervention, or should have been measured for both intervention and comparison groups at least once following the end of the intervention. When sufficient data was unavailable for effect sizes to be calculated but the study met all other inclusion criteria, the first author of the paper was contacted to elicit this data.

Unpublished studies and conference proceedings were not included for pragmatic reasons. English language only papers were included.

Search methods for identification of studies

The electronic databases Web of Science (1966-2007), PsycInfo (1966-2007), SPORTDiscus (1966-2007) and the Cochrane Library were searched using the following search terms:

1) Self-efficacy OR Social Cognitive Theory OR Vicarious Learning OR Mastery Experience OR Verbal Persuasion OR Persuasion OR Protection Motivation Theory.

2) Intervention* OR Randomi?ed controlled trial* OR Follow up studies OR Program evaluation OR Experiment OR program OR Trial

3) Sport OR exercise OR physical activity

Searches were completed, and eligibility of each study was determined, by the first author. Abstracts were cross-checked against the inclusion criteria. Where the first author was unsure of relevance the abstract was retained and decisions regarding inclusion and exclusion were resolved by discussion with all authors.

Reference lists of all included papers were checked and experts in the subject area were contacted and asked to identify additional papers.

Data extraction

Relevant papers were retrieved and automatically entered into reference software (Endnote version 5). Data were extracted and the first author entered it on to the standardised data extraction form developed by the authors. A Social Cognitive Theory coding frame was developed to allow individual intervention components to be reliably classified. These intervention components consisted of practical strategies that were elaborated from the four sources of self-efficacy identified by Bandura (1977). The data extraction form and coding frame are available from the authors upon request. The first author coded each intervention according to this coding frame and coding was validated by a second coder following detailed instructions. Any disagreements were resolved by discussion. Interrater reliability was good (all kappas between 0.83 and 1).

Meta-analytic strategy

The effect size estimate employed was Cohen's *d* (Cohen, 1992), the standardised mean difference in physical activity self-efficacy. Meta-analytic calculations were conducted using Schwarzer's (1988) Meta computer program, using a random effects model.

Where there were two experimental groups within one study, control group data was compared with each experimental group separately to yield two effect size estimates. When

studies had measured self-efficacy on more than one occasion we took the first measurement following the end of the intervention, as this is when the largest change in self-efficacy attributable to the intervention should have occurred.

Homogeneity was assessed using the Q coefficient. Where the Q statistic is significant this represents heterogeneity in the data set beyond that expected by sampling error alone, indicating additional systematic factors contributing to variance. Moderator analyses were conducted to explore causes of heterogeneity, by comparing the mean variability in effect size estimates of two groups of studies characterised by the presence or not of particular study features, e.g. intervention techniques. Pairwise Z tests were used to determine which intervention techniques accounted for significantly different effect size estimates.

Pearson product-moment correlation coefficient was used to assess the extent to which change in self-efficacy, as a consequence of particular intervention characteristics, was associated with change in physical activity behaviour.

Results

The search strategy generated 2105 papers potentially relevant to this review. We extracted full text publications for 265 papers, of which 27 unique studies were relevant to our review. These contained 37 tests of the effect of intervention on self-efficacy. Reasons for exclusion included design, participant and intervention characteristics (See figure 1).

FIGURE 1 ABOUT HERE

Study characteristics

A mean of 204 participants were included in each study (range=33 to 874; see table 1). There were fifteen randomised experiments included in this review. In the twelve non-randomised

studies, three were non-randomised experiments, two used a quasi-experimental design and there were seven pre and post intervention studies.

TABLE 1 ABOUT HERE

Intervention characteristics

A theoretical rationale was explicitly mentioned in twenty three of the included studies, four studies mentioned no theoretical rationale in their study description (See table 2). Authors mentioned more than one theory in nine study descriptions.

The majority of the intervention studies focused on lifestyle physical activity e.g. walking and gardening (n=21), a further 6 studies targeted recreational physical activity e.g. aerobics class, gym sessions. Typical individual intervention activities included face-to-face and telephone counselling sessions, and email feedback. Group activities consisted primarily of behaviour change classes, discussion groups and watching DVD's. Workplace, primary care, media and university settings were most often utilised.

