



A systematic review of workplace health promotion interventions for increasing physical activity

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Purpose. The benefits of an active lifestyle are widely documented, yet studies show that only a small proportion of adults engage in sufficient levels of physical activity. The workplace presents an ideal avenue for delivering initiatives to promote physical activity, overcoming commonly cited barriers such as a 'lack of time' and providing access to a large intersection of society. The purpose of this study was to (1) explore the types of interventions workplaces implement to promote physical activity among staff, (2) describe the characteristics of those interventions, (3) understand whether these interventions positively impact on activity levels, and (4) assess the methodological quality of studies.

Methods. A systematic review of workplace physical activity interventions published up to April 2011 was conducted to identify types of interventions and their outcomes.

Results. Of the 58 studies included, the majority utilized health promotion initiatives. There were six physical activity/exercise interventions, 13 counselling/support interventions, and 39 health promotion messages/information interventions. Thirty-two of these studies showed a statistically significant increase in a measure of physical activity against a control group at follow-up.

Conclusions. While the studies included in this review show some evidence that workplace physical activity interventions can be efficacious, overall the results are inconclusive. Despite the proliferation of research in this area, there is still a need for more well-designed studies to fully determine the effectiveness of workplace interventions for increasing physical activity and to identify the types of interventions that show the most promise.

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The second author conceived and designed the study, acted as second reviewer for selection of articles, participated in interpretation of data and critically revised the manuscript. The first author participated in study design, acted as first reviewer for selection of articles, interpreted the data and drafted the manuscript. The third author participated in interpretation of data and critically revised the manuscript. All authors read and approved the final manuscript.

Statement of contribution***What is already known on this subject?***

- Despite the recognized health benefits of regular physical activity, only a small proportion of adults engage in sufficient levels of physical activity.
- The workplace presents an ideal avenue for the delivery of initiatives to promote physical activity.
- Previous reviews have concluded that the efficacy of workplace physical activity interventions is unclear and that many published studies are of poor methodological quality.

What does this study add?

- This systematic review includes more randomized controlled trials and quasi-experimental studies than previously published reviews of workplace physical activity interventions.
- While the studies included in this review do show some evidence that workplace physical activity interventions can be efficacious, overall the results are inconclusive.
- This review highlights that there is still a need for further well-designed studies to be carried out in order to evaluate the effectiveness of workplace interventions for increasing physical activity and identify the types of interventions that show the most promise.

The benefits of an active lifestyle are widely documented in the literature, and current public health guidelines recommend that healthy adults engage in a minimum of 150 min of moderate-to-vigorous intensity physical activity every week (Department of Health, 2011; World Health Organisation, 2010). Engaging in regular physical activity is important for both the physical and psychological well-being of people of all ages (Warburton, Nicol, & Bredin, 2006). Physical inactivity is a significant risk factor for the development of preventable chronic diseases such as coronary heart disease, stroke, and type 2 diabetes (Fine, Philogene, Gramling, Coups, & Sinha, 2004; Jeon, Lokken, Hu, & van Dam, 2007; Mora, Cook, Buring, Ridker, & Lee, 2007). Regular physical activity helps to reduce body mass index and can serve a rehabilitative purpose, helping with the management of musculoskeletal disorders (Banbury, Neil, & Johnson, 2010; Department of Health, 2009). Furthermore, research suggests that an active lifestyle may reduce the risk of premature death by around 20–30% (Department of Health, 2004). Physical activity is increasingly recognized for its mental health benefits with several studies showing that engaging in regular physical activity can reduce the symptoms of depression and anxiety, improve mood, and aid stress management (Blake, Mo, Malik, & Thomas, 2009; Fox, 1999; Paluska & Schwenk, 2000). There is also an associated economic benefit, as the combined cost of treating preventable illnesses and the loss of working days due to sickness absence, across the global is substantial (Department of Health, 2009; Katzmarzyk & Janssen, 2004; Medibank, 2007; Oldridge, 2008).

Despite the recognized health benefits of regular physical activity, studies from across Europe show that only a small proportion of adults engage in sufficient levels of physical activity (Dugdill, Brette, Hulme, McCluskey, & Long, 2008). For example, a study conducted across the European Union found that two-thirds of the adult population did not reach the recommended levels of physical activity (Sjöström, Oja, Hagströmer, Smith, & Bauman, 2006). Similarly, data from the United Kingdom reveal that only 39% of men and 29% of women meet government recommendations (NHS, 2008). Promoting regular exercise is thus crucial for societal health and well-being, as well as economic benefit and increasing physical activity is a significant public health issue for governments around the globe.

Public health policy worldwide has emphasized the need to create a culture that is conducive to regular physical activity (Department for Work & Pensions, Department of HSE, 2005; NICE, 2008; US National Physical Activity Plan, 2010). Specifically, employers are encouraged to play a key role in promoting the health and well-being of working-age adults (Department of Health, 2008; NHS Information Centre, 2008; World Health Organisation/World Economic Forum, 2008). It is argued that investing in the health of employees will have a multitude of benefits including reduced sickness absence, increased staff retention, and better productivity (NHS Information Centre, 2008; Proper, Hildebrandt, Van der Beek, Twisk, & Van Mechelen, 2003). From a public health perspective, the workplace presents an ideal avenue for the delivery of initiatives to promote physical activity, overcoming commonly cited barriers such as a 'lack of time' and providing access to a large and diverse intersection of society (Dugdill *et al.*, 2008). Against this backdrop, several published papers have reviewed the effectiveness of health promotion in the workplace. An early meta-analysis of worksite physical activity interventions found that there was limited evidence for an increase in physical activity (Dishman, Oldenburg, O'Neal, & Shepard, 1998). Furthermore, the majority of studies included in this early review were deemed to be of poor scientific quality (Dishman *et al.*, 1998). A more recent meta-analysis by Abraham and Graham-Rowe (2009) revealed that overall, worksite interventions had small positive effects on physical activity. The authors suggested that more recent interventional studies should be better designed. Similarly, in a systematic review of worksite physical activity interventions (across Europe, Australia, New Zealand, and Canada), Dugdill *et al.* (2008) found some evidence that workplace walking and workplace counselling interventions positively impacted upon physical activity behaviour. They also emphasized the need for more well-designed studies to be conducted.

Given the increasing emphasis on the workplace as a key setting for the promotion of health, and the known benefits of physical activity on health, it is important to understand *how* physical activity is being promoted in workplace health promotion programmes and to understand what effects, if any, they have on the physical activity levels of employees. The purpose of the present article is therefore to complement and broaden knowledge gained from existing reviews of worksite physical activity interventions by providing an up-to-date overview of research studies in this area. Specific objectives of the article include (1) to explore the types of interventions workplaces implement to promote physical activity among staff, (2) to describe the characteristics of those interventions (e.g., sample size/demographics, type of intervention, physical activity measures, theoretical underpinnings), (3) to understand whether these interventions positively impact physical activity levels, and (4) to assess the methodological quality of studies. Based on the findings, we present a summary of what is known about the current state of worksite physical activity intervention research and ideas about directions for future research and practice.