Interventions ranged in duration from a 2-5 minute brief interventions (Calfas et al., 1997; Naylor et al., 1999) to interventions of two years in length (Rejeski et al., 2001). The number of contact sessions with the research team also varied greatly. Most commonly a researcher or health professional was assigned the role of intervention deliverer (See table 2 for details).

TABLE 2 ABOUT HERE

Contents of interventions

Participants were required to perform physical activity in the majority of interventions (n=34, 92%) and this most commonly took place outside of the intervention sessions in the participants own time (See table 3). Some 62% (n= 23) of intervention groups self-monitored

their physical activity behaviour, typically using a diary or pedometer. Persuasion was used as a strategy in 89% (n=33) of intervention groups. Participants were required to set goals for themselves in 59% (n= 16) of the groups and in 30% (n= 11) of interventions participants were set goals by the person delivering the intervention. General goal setting was more commonly employed than specific goal setting e.g. action planning (n=17, 46% and n=10, 27% respectively). Less than one third of intervention groups received any feedback on their physical activity performance (n=11, 30%). Approximately half of intervention groups were encouraged to identify barriers to participating in physical activity (n=19, 51%) and devise ways to overcome these barriers (n=18, 49%). A minority of studies included vicarious experience (n=9, 24%) or physiological or affective states (n=1, 2.7%) as strategies to enhance self-efficacy. Intervention content was tailored to the individual in 40.5% (n= 15) of intervention studies.

TABLE 3 ABOUT HERE

Meta-analysis results

There were a total of 37 experimental groups that attempted to increase self-efficacy for physical activity. The total number of participants included in the meta-analysis was 6787. There was a significant effect of interventions on physical activity self-efficacy but the mean effect size was small d= 0.16 (95% CI: 0.08-0.25, P<0.001).

Moderator analyses

Greater variability in effect size estimates existed than that explained by random sampling error alone (Q=91.8, p<0.001). Thus moderator analyses were completed to search for systematic sources of heterogeneity. We conducted 27 moderator analyses (See table 4).

a) Graded mastery experience. There was a significant association (Z= 2.92, p<0.05) between graded mastery experience and self-efficacy with interventions that contained graded mastery

producing lower effects on self-efficacy (d= 0.03) than interventions that did not contain this technique (d= 0.19).

b) Vicarious experience. There was a significant difference between interventions that included this strategy and those that did not (Z= 4.07, p<0.001) with vicarious experience producing larger effect size estimates (d=0.32) compared to those not including vicarious experience as a strategy (d= 0.11).

c) Persuasion. A negative association was found between persuasion, and physical activity self-efficacy. There were significantly higher effect size estimates in interventions that did not use verbal persuasion (Z= 2.14, p<0.05) or persuasion delivered via other means (Z= 2.49, p<0.01), suggesting persuasion had an adverse effect on self-efficacy.

d) *Goal setting*. Significantly greater effect size estimates were found (Z= 1.61, p<0.05) in interventions where participants were set goals by the person delivering the intervention (d= 0.22) with effect sizes lower in interventions that excluded this technique (d= 0.14).

e) *Feedback*. Providing feedback by comparing participants performance with the performance of others produced the largest effect size estimates (d=0.44), followed by feedback on the participant's past performances (d= 0.43). There was a significant association between both of these types of feedback and self-efficacy (p<0.001). Providing feedback verbally produced lower self-efficacy effect sizes (Z= 2.16, p<0.05), yet providing feedback via email or online was associated with higher self-efficacy (Z= 2.63, p<0.01).

f) *Barriers*. Including barrier identification in intervention groups resulted in a significant negative relationship with self-efficacy (Z= 2.55, p<0.01), a similar relationship was demonstrated when problem solving was included as a strategy (Z= 2.80, p<0.01). Effect size estimates were higher when the strategy was not present (both d=0.23) compared to when it was included (both d=0.10).

g) *Tailoring.* Interventions that included tailoring had a larger overall effect size (d=0.26) than those not tailored (d=0.07), this relationship was significant (p<0.001).

TABLE 4 ABOUT HERE

Self-efficacy and physical activity behaviour

Data on physical activity behaviour was provided for 24 intervention groups. There was a moderate, non-significant positive association between changes in physical activity self-efficacy and changes in physical activity behaviour (r = 0.266, p= 0.208).