Methods

Literature search

The following electronic databases were searched for studies that assessed workplace health promotion interventions' influence on levels of physical activity: Medline (1950–2011), Embase (1980–2011), Cinahl (1982–2011), PsychINFO (1950–2011), The Cochrane Library (Issue 4, 2011), and the National Research Register (Issue 4, 2011). A broad search strategy was developed using a combination of the search terms: Physical activity, Exercise, Health Promotion, Work, Worksite, Workplace, Employee, Employees

Keyword combination:

Physical activity OR exercise OR health promotion AND Work OR Workplace OR Worksite OR Employee OR Employees

Figure 1. Search strategy used for literature search.

(Figure 1). Peer-reviewed studies published in English up to 1 April 2011 were retrieved. In addition, the reference lists of included studies and related systematic and non-systematic review articles were manually checked for further relevant articles.

Study inclusion and exclusion criteria

Studies were included in the review if they met the following inclusion criteria:

1. Reported outcomes of an intervention study designed to increase energy expenditure amongst employees;
2. Conducted in a workplace setting;
3. Included an outcome measure assessing level of physical activity;
4. Employed a randomized controlled trial (RCT),¹ prospective randomized trial (PRT),² or quasi-experimental design.³

Studies that did not meet these criteria were excluded from the review. In addition, studies that only included employees with an existing health problem (e.g., cardiovascular disease, neck problems) or were published in a non-English language journal were also excluded from the study. There were no restrictions on the basis of sample size, participant characteristics (e.g., age, gender), type of intervention, and study length or duration of follow-up. Studies were eligible if an intervention group was compared with either an untreated comparison/control or another intervention group. Quasi-experimental studies and PRTs were included in addition to RCTs, as it is acknowledged that a true RCT design might not always be possible in a workplace setting. Multi-component health promotion interventions, where the main objectives were to improve general health practices or reduce BMI, were included in the review as long as they reported an outcome measure specifically related to participants' levels of physical activity. Two researchers independently reviewed all potentially relevant articles identified from the literature search for eligibility. Any disagreements between them were resolved by discussion.

Data extraction and quality assessment

The final sample of selected studies was reviewed by the lead author, who extracted data on the sample characteristics, intervention and study design, measures used to assess

¹ A study in which people are allocated at random to one of several intervention groups. One of these groups is the standard of comparison or a control.

² A study in which people are allocated at random to one of several intervention groups. These intervention groups are compared with each other and there is no control group.

³ An experimental study similar to a randomised controlled trial, except there is no random assignment of participants to groups.

physical activity, and the results of each paper in relation to physical activity outcomes. Data were reported using standardized data extraction forms recommended by the Scottish Intercollegiate Guidelines Network (SIGN; 2011). Methodological quality of each study was then assessed independently by two reviewers using a checklist adapted from an earlier systematic review of workplace weight loss interventions (Benedict & Arterburn, 2008) and recommendations from the SIGN (2011). Additionally, the present review used the taxonomy of behaviour change techniques (BCTs) developed by Michie *et al.* (2011) to code the specific strategies and techniques used in the interventions to promote physical activity.

Results

Included studies

A total of 58 studies met the inclusion criteria. Details regarding the process followed in the review and selection of the studies are presented in Figure 2. Following selection, studies were grouped into three types of intervention: (1) physical activity/exercise interventions (including interventions such as active travel, stair walking interventions, and exercise classes; $n = 6$); (2) counselling/support interventions (including telephone counselling/coaching, motivational interviewing, peer support, and group-based counselling/coaching interventions; $n = 13$); (3) health promotion messages/information interventions (including interventions such as health checks/screening, the delivery of health promotion messages/information via email, posters, flyers, information classes, internet, etc. and multi-component health promotion programmes ($n = 39$)). For each intervention type, we report the characteristics of the studies (e.g., sample size, population, recruitment, use of theory), reported impact on physical activity levels, and a quality assessment.

Physical activity/exercise interventions

Six of the studies were categorized as physical activity/exercise interventions (Coleman *et al.*, 1999; Gilson *et al.*, 2009; Lee & White, 1997; Talvi, Jarvisalo, & Knuts, 1999; von Thiele Schwarz, Lindfors, & Lundberg, 2008; Yancey *et al.*, 2004).

Study characteristics. The sample size of these studies ranged from 32 to 798 participants. Two studies focused solely on female employees. Three studies had a majority of female participants (>70%), while one had a majority of male participants. One study imposed age restrictions on the sample, recruiting only employees over the age of 40. Three studies recruited staff from universities, two recruited employees from public health care organizations, and one involved staff from two oil refineries.

The mode of physical activity intervention included walking, aerobics, muscle training and stretching, and a choice of medium-to-high intensity exercises. The majority of studies focused on increasing physical activity as the primary outcome measure. One also targeted multiple health behaviours including dietary habits, smoking, and sleep.

Two studies reported using a sociocultural ecological approach, which centred on environmental level change to inform the design of the interventions. The remaining studies did not mention the theoretical basis of the interventions.

All studies used self-report measures to assess the levels of physical activity. One used the International Physical Activity Questionnaire (IPAQ), one used a 1-week activity recall

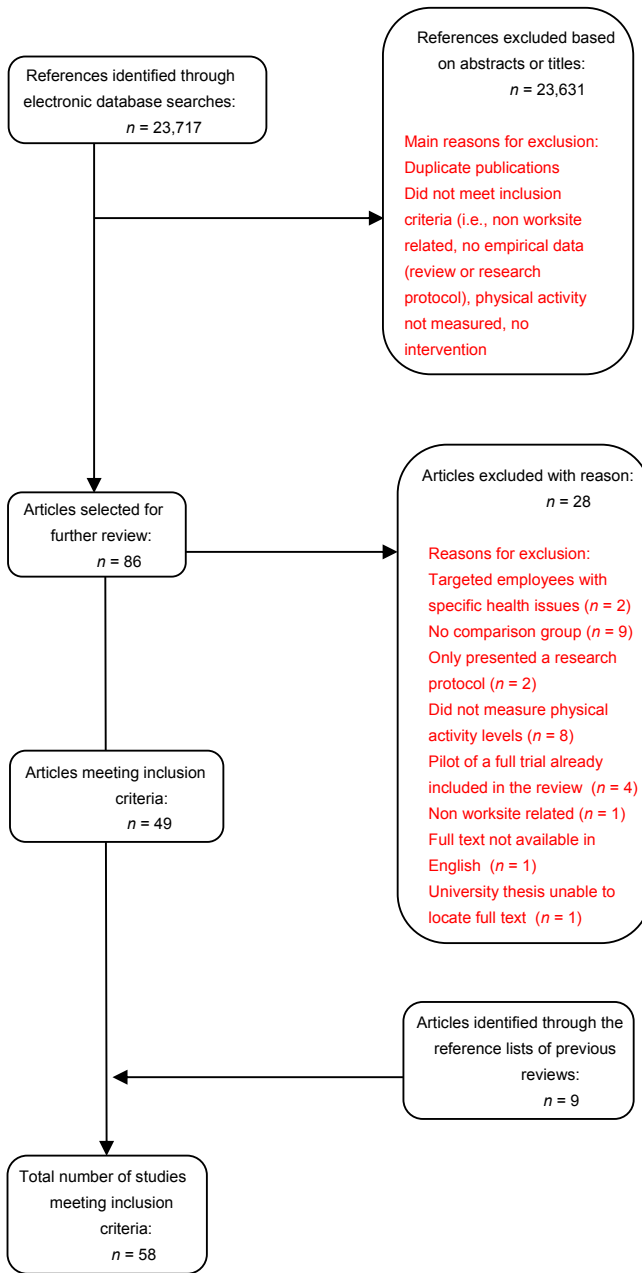


Figure 2. Flow chart showing study selection process.

questionnaire developed from the Stanford Physical Activity Recall measure, two studies reported developing their own questions to assess exercise habits, and two studies asked participants to keep a physical activity diary. These studies also included an objective measure of physical activity, asking participants to wear an accelerometer or pedometer. Further details about the characteristics of the physical activity/exercise intervention studies are presented in Table S1 in the online supporting information.

Effect of interventions on physical activity levels. Four of the studies indicated some improvement in physical activity behaviour following the intervention (Coleman *et al.*, 1999; Gilson *et al.*, 2009; Talvi *et al.*, 1999; von Thiele Schwarz *et al.*, 2008). However, only two studies showed a statistically significant increase in physical activity levels against a control group (Gilson *et al.*, 2009; von Thiele Schwarz *et al.*, 2008). Gilson *et al.* (2009) found that participants assigned to two different walking conditions showed a significant increase in step counts post-intervention compared with a control group ($p < .01$). Participants assigned to the workplace walking programme increased their step counts by over 968 steps at the end of the intervention. Participants given encouragement to increase their workplace walking also demonstrated an increase of over 699 steps. In comparison, individuals in the control group had decreased their step counts post-intervention. von Thiele Schwarz *et al.* (2008) found that participants assigned to an intervention involving 2.5 hr of mandatory workplace physical activity had increased their weekly physical activity by 2–4 hr following the intervention. In contrast, participants assigned to the control group and a comparison group given reduced working hours demonstrated no difference in physical activity levels.

Quality assessment. Full details of the quality assessment for the six physical activity/exercise interventions are presented in Table 1. Four studies were RCTs, one was a PRT, and one was a quasi-experimental study. Of the randomized trials, three randomized to intervention or control groups by worksite and two randomized at the individual level. Blinding of the investigator was not mentioned in any of the studies. The use of intention-to-treat analysis was described in one study. Specific eligibility criteria were also reported in one study. Five studies explicitly reported that groups were similar at baseline. One did not take any baseline measures. Half of the studies reported attrition rates, which ranged from 9.2% to 10%. Two studies did not provide any information about the length of follow-up. In the remaining four studies, length of follow-up ranged from 32 weeks to 3 years.

Counselling/support interventions

A total of 13 studies were categorized as counselling/support interventions (Aittasalo, Miiunpalo, & Suni, 2004; Campbell *et al.*, 2002; Elliot *et al.*, 2004; Gold, Anderson, & Serxner, 2000; Heirich, Foote, Erfurt, & Konopka, 1993; MacKinnon *et al.*, 2010; Moy, Sallam, & Wong, 2006; Nichols *et al.*, 2000; Nisbeth, Kalusen, & Andersen, 2000; Opdenacker & Boen, 2008; Proper *et al.*, 2003; Purath, Miller, McCabe, & Wilbur, 2004; van Wier *et al.*, 2009).

Study characteristics. The sample size of studies ranged from 36 to 1,880 participants. Two studies focused solely on female employees, and two focused solely on male employees. One study had a majority of female participants (>70%), and one study had a majority of male participants. In the remaining studies, the authors either did not provide any information about the gender of the participants or reported a combination of male and female employees. Two studies recruited staff from universities, two recruited staff from fire stations, one involved staff from government departments, and one included participants from both public and private sector organizations. The remaining recruited staff from various mid-to-large-sized companies.

The interventions included individual face-to-face counselling, telephone counselling, counselling and fitness testing, individual and group counselling, group-based behavio-

Table 1. Quality assessment of selected studies: physical activity/exercise interventions

Study	Described		Randomised – worksite or individual?	Eligibility criteria	Groups similar at baseline?	Investigator kept blind	Attrition reported	Non- randomized comparison	Intention- to-treat analysis	Percent completing trial
	Design	method of worksite recruitment								
Coleman <i>et al.</i> (1999)	PRT	✓	Individual	✓	✓	×	×	×	×	×
Gilson <i>et al.</i> (2009)	RCT	×	Individual	×	✓	×	×	×	✓	×
Lee and White (1997)	RCT	✓	Individual	×	✓	×	×	×	×	×
von Thiele Schwarz <i>et al.</i> (2008)	RCT	✓	Worksite	×	✓	×	✓	×	×	90.80
Talvi <i>et al.</i> (1999)	Non-RCT	✓	N/A	×	✓	×	✓	✓	×	90
Yancey <i>et al.</i> (2004)	RCT	✓	Worksite	×	×	×	✓	×	×	90

Note. PRT = prospective randomized trial; RCT = randomized controlled trial.

ural skills training and gym membership, counselling and mutual activity sessions, a peer support programme and tailored online magazines, motivational interviewing/counselling versus team-based health promotion classes, face-to-face versus telephone exercise coaching, and telephone versus online counselling. Eight of the interventions targeted multiple health behaviours.

Seven studies mentioned the theoretical basis of the interventions. Four were guided by the Transtheoretical Model with interventions matched to the participant's stage of change. Two studies reported using principles from Social Cognitive Theory to inform the design of the interventions. A combination of theories was used to inform one intervention, including the Transtheoretical Model, Social Cognitive Theory, and models of social support.

Self-report measures were used to assess levels of physical activity in all of the studies. Several developed self-report questionnaires for exercise habits. Others used standardized measures of physical activity such as the IPAQ, 7-day physical activity recall questionnaire, the Paffenbarger physical activity questionnaire, and the short questionnaire to assess health-enhancing physical activity (SQUASH). Further details about the characteristics of the selected studies are presented in Table S2 in the online supporting information.