Discussion

Our meta-analysis of physical activity intervention studies that have attempted to increase physical activity self-efficacy found a small but significant effect of interventions on self-efficacy (d= 0.16, p<0.001). Moderator analyses revealed that interventions that used vicarious experience, feedback, providing participants with interventionist-set goals and tailoring of interventions produced significantly higher levels of physical activity self-efficacy than interventions where these techniques were not included. Interventions that used persuasion, graded mastery and barrier identification techniques produced significantly lower levels of self-efficacy than interventions where these techniques were not included.

Intervention techniques

Intervention studies that included graded mastery, in which the target behaviour became increasingly difficult, were associated with significantly lower physical activity self-efficacy scores (p<0.05). This finding is in opposition to previous literature, where breaking down a distal goal into achievable sub goals that are approached in a hierarchical manner has been found to increase self-efficacy in laboratory settings (e.g. Stock & Cervone, 1990). It is possible that this technique might lead to low self-efficacy initially but might be more helpful

in maintaining self-efficacy in the longer term. However we cannot confirm this as we measured self-efficacy only at one time point, immediately post-intervention.

Physical activity self-efficacy was significantly higher when vicarious experience was included as a technique. This supports the view that seeing a similar other perform the behaviour can raise the individual's belief that they too possess the capabilities to master the same activity (Bandura, 1977). Yet even though the inclusion of this technique was associated with large self-efficacy effects, vicarious experience was rarely used in the studies in the present review.

A significant negative relationship was found between verbal persuasion and self-efficacy despite the fact that some 89% of intervention groups included this technique. This supports the view that verbal persuasion alone is limited in its power to create enduring increases in self-efficacy perceptions, an observation previously made by many commentators (Bandura, 1997)

When participants were set goals by the interventionist significantly higher effect size estimates were produced, interventions in which participants set their own goals were not significantly associated with changes in self-efficacy. Schunk et al (1995) found that self-set goals enhance motivation and self-regulation, and thus self-efficacy, due to greater goal commitment from the participant. However our finding and that of others (Locke and Latham, 1990) does not support this conclusion. Our findings might indicate that, compared to interventionists, participants do not have adequate skills to develop realistic and achievable goals without appropriate guidance; instead they may develop unrealistically large goals (Strecher et al, 1995). Furthermore, it might be the case that participants are aware of this skill deficit and so possess a lack of confidence in setting their own goals as well as a lack of confidence in performing the behaviour itself, thus reducing their overall perception of self-efficacy.

The minority of studies that provided participants with feedback on their past performances and through comparisons of their performance with the performance of others, were associated with the highest effect size estimates generated in this meta-analysis (d= 0.43-0.44). According to Bandura (1997) personal performance successes enhance perceived self-efficacy so being made aware of such successes in these interventions may have served to enhance this perception. Furthermore providing comparative feedback has been shown to successfully impact perceived self-efficacy in a laboratory setting (Bandura & Jourden, 1991)

Using barrier identification as an intervention technique was also associated with a reduction in self-efficacy as was the technique of encouraging participants to identify ways of overcoming these barriers. This was an unexpected finding as barrier identification is a commonly used behaviour change technique in physical activity interventions; indeed the technique was used in around half of the studies in the present review. It may be that the use of such techniques is unhelpful at the motivational phase of behaviour change. In motivational interviewing (Miller & Rollnick, 2002), behaviour change is facilitated by encouraging a person to identify how they *can* bring about behaviour change. By contrast, barrier identification encourages the individual to rehearse reasons why the behaviour would be difficult.

Several findings are counter to what we would expect according to previous literature e.g. graded mastery being associated with lower self-efficacy. It is possible this is a statistical fluke as a consequence of multiple comparisons; it may instead represent ineffective use of techniques that are successful at changing self-efficacy, but only if delivered correctly. This highlights the importance of specifying exactly what techniques are used in intervention studies and ensuring techniques are implemented correctly in intervention sessions, thus maintaining intervention fidelity.