Effect of interventions on physical activity levels. Ten of the studies indicated some improvement in physical activity behaviour following the intervention (Campbell *et al.*, 2002; Elliot *et al.*, 2004; Gold *et al.*, 2000; Heirich *et al.*, 1993; MacKinnon *et al.*, 2010; Nichols *et al.*, 2000; Opdenacker & Boen, 2008; Proper *et al.*, 2003; Purath *et al.*, 2004; van Wier *et al.*, 2009). Eight of these studies showed a statistically significant increase in physical activity levels against a control group (Campbell *et al.*, 2002; Elliot *et al.*, 2004; Gold *et al.*, 2000; Heirich *et al.*, 1993; MacKinnon *et al.*, 2010; Nichols *et al.*, 2000; Proper *et al.*, 2003; van Wier *et al.*, 2009).

van Wier *et al.* (2009) found that telephone counselling was more effective at significantly increasing physical activity levels compared with a control group, than an Internet counselling intervention ($p < .001$). Similarly, Gold *et al.* (2000) found that participants assigned to a telephone counselling intervention were significantly more likely to reduce their risk in the area of exercise and activity (45.2% of participants reduced their risk) compared with the employees in the comparison group (26.6% reduced risk; $p < .05$). Campbell *et al.* (2002) reported that women with access to a tailored computer-based intervention and peer support in the form of trained behaviour change mentors in the workplace, significantly increased their average frequency of strengthening and flexibility exercise compared with the control group. Two studies also found that individual face-to-face counselling ($p < .01$; Heirich *et al.*, 1993) and a behavioural skills intervention ($p < 0.10$; Nichols *et al.*, 2000) resulted in greater improvements in physical activity habits compared with control conditions, in which participants were given access to free gym and fitness facilities. In fact, Heirich *et al.* (1993) found that while more participants in the two counselling conditions (44% and 45%) were exercising three times per week or more at follow-up compared with the control group, participants assigned to a staffed physical fitness facility condition showed a significant decline in the percentage of people engaging in regular exercise at follow-up (-6% ; $p < .01$). Proper *et al.* (2003) also reported a significant increase in total energy expenditure amongst participants assigned to a tailored individual counselling condition in comparison with the control condition. In contrast, two studies found that a team-based health promotion intervention appeared to be more effective at improving exercise habits at follow-up compared with a

control group than a one-to-one counselling intervention ($p < .05$; Elliot *et al.*, 2004; MacKinnon *et al.*, 2010).

Quality assessment. Full details of the quality assessment are presented in Table 2. Nine studies were RCTs, two were PRTs, and two studies used a quasi-experimental design. Of the randomized trials, six randomized to intervention or control group by worksite and five randomized at the individual level. Blinding of the investigator was not mentioned in any of the studies. The use of intention-to-treat analysis was described in one study. Specific eligibility criteria were reported in eight studies. Four of the studies explicitly reported that groups were similar at baseline. In the remaining nine studies, this information was either omitted or some differences in baseline measures were found between groups. Information on attrition was reported in ten studies. The attrition rates varied considerably ranging from 1% to 65%. Length of follow-up was also reported in ten studies and ranged from 6 weeks to 4 years. In five of the RCTs, the control groups also received some form of minimal intervention (e.g., lifestyle brochures).

Health promotion messages/information interventions

The majority (67%) of all included studies were interventions providing health promotion messages/information ($n = 39$; Badland & Schofield, 2005; Bergstrom *et al.*, 2008; Blair *et al.*, 1986; Blissmer & McAuley, 2002; Boudreau, Godin, Pineau & Bradet, 1995; Cardinal & Sachs, 1996; Cook *et al.*, 2001; Cook *et al.*, 2007; De Cocker, De bourdeaudhuij, & Cardon, 2010; Dishman *et al.*, 2009; Emmons *et al.*, 1999; French *et al.*, 2010; Hager *et al.*, 2002; Hallam & Petosa, 1998; Hedberg *et al.*, 1998; Kronenfeld *et al.*, 1987; Kwak *et al.*, 2009; Loughlan & Mutrie, 1997; Marshall *et al.*, 2003; McEachan *et al.*, 2011; Morgan *et al.*, 2011; Mutrie *et al.*, 2002; Naito *et al.*, 2008; Napolitano *et al.*, 2003; O'Loughlin *et al.*, 1996; Ostwald, 1989; Peterson & Aldana, 1999; Plotnikoff *et al.*, 2005; Plotnikoff *et al.*, 2007; Robbins *et al.*, 1987; Sherman *et al.*, 1989; Siegel, Prellip, Erausquin, & Kim, 2010; Speck & Looney, 2001; Spittaels *et al.*, 2007; Sorensen *et al.*, 2005; Sternfeld *et al.*, 2009; Stonecipher & Hyner, 1993; Titze *et al.*, 2001; Yap *et al.*, 2009).

Study characteristics. The sample size of the studies varied considerably ranging from 46 to 4,894 participants. In terms of gender, two interventions included only female employees and one intervention consisted solely of male participants. There were also seven studies with a majority of female participants (70%>), and two had a majority of male participants. In the remaining studies, the authors either did not provide any information about the gender of the participants or included a mixture of male and female employees. Five studies recruited staff from a university, three recruited staff from government departments, two from hospitals, and three involved employees from different schools. In one study, participants were recruited from three different public sector organizations: a school, a university, and a health board. In another, participants came from both a government and commercial organization. The remaining studies recruited participants from various mid-to-large-sized companies.

The mode of intervention used in the studies varied considerably and included posters promoting stair use, health screening accompanied by targeted health promotion activities, written health promotion materials, email messages, health promotion workshops/classes, Web-based health promotion messages, record keeping

Table 2. Quality assessment of selected studies: counselling/support interventions

Study	Design	Described method of workplace recruitment	Randomized – worksite or individual?	Eligibility criteria	Groups similar at baseline?	Investigator kept blind	Attrition reported	Non-randomized comparison	Intention-to-treat analysis	Per cent completing trial
Aittasalo <i>et al.</i> (2004)	RCT	✓	Individual	✓	✓	×	✓	×	×	99
Campbell <i>et al.</i> (2002)	RCT	✓	Worksite	✓	×	×	✓	×	×	62.6
Elliot <i>et al.</i> (2004)	RCT	✓	Worksite	×	×	×	×	×	×	100
Gold <i>et al.</i> (2000)	Non-RCT	✓	N/A	✓	✓	×	×	✓	×	×
Heirich <i>et al.</i> (1993)	RCT	✓	Worksite	×	×	×	×	×	×	×
MacKinnon <i>et al.</i> (2010)	RCT	✓	Worksite	×	✓	×	✓	×	✓	35
Moy <i>et al.</i> (2006)	Non-RCT	×	N/A	✓	×	×	✓	✓	×	75
Nichols <i>et al.</i> (2000)	RCT	×	Individual	×	×	×	✓	×	×	91
Nisbeth <i>et al.</i> (2000)	RCT	✓	Individual	×	✓	×	✓	×	×	85
Opdenacker and Boen (2008)	PRT	✓	Individual	✓	×	×	✓	×	×	93
Proper <i>et al.</i> (2003)	RCT	×	Worksite	✓	×	×	✓	×	×	76
Purath <i>et al.</i> (2004)	PRT	✓	Worksite	✓	×	×	✓	×	×	94.4
van Wier <i>et al.</i> (2009)	RCT	✓	Individual	✓	×	×	✓	×	×	67.4

Note. PRT = prospective randomized trial; RCT = randomized controlled trial.

of physical activities, and multicomponent interventions (e.g., a combination of emails, posters, and flyers). Two studies compared the effectiveness of Web versus printed health promotion materials. The majority of these interventions were designed to target multiple health behaviours (e.g., promoting healthy eating as well as physical activity).

Twenty-one studies (54%) mentioned the theoretical basis of the interventions. Fourteen were guided by the Transtheoretical Model with interventions matched to the participant's stage of change. Four studies reported using principles from Social Cognitive Theory to inform the design of the interventions. One study used the Theory of Planned Behaviour and two reported using multiple socio-cognitive theories to inform the intervention including Social Cognitive Theory, Protection Motivation Theory, Stages of Change Model, and the Theory of Planned Behaviour.

A variety of self-report measures were used to assess the levels of physical activity. Most studies ($n = 15$) developed self-report questions for exercise habits. Others used standardized measures of physical activity such as the IPAQ, 7-day physical activity recall questionnaire, the Godin leisure time exercise questionnaire, Stanford Brief Activity Survey (SBAS), the SQUASH, and the Aerobic Centre Longitudinal Study Physical Activity Questionnaire. Four studies also included an objective measure of physical activity, asking participants to wear an accelerometer or pedometer. Further details about the characteristics of the selected studies are presented in Table S3 in the online supporting information.

Effect of interventions on physical activity levels. Twenty-nine indicated some improvement in physical activity behaviour following the intervention period (Blair *et al.*, 1986; Blissmer & McAuley, 2002; Cardinal & Sachs, 1996; Cook *et al.*, 2001; Cook, Billings, Hersch, Back, & Hendrickson, 2007; Dishman, DeJoy, Wilson, & Vandeberg, 2009; Emmons *et al.*, 1999; Hager *et al.*, 2002; Hallam & Petosa, 1998; Hedberg *et al.*, 1998; Kronenfeld *et al.*, 1987; Kwak *et al.*, 2009; Loughlan & Mutrie, 1997; Morgan *et al.*, 2011; Mutrie *et al.*, 2002; Naito *et al.*, 2008; Napolitano *et al.*, 2003; O'Loughlin *et al.*, 1996; Peterson & Aldana, 1999; Plotnikoff *et al.*, 2005; Plotnikoff *et al.*, 2007; Robbins *et al.*, 1987; Sherman *et al.*, 1989; Speck & Looney, 2001; Spittaels *et al.*, 2007; Sorensen *et al.*, 2005; Sternfeld *et al.*, 2009; Titze *et al.*, 2001; Yap *et al.*, 2009). Twenty-two of these showed a statistically significant increase in physical activity levels against a control (Blair *et al.*, 1986; Blissmer & McAuley, 2002; Cardinal & Sachs, 1996; Cook *et al.*, 2001; Dishman *et al.*, 2009; Emmons *et al.*, 1999; Hager *et al.*, 2002; Hallam & Petosa, 1998; Hedberg *et al.*, 1998; Kwak *et al.*, 2009; Morgan *et al.*, 2011; Mutrie *et al.*, 2002; Naito *et al.*, 2008; Napolitano *et al.*, 2003; O'Loughlin *et al.*, 1996; Peterson & Aldana, 1999; Plotnikoff *et al.*, 2005; Speck & Looney, 2001; Sorensen *et al.*, 2005; Sternfeld *et al.*, 2009; Titze *et al.*, 2001; Yap *et al.*, 2009).

Six found that interventions with stage-of-change-matched health promotion materials showed a significantly greater increase in physical activity levels at follow-up when compared with stage mismatched or control conditions (Blissmer & McAuley, 2002; Mutrie *et al.*, 2002; Napolitano *et al.*, 2003; Peterson & Aldana, 1999; Sternfeld *et al.*, 2009; Yap *et al.*, 2009). One study reported that participants assigned to both a stage-matched and a stage-mismatched email intervention showed a significantly greater increase in their leisure-time physical activity post-intervention (by 8.6% and 6.3%, respectively), compared with participants assigned to the control group ($p < .05$; Hager *et al.*, 2002). Another found that an online intervention incorporating stage-of-change-

targeted reminder emails was equally as effective as an online intervention without stage-matched reminder emails and a standard physical activity advice condition in significantly increasing physical activity levels at follow-up ($p < .001$; Spittaels *et al.*, 2007). However, in contrast, one study found that stage-matched health promotion materials delivered via the Web and in a printed format were both ineffective at increasing physical activity (Marshall, Leslie, Bauman, Marcus, & Owen, 2003).

Another study found that an intervention that allowed employees to take an active role in designing and implementing health promotion activities was more effective in improving exercise habits than a standard self-help programme on physical activity ($p < .05$; Emmons *et al.*, 1999). Cardinal and Sachs (1996) found that a health promotion packet that encouraged participants to engage in 30 min of physical activity on most days of the week was more effective at increasing weekly leisure-time physical activity compared with a health promotion packet that encouraged a gradual increase in the number of weekly exercise sessions ($p < .01$).

Quality assessment. Full details of the quality assessment are presented in Table 3. Eighteen studies were RCTs, three were PRTs, and 18 studies used a quasi-experimental design. Of the randomized trials, eight randomized to intervention or control group by worksite and 13 randomized at the individual level. Blinding of the investigator was mentioned in three of the studies. The use of intention-to-treat analysis was described in seven studies. Specific eligibility criteria were reported in 13 studies. Just over a third of the studies ($n = 14$) explicitly reported that groups were similar at baseline. In the remaining studies, this information was either omitted or some differences in baseline measures were found between groups. Most studies ($n = 30$) provided specific information on attrition. The attrition rates ranged from 4% to 56%. Length of follow-up was reported in 24 studies and ranged from 2 weeks to 5 years. In seven of the RCTs, the control groups also received some form of minimal intervention (e.g., information about their health status).

Behaviour change techniques in interventions

A review of BCTs within intervention descriptions was also carried out. The lack of clear detail provided in some articles made evaluation of BCTs more difficult; therefore, only techniques explicitly referenced by authors and agreed on as present by two reviewers have been included in the summary table (see Table 4). The number of techniques identified per study ranged from 0 to 10. In 13 studies, the research team was unable to identify an explicit BCT from the intervention description. However, the majority (67%) of studies coded multiple BCTs (mean = 3.2). The main BCTs identified in the interventions included: goal setting (behaviour; 21 studies), provide instruction on how to perform the behaviour (20 studies), Prompt self-monitoring of behaviour (14 studies), provide information on where and when to perform the behaviour (13 studies), plan social support/social change (12 studies), and provide information on consequences of behaviour in general (12 studies).