Strengths and limitations

This is the first paper, to our knowledge, that has attempted to describe the contents of physical activity interventions that have aimed to increase self-efficacy, and has categorised interventions in terms of specific practical strategies based on Social Cognitive Theory (Bandura, 1977). We have also demonstrated, via meta-analysis with moderator analyses, which Social Cognitive Theory specific techniques are associated with an improvement or deterioration in physical activity self-efficacy. Whilst other work has already reliably categorised specific intervention techniques drawn from several theories (Abraham & Michie, 2008) we have developed and reliably used a coding frame derived from Social Cognitive Theory for categorising physical activity interventions. This review provides the first systematic attempt to identify effective physical activity intervention techniques aimed at increasing self-efficacy, and thereby should inform future practice concerning how to develop physical activity interventions.

We have also found a positive albeit non significant relationship between physical activity self-efficacy and physical activity behaviour, which supports previous literature reporting self-efficacy as a determinant of physical activity behaviour (e.g. Strachan et al, 2005)

We have shown which intervention techniques are associated with changes in self-efficacy. More research is required to understand the causal pathway between specific intervention techniques and self-efficacy outcomes; this requires rigorous experimental testing of individual techniques in isolation and in combination, using factorial design. Even so, this review can be considered useful in generating hypotheses for future experimental intervention studies.

This meta-analysis did not include ‘grey’ or unpublished literature in this review. It has been argued that larger effect sizes tend to be reported in published as opposed to unpublished literature (Glass, McGraw & Smith, 1981), thus the effect sizes used in this meta-analysis might reflect an overestimation in the true impact of the interventions on self-

efficacy beliefs. Furthermore it has been argued that positive results are more likely to be published than negative findings (Easterbrook, Gopalan & Matthews, 1991). Despite this, a number of intervention studies included in this meta-analysis did report negative findings.

Comparing physical activity interventions is inherently difficult due to the inadequacy in reporting of intervention components, a common finding in previous reviews of intervention effects. It could be the case therefore that recommendations regarding effective intervention techniques on the basis of these incomplete descriptions are potentially misleading. Future intervention developers should report their interventions according current guidelines (Davidson et al., 2003; Des Jarlais, Lyles & Crepaz, 2004; Moher, Schultz & Altman, 2001) and in enough detail that would allow for ongoing standardisation of behavioural change techniques (Abraham & Michie, 2008). Finally, physical activity was the only behaviour attended to, as extending the review to the entire self-efficacy intervention literature would involve considerable heterogeneity in studies examined. Future research should involve similar reviews of the effectiveness of specific intervention techniques across other health behaviours, and in different populations e.g. clinical and older adult populations.

Implications and future research

The findings of this meta-analysis suggest tentative recommendations for those considering developing a physical activity intervention with the aim of increasing self-efficacy, and thus provide a resource for intervention developers in the form of guidelines for future intervention development.

The largest effects were found for vicarious experience and feedback techniques. We would therefore suggest that future physical activity interventions include vicarious experience as a technique to enhance self-efficacy and thus physical activity behaviour, and interventionists should provide participants with feedback by comparing an individual's performance with that of similar others. Indeed monitoring behavioural performance without

the focus on goal achievement might be useful for enhancing self-efficacy beliefs in physical activity interventions.

In terms of goal setting, we would suggest goals are specific rather than general in nature and goals should be provided by, or developed in collaboration with, the intervention deliverer in order for realistic and achievable goals are made. Tailoring an intervention to individual participant characteristics is also suggested for physical activity interventions.

According to our findings persuasion used as a stand alone technique has a weak impact on self-efficacy beliefs and one could therefore question the appropriateness of using valuable intervention time for this technique. Despite being a common behaviour change technique we would not recommend the use of a barrier identification task when attempting to enhance self-efficacy beliefs, instead getting a person to discuss how they *can* achieve the desired behaviour change might be a more productive focus of physical activity interventions. Finally continuously increasing the level of difficulty in physical activity tasks i.e. graded mastery might compromise initial self-efficacy levels for physical activity thus we would not recommend this as a strategy for enhancing self-efficacy beliefs.

We have successfully identified associations between specific intervention techniques and the impact of those on self-efficacy. These associations are reported in terms of tentative recommendations for the development of future physical activity interventions that aim to increase self-efficacy. In addition, this review has generated hypotheses for future experimental studies to test.

Furthermore, this review suggests that several techniques that are commonly used may be ineffective or counter-productive, possibly as a consequence of the poor implementation of strategies that could be effective if implemented well. It is also possible that the techniques found to be ineffective in this review might not be useful for initiation of self-efficacy, but could be helpful at maintaining self-efficacy once an initial change has been

achieved. As the present review only used the self-efficacy measurement immediately post intervention we could not identify which techniques are effective at maintaining physical activity self-efficacy in the longer term. Future research should attend to this issue.

Enhancing our knowledge of effective and ineffective behaviour change techniques further is arguably being hindered by the inadequacy of intervention reporting, and by a lack of experimental tests of individual intervention techniques and the associated impact on physical activity self-efficacy conducted outside of the laboratory. This must be rectified for our knowledge in this area to be much improved.

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Figure 1. Flowchart describing the number of articles retrieved, and included and excluded at each stage of the review process.

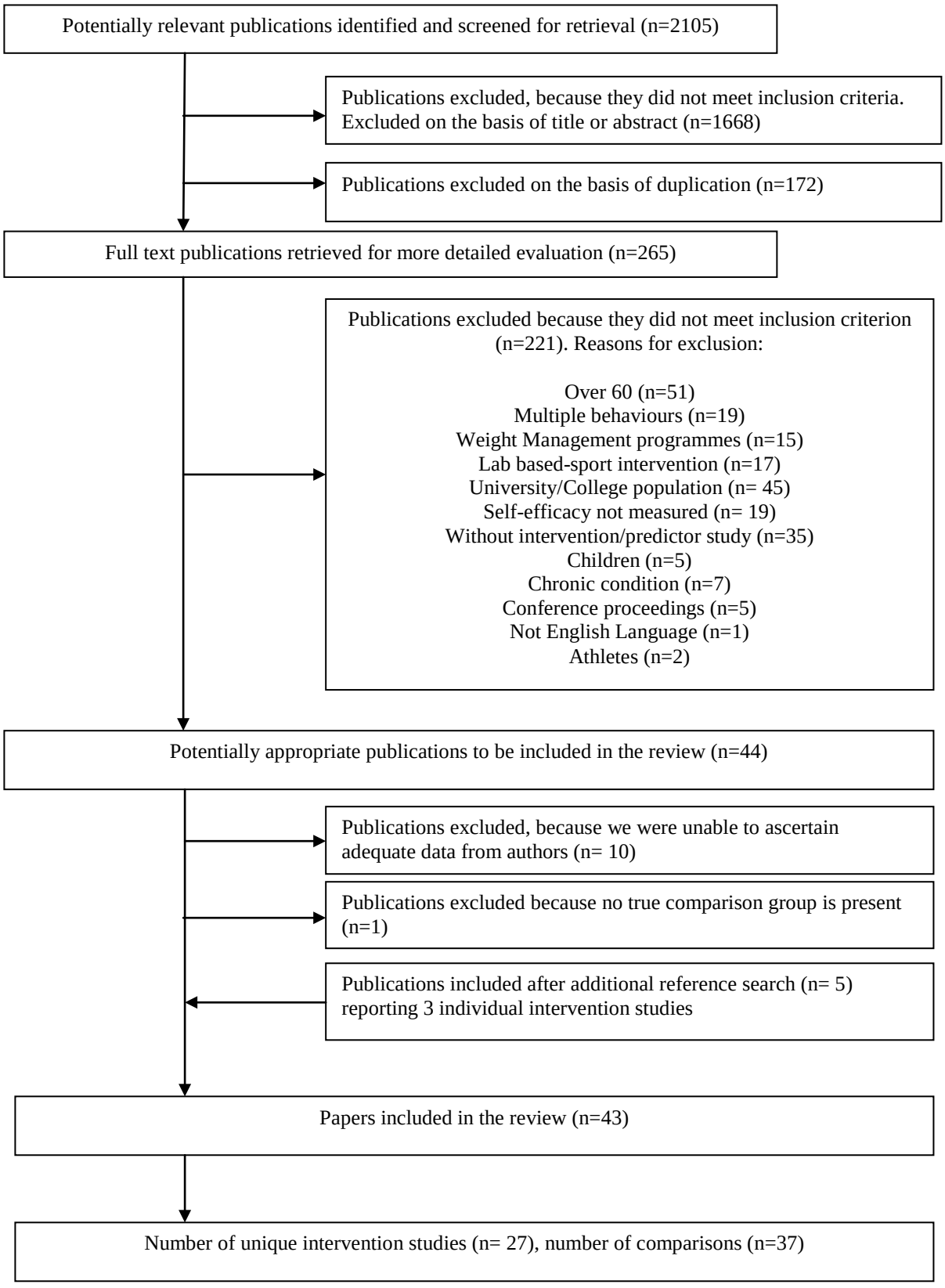

Table 1. Summary of the study characteristics of included studies

Study characteristics	Frequencies
Participant numbers (From 27 studies)	
Mean number of participants	204
Median number of participants	153
Sum of number of included participants	5501
Range of number of included participants	33-874
Number of studies	27
Number of experimental conditions	37
Participant characteristics	
Mean age	43 years
Median age	42.9 years
Mean age range	31-55 years
Mean number of females per study	138
Mean number of males per study	61
Mean number of white participants per study	155
Mean number of non-white participants per study	48
Study design	
Experiment (randomised)	15
Experiment (non-randomised)	3
Quasi-experimental	2
Pre-post design	7
Simple randomisation	7

Group randomisation	2
Stratified randomisation	6
Self-efficacy measures	
Barrier measure	15
General self-efficacy measure	9
Other	3

Note: Gender and ethnicity data was not provided for all studies

Table 2. Summary of the intervention characteristics of included studies

Intervention characteristics	Frequencies
Theoretical basis explicitly mentioned	23
No theoretical basis explicitly mentioned	4
Theoretical model	
Social Cognitive Theory	17
Transtheoretical Model	13
Theory of Planned Behaviour	2
Protection Motivation Theory	1
Self-determination theory	1
Type of activities:	
Individual	17
Group	4
Both	6
Focus:	
Recreational physical activity (e.g. aerobics class, gym, jogging)	6
Lifestyle physical activity (e.g. walking, gardening)	21
Average duration:	
5 minutes- 5 weeks	7
6 weeks- 11 weeks	6