Discussion

The purpose of this review was to systematically examine and summarize the evidence on workplace interventions to promote physical activity. In accordance with the growing

Table 3. Quality assessment of selected studies: health promotion messages/information

Study	Design	Described method of worksite recruitment	Randomized – worksite or individual?	Eligibility criteria	Groups similar at baseline?	Investigator kept blind	Attrition reported	Non- randomized comparison	Intention- to-treat analysis	Percent completing trial
Badland and Schofield (2005)	Non-RCT	✓	N/A	×	×	×	×	✓	×	×
Bergström et al. (2008)	Non-RCT	✓	N/A	×	×	×	✓	✓	×	×
Blair et al. (1986)	Non-RCT	×	N/A	×	×	×	✓	✓	×	96
Blissmer and McAuley (2002)	RCT	✓	Individual	✓	✓	×	✓	×	×	68.4
Boudreau et al. (1995)	Non-RCT	✓	N/A	✓	×	×	✓	✓	×	81
Cardinal and Sachs (1996)	RCT	✓	Individual	✓	✓	×	✓	×	×	95.6
Cook et al. (2001)	Non-RCT	✓	N/A	×	×	×	✓	✓	×	89
Cook et al. (2007)	PRT	✓	Individual	×	✓	×	✓	×	×	87.3
De Cocker et al. (2010)	Non-RCT	✓	N/A	×	×	×	✓	✓	×	49

Continued

Table 3. (Continued)

Study	Design	Described method of worksite recruitment	Randomized – worksite or individual?	Eligibility criteria	Groups similar at baseline?	Investigator kept blind	Attrition reported	Non-randomized comparison	Intention-to-treat analysis	Percent completing trial
Dishman <i>et al.</i> (2009)	RCT	✓	Worksite	×	×	×	✓	×	×	66.9
Emmons <i>et al.</i> (1999)	RCT	✓	Worksite	✓	✓	×	✓	×	×	74.4
French <i>et al.</i> (2010)	RCT	✓	Worksite	×	×	×	✓	×	✓	60
Hager <i>et al.</i> (2002)	RCT	✓	Individual	×	×	×	✓	×	×	77
Hallam and Petosa (1998)	Non-RCT	✓	N/A	✓	×	×	✓	✓	×	73.3
Hedberg <i>et al.</i> (1998)	Non-RCT	✓	N/A	×	✓	×	✓	✓	×	86
Kronenfeld <i>et al.</i> (1987)	Non-RCT	✓	NA	×	✓	×	✓	✓	×	80
Kwak <i>et al.</i> (2009)	Non-RCT	✓	N/A	×	×	×	✓	✓	×	75.8
Loughlan and Mutrie (1997)	RCT	✓	Individual	×	×	×	×	×	×	×

Continued

Table 3. (Continued)

Study	Design	Described method of worksite recruitment	Randomized – worksite or individual?	Eligibility criteria	Groups similar at baseline?	Investigator kept blind	Attrition reported	Non- randomized comparison	Intention- to-treat analysis	Percent completing trial
Marshall et al. (2003)	PRT	✓	Individual	×	✓	✓	✓	×	✓	78
McEachan et al. (2011)	RCT	✓	Worksite	✓	✓	×	✓	×	×	×
Morgan et al. (2011)	RCT	✓	Individual	×	✓	✓	✓	×	✓	81.8
Mutrie et al. (2002)	RCT	✓	Individual	✓	×	✓	✓	×	✓	56
Naito et al. (2008)	Non-RCT	✓	NA	×	×	×	×	✓	×	×
Napolitano et al. (2003)	RCT	✓	Individual	✓	✓	×	✓	×	×	80
O’Loughlin et al. (1996)	Non-RCT	✓	NA	×	×	×	×	✓	×	×
Ostwald (1989)	Non-RCT	✓	NA	×	×	×	✓	✓	×	×
Peterson and Aldana (1999)	RCT	✓	Individual	×	✓	×	✓	×	×	67
	RCT	✓	Individual	✓	×	×	×	×	×	×

Continued

Table 3. (Continued)

Study	Design	Described method of worksite recruitment	Randomized –worksite or individual?	Eligibility criteria	Groups similar at baseline?	Investigator kept blind	Attrition reported	Non- randomized comparison	Intention- to-treat analysis	Percent completing trial
Plotnikoff <i>et al.</i> (2005)	RCT	✓	Worksite	×	×	×	✓	×	×	56.7
Plotnikoff <i>et al.</i> (2007)	Non-RCT	✓	NA	×	×	×	✓	✓	×	67
Robbins <i>et al.</i> (1987)	Non-RCT	✓	NA	×	×	×	×	✓	×	×
Sherman <i>et al.</i> (1989)	RCT	✓	Worksite	×	×	×	×	×	×	×
Siegel <i>et al.</i> (2010)	RCT	✓	Worksite	✓	✓	×	×	×	×	×
Speck and Looney (2001)	PRT	✓	Individual	✓	✓	×	✓	×	✓	72
Spittaels <i>et al.</i> (2007)	RCT	✓	Worksite	✓	×	×	✓	×	✓	×
Sorensen <i>et al.</i> (2005)	RCT	✓	Individual	✓	×	×	✓	×	✓	69.9

Continued

Table 3. (Continued)

Study	Design	Described method of worksite recruitment	Randomized – worksite or individual?	Eligibility criteria	Groups similar at baseline?	Investigator kept blind	Attrition reported	Non- randomized comparison	Intention- to-treat analysis	Percent completing trial
Sternfeld et al. (2009)	Non-RCT	✓	NA	×	×	×	✓	✓	×	98.4
Stonecipher and Hyner (1993)	Non-RCT	✓	NA	×	✓	×	✓	✓	×	44
Titze et al. (2001)	Non-RCT	✓	NA	×	×	×	×	✓	×	×
Yap et al. (2009)	Non-RCT	✓	NA	×	×	×	×	✓	×	×

Note. PRT = prospective randomized trial; RCT = randomized controlled trial.