12 weeks-24 weeks	9
Over 24 weeks	5
Number of intervention sessions:	
0-5	11
6-11	8
12-24	4

More than 24 sessions	4
Delivered by:	
a) Researcher	8
b) Nurse	3
c) GP	4
d) Health and fitness professional	7
e) Health educator	2
f) Not stated	4
g) Other	5
Setting:	
Workplace	4
College/University	2
GP Surgery	5
Media	2
By post	3
Not stated	5
Other	6
Delivery mode:	
Training sessions	6
Discussion group	6
Web-based	2
Telephone	5
Self-help manuals	2
Mass media	2
Other	7

Table 3. Frequencies of intervention techniques that were used in the interventions.

SCT Technique	No. of intervention groups using technique	(% of intervention groups)
Enactive Mastery Experience	34	91.9%
Performed during the intervention	4	10.81%
Performed outside sessions (timetabled)	2	5.41%
Performed outside sessions (untimetabled)	28	75.68%
Thinking back to times when have previously been successful at performing the behaviour	0	0
Self-monitoring	23	62.2%
Graded Mastery	9	24.32%
Vicarious experience	9	24.32%
See interventionist carry out the behaviour	2	5.41%
See similar other carry out the behaviour-virtual	3	8.11%
See similar other carry out the behaviour-real life	2	5.41%
Persuasion	33	89.19%
Designed to promote:		
Response efficacy- focus on benefits	26	70.27%
Self-efficacy- confidence building	24	64.86%
Other knowledge- new information about physical activity	27	72.97%
Information given verbally	19	51.35%
Information given via other means e.g. online,	27	72.97%

self-help

Is there goal setting?	27	72.97%
Goal set by self	16	59.26%
Goal set by interventionist	11	29.73%
General goal setting	17	45.95%
Specific goal setting e.g. action planning	10	27.03%
Was there feedback?	11	29.73%
Specific feedback through comparisons with:		
Past performance	6	16.22%
Performance of others	5	13.51%
Specific goals set by participant	5	13.51%
Specific goals set by interventionist	5	13.51%
Verbal feedback from interventionist	6	16.22%
Verbal feedback from others	0	0
Message feedback e.g. online, postal	5	13.51%
Barriers		
Barrier identification tasks	19	51.35%
Work out how to overcome barriers	18	48.65%
Is the intervention tailored?	15	40.5%
Physiological feedback	1	2.7%
Fitness feedback	5	13.51%