Table 4. Behaviour change techniques (BCTs) used in the interventions

Study	BCTs used
<i>Physical activity/exercise interventions</i>	
Coleman <i>et al.</i> (1999)	Prompt self-monitoring of behaviour Provide instruction on how to perform the behaviour Goal setting (behaviour) Agree behavioural contract Set graded tasks Stimulate anticipation of future rewards Provide rewards contingent on successful behaviour Providing feedback on performance Barrier identification/problem-solving
Gilson <i>et al.</i> (2009)	Set graded tasks Provide information on where and when to perform the behaviour Use of follow-up prompts Prompt practice
Lee and White (1997)	Provide instruction on how to perform the behaviour Barrier identification/problem-solving
Talvi <i>et al.</i> (1999)	No BCTs identified in intervention description
von Thiele Schwarz <i>et al.</i> (2008)	Provide instructions on how to perform the behaviour
Yancey <i>et al.</i> (2004)	Model/demonstrate the behaviour
<i>Counselling/Support interventions</i>	
Aittasalo <i>et al.</i> (2004)	Goal setting (behaviour) Action planning Prompt review of behavioural goals Prompt self-monitoring of behaviour
Campbell <i>et al.</i> (2002)	No BCTs identified in intervention description
Elliot <i>et al.</i> (2004)	Provide normative information about others' behaviour Provide information on consequences of behaviour in general Goal setting (behaviour) Action planning Motivational interviewing Provide feedback on performance Provide instruction on how to perform the behaviour Prompt review of behavioural goals Facilitate social comparison
Gold <i>et al.</i> (2000)	Barrier identification/problem-solving Plan social support/social change
Heirich <i>et al.</i> (1993)	Goal setting (behaviour) Providing instruction on how to perform the behaviour Plan social support/change
MacKinnon <i>et al.</i> (2010)	Plan social support/change Goal setting (behaviour) Facilitate social comparison Motivational interviewing Provide normative information about others' behaviour
Moy <i>et al.</i> (2006)	Prompt rewards contingent on effort or progress towards behaviour
Nichols <i>et al.</i> (2000)	No BCTs identified in intervention description

Continued

Table 4. (Continued)

Study	BCTs used
Nisbeth et al. (2000)	Provide information on consequences of the behaviour to the individual Goal setting (behaviour) Action planning
Opdenacker and Boen (2008)	Provide instruction on how to perform the behaviour Goal setting (behaviour) Action planning Providing information on where and when to perform the behaviour Provide instruction on how to perform the behaviour Barrier identification/problem-solving Prompt behavioural of behavioural goals Prompt self-monitoring of behaviour
Proper et al. (2003)	Action planning
Purath et al. (2004)	Goal setting (behaviour) Action planning Prompt review of behavioural goals Agree behavioural contract Use of follow-up prompts
van Wier et al. (2009)	Goal setting (behaviour) Action planning Prompt review of behavioural goals Agree behavioural contract Use of follow-up prompts
<i>Health promotion messages/information interventions</i>	
Badland and Schofield (2005)	Provide information on where and when to perform the behaviour
Bergström et al. (2008)	Action planning Provide normative information about other behaviour
Blair et al. (1986)	Information on where and when to perform the behaviour Use of follow-up prompts
Blissmer and McAuley (2002)	Providing information on consequences of behaviour in general Goal setting (behaviour) Barrier identification/problem-solving Provide rewards contingent on successful behaviour Plan social support/social change Relapse prevention/coping planning
Boudreau et al. (1995)	Provide information on the consequences of the behaviour to the individual
Cardinal and Sachs (1996)	Provide instruction on how to perform the behaviour Relapse prevention/coping planning Action planning Set graded tasks
Cook et al. (2001)	No BCTs identified in intervention description
Cook et al. (2007)	No BCTs identified in intervention description
De Cocker et al. (2010)	Facilitate social comparison Provide instruction on how to perform the behaviour Provide feedback on behaviour Goal setting (behaviour)
Dishman et al. (2009)	

Continued

Table 4. (Continued)

Study	BCTs used
Emmons <i>et al.</i> (1999) French <i>et al.</i> (2010)	Provide information on consequences of behaviour in general
	Goal setting (behaviour)
	Action planning
	Provide rewards contingent on successful behaviour
	Provide information on where and when to perform the behaviour
	Prompt practice
	Environmental restructuring
	No BCTs identified in intervention description
	Prompt rewards contingent on effort or progress towards a behaviour
	Provide information on where and when to perform the behaviour
Hager <i>et al.</i> (2002)	Model/demonstrate the behaviour
	Prompt practice
	Plan social support/social change
	Goal setting (behaviour)
	Barrier identification/problem-solving
	Provide instruction on how to perform the behaviour
	Environmental restructuring
Hallam and Petosa (1998)	Relapse prevention/coping planning
	Prompt use of imagery
	Provide information on consequences of behaviour in general
	Goal setting (behaviour)
	Prompt review of behavioural goals
	Prompt self-monitoring of behaviour
	Provide instruction on how to perform the behaviour
	Plan social support/social change
	Relapse prevention/coping planning
	Time management
Hedberg <i>et al.</i> (1998)	No BCTs identified in intervention description
Kronenfeld <i>et al.</i> (1987)	Provide information on where and when to perform the behaviour
Kwak <i>et al.</i> (2009)	Provide normative information about others' behaviour
	Promote self-monitoring of behaviour
	Provide information on consequences of behaviour to the individual
	Provide information on where and when to perform the behaviour
	Provide information on consequences of behaviour to the individual
	Goal setting (outcome)
Loughlan and Mutrie (1997)	Plan social support/social change
	Barrier identification/problem-solving
	Provide information on where and when to perform the behaviour
	Goal setting (behaviour)
	Prompt self-monitoring of behaviour
Marshall <i>et al.</i> (2003)	Teach to use prompts/cues
	Plan social support/social change
	Stimulate anticipation of future rewards
	Provide information on consequences of behaviour in general
	Prompt self-monitoring of behaviour
McEachan <i>et al.</i> (2011)	Plan social support/social change

Continued

Table 4. (Continued)

Study	BCTs used
Morgan et al. (2011)	Goal setting (behaviour) Time management Teach to use prompts/cues Provide instruction on how to perform the behaviour Prompt review of behavioural goals Prompt self-monitoring of behaviour Provide feedback on performance Provide information on consequences of behaviour in general Prompt self-monitoring of behaviour Goal setting (behaviour) Set graded tasks Barrier identification/problem-solving Plan social support/social change Prompt rewards contingent on effort or progress towards behaviour
Mutrie et al. (2002)	Prompt self-monitoring of behaviour Provide information on where and when to perform the behaviour Provide instruction on how to perform the behaviour
Naito et al. (2008)	Prompt self-monitoring of behaviour Provide information on where and when to perform the behaviour Provide instruction on how to perform the behaviour
Napolitano et al. (2003)	Provide information on consequences of behaviour in general Barrier identification/problem-solving Provide instruction on how to perform the behaviour Prompt self-monitoring of behaviour Prompt self-monitoring of behavioural outcome Goal setting (behaviour) Plan social support/social change
O'Loughlin et al. (1996)	Provide information on consequences of behaviour to the individual Goal setting (behaviour) Set graded tasks
Ostwald (1989)	Provide information on consequences of behaviour in general Provide information on consequences of behaviour to the individual Provide information on where and when to perform the behaviour Provide instruction on how to perform the behaviour
Peterson and Aldana (1999)	Provide information on consequences of behaviour in general Goal setting (behaviour) Relapse prevention/coping planning
Plotnikoff et al. (2005)	No BCTs identified in intervention description
Plotnikoff et al. (2007)	Provide information on consequences of behaviour in general Provide instruction on how to perform the behaviour
Robbins et al. (1987)	Provide information on consequences of behaviour to the individual Provide feedback on performance
Sherman et al. (1989)	No BCTs identified in intervention description
Siegel et al. (2010)	No BCTs identified in intervention description
Speck and Looney (2001)	Prompt self-monitoring of behaviour Provide instruction on how to perform the behaviour
Spittaels et al. (2007)	