Table 4. Comparison between self-efficacy levels, according to whether specific techniques are included in the physical activity intervention and when the technique is not included

	Present					Not present					
	n	K	CI	Q	*d*	n	K	CI	Q	*d*	Z
Enactive mastery experience	6419	34	0.08-0.25	88.1***	0.17	368	3	-0.22-0.53	3.66	0.15	0.11
Perform behaviour- during	500	4	-0.23-0.69	24.97***	0.23	6287	33	0.07-0.23	61.38***	0.15	0.89
Perform behaviour- timetabled	5527	28	0.08-0.24	47.65**	0.16	1260	9	-0.07-0.40	44.07***	0.17	0.08
Self-monitoring	3928	23	0.03-0.24	52.7***	0.14	2859	14	0.07-0.34	37.46***	0.21	1.45
Graded mastery	1719	9	-0.19-0.26	45.48***	0.03	5068	28	0.12-0.27	40.98*	0.19	2.92*
Vicarious experience	2151	9	0.12-0.52	43.30***	0.32	4636	28	0.03-0.19	44.03*	0.11	4.07***
Persuasion	6380	33	0.08-0.36	59.86**	0.15	407	4	-0.37-0.69	24.71***	0.16	0.18
Persuasion-response efficacy	5521	26	0.07-0.20	32.8	0.14	1266	11	-0.06-0.40	55.8***	0.17	0.56
Persuasion-self efficacy	5292	24	0.05-0.22	39.56*	0.14	1495	13	0.007-0.37	46.39***	0.19	0.93
Persuasion-knowledge	5351	27	0.07-0.24	57.92***	0.15	1436	10	-0.02-0.37	31.81***	0.17	0.35
Verbal persuasion	3394	19	0.01-0.21	36.43**	0.11	3393	18	0.08-0.35	51.11***	0.22	2.14*
Persuasion via other means	5585	27	0.01-0.18	44.13*	0.11	1202	10	0.04-0.5	34.13***	0.27	2.49**

Goal setting	4849	27	0.08-0.28	81.27***	0.18	1938	10	-0.008-0.24	10.2	0.12	1.13
Goal set by self	2363	16	0.06-0.25	18.96	0.15	4424	21	0.04-0.3	72.72***	0.17	0.28
Goal set by interventionist	2486	11	0.02-0.43	62.29***	0.22	4301	26	0.07-0.21	29.48	0.14	1.61*
General goal setting	3272	17	0.05-0.19	18.89	0.12	3515	20	0.02-0.29	72.27***	0.16	0.85
Specific goal setting	1577	10	-0.04-0.45	60.37***	0.21	5210	27	0.06-0.18	29.14	0.12	1.42
Feedback	2844	11	-0.004-0.36	43.38***	0.18	3943	26	0.07-0.25	47.8**	0.16	0.36
Feedback-past performances	919	6	0.30-0.56	4.06	0.43	5868	31	0.02-0.19	65.99***	0.11	4.47***
Feedback-other's performances	799	5	0.30—0.58	3.84	0.44	5988	32	0.03-0.19	67.87***	0.11	4.27***
Feedback- participant's goals	965	5	-0.09-0.45	11.82**	0.18	5822	32	0.07-0.25	79.59***	0.16	0.23
Feedback-interventionist goals	1729	5	-0.16-0.52	29.07***	0.18	5058	32	0.08-0.25	60.06***	0.17	0.17
Feedback given verbally	1633	6	-0.20-0.34	21.98***	0.07	5154	31	0.11-0.27	64.77***	0.19	2.16*
Message feedback	1211	5	0.09-0.51	19.09**	0.30	5576	32	0.05-0.22	73.46***	0.14	2.63**
Barrier Identification	4175	19	0.02-0.19	28.37*	0.10	2612	18	0.09-0.37	55.24***	0.23	2.55**
Problem solving	4025	18	0.005-0.185	27.19*	0.10	2762	19	0.09-0.37	55.27***	0.23	2.80**
Tailoring	2544	15	0.10-0.42	49.95***	0.26	4243	22	-0.003-0.14	25.09	0.07	3.8***

n= number of participants, k= number of tests of the relationship, CI= 95% confidence interval, Q= test statistic of homogeneity, d= Mean effect size, Z= moderator analysis test statistic

*P<0.05 **p<0.01 ***p<0.001