Continued

Table 4. (Continued)

Study	BCTs used
	Provide information on consequences of behaviour in general Provide normative information about others behaviour Action planning Provide instruction on how to perform the behaviour Use of follow-up prompts
Sorensen <i>et al.</i> (2005)	Provide feedback on performance
	Provide information on where and when to perform the behaviour
Sternfeld <i>et al.</i> (2009)	Provide information on consequences of behaviour in general Goal setting (behaviour) Provide information on consequences of behaviour to the individual Use of follow-up prompts Prompt self-monitoring of behaviour Barrier identification/problem-solving
Stonecipher and Hyner (1993)	No BCTs identified in intervention description
Titze <i>et al.</i> (2001)	Provide information on consequences of behaviour in general Provide information on where and when to perform the behaviour Provide instruction on how to perform the behaviour
Yap <i>et al.</i> (2009)	No BCTs identified in intervention description

public health emphasis on active lifestyles and workplace health and well-being, our findings demonstrate that there is a considerable volume of evidence in this area, including a further 12 studies published since the 2008/2009 systematic reviews on the same topic (Abraham & Graham-Rowe, 2009; Dugdill *et al.*, 2008).

Types of interventions

Of the 58 studies included, the majority utilized health promotion initiatives. There were eight physical activity/exercise interventions, 13 counselling/support interventions, and 39 health promotion messages/information interventions. However, the review identified only six studies that included an actual workplace physical exercise component (e.g., aerobic classes or walking groups).

Intervention characteristics

The majority of studies utilized psychological or behavioural strategies to change people's exercise behaviour. Almost half of the 58 intervention studies were designed to target multiple health behaviours and most targeted both men and women, with several also focused mainly on women participants. The mode and delivery of intervention also varied considerably across the studies ranging from face-to-face communication, posters, logging of activities, emails, and group exercise.

Several studies in this review drew on the Transtheoretical Model in order to tailor interventions to specific stages of change. However, these studies reported mixed findings. In an earlier meta-analysis of workplace physical activity interventions, Abraham and Graham-Rowe (2009) concluded that interventions that individually tailored information and feedback were no more effective than interventions providing generic

information, and indeed, poor outcomes from tailored interventions delivered in the workplace have also been observed in the promotion of other health behaviours (McHugh & Suggs, 2012). This pattern of findings is somewhat surprising given that many studies have advocated the tailoring of health education and behaviour change communications and shown positive data trends (Brug, Oenema, & Campbell, 2003; Dijkstra, De Vries, & Roijackers, 1999; Kreuter, Strecher, & Glassman, 1999; Suggs, 2003, 2006). It is possible that tailored programmes are not tailored to the most predictive constructs or that messages alone are not enough to raise physical activity levels via a workplace setting. Indeed, it may be that within a workplace setting, social influences play a greater role in an individual's health behaviour choices than individual factors alone. For example, both Elliot *et al.* (2004) and MacKinnon *et al.* (2010) found that team-based health promotion classes had a more positive impact on physical activity behaviour than individual health counselling.

It is notable that very few of the workplace interventions identified in this review included an actual physical exercise or physical activity component. Of the six physical activity interventions identified, two walking interventions reported a significant increase in physical activity levels following the intervention. This finding is reflective of earlier systematic reviews, which also found some evidence to support the efficacy of workplace walking interventions for promoting overall physical activity levels (Abraham & Graham-Rowe, 2009; Dugdill *et al.*, 2008). One explanation for this could be that interventions that provide individuals with an opportunity to engage in physical activity during their working day also help to overcome the commonly cited barrier to exercise participation: lack of time (Dugdill *et al.*, 2008). Such interventions may help individuals to develop exercising as a healthy habit, which can more readily be maintained following the end of the programme (Verplanken & Melkevik, 2008).

Impact on physical activity levels

Findings from the current review show that while there are several examples of studies in which a workplace intervention has been successful in increasing certain elements of physical activity behaviour against a control group ($n = 32$), equally there are a volume of studies in which no difference has been observed or in which both the control and intervention conditions have demonstrated similar increases in the levels of physical activity. Consequently, although workplace interventions do show some promise for increasing physical activity, the evidence base for their efficacy is not overwhelmingly strong. In addition, it is unclear from the reviewed studies whether particular types of interventions (e.g., counselling vs. exercise interventions) or delivery formats (e.g., telephone vs. internet or individual vs. group) are more effective than others. There is also inconclusive evidence regarding the efficacy of tailoring interventions to particular 'stages of change'. While some studies have shown that stage-matched interventions are more effective than non-stage-matched interventions, other studies found no such effect. Consequently, similar to the findings of the earlier systematic reviews in this area, it appears that firm recommendations about the effectiveness of workplace interventions for increasing physical activity or the types of interventions that show the most promise are still not possible.

Methodological quality of studies

Most of the studies included were RCTs. Although the quality of available evidence varies considerably, our quality assessment indicated several common methodological limita-

tions across studies. A key area of concern is related to outcome measurements of physical activity. The majority of the reviewed studies relied solely on self-report measures. Furthermore, many of these used non-validated questionnaires or single items to assess physical activity behaviour. This not only introduces the risk of response bias but can also make direct comparison between studies problematic.

It was also noted that many of the reviewed interventions included multiple heterogeneous components. As a result, the success of a particular intervention cannot be attributed to a specific intervention component. In addition, several of the RCTs lacked a true control group, in that control participants were also given some form of minimal intervention. This can potentially obscure the real effectiveness of an intervention for increasing physical activity and may therefore limit generalizability of the findings. However, in some situations, it could also be argued that a minimal intervention control group might be more appropriate in a workplace setting (e.g., if the intervention involves co-workers who are randomized at an individual level).

Participation in the interventions was primarily on a voluntary basis. Employees enrolling in the programmes may therefore have had greater motivation to change their health behaviours than other employees. This is a particular concern in the non-RCTs, where researchers often compared volunteer participants with non-participants in the same organization. Unfortunately, in real-world research, it is often impractical in a workplace setting to randomly assign employees to treatment groups. For example, health promotion materials may be exchanged between employees in different treatment groups, thus introducing contamination bias and potentially obscuring the effects of a given intervention. For this reason, many of the RCT studies included in this review randomized at the worksite rather than individual employee level. However, although this is a feasible and practical approach, our review found that participant characteristics in the control and intervention conditions were not always equivalent at baseline. Although differences at baseline can be taken into account statistically when comparing experimental conditions, this nonetheless introduces the risk of subsequent bias in intervention outcomes, particularly because many studies fail to fully report statistical analyses undertaken and biases in recruitment.

The review found that long-term intervention effects (6 months $\geq$ after the end of the intervention) were only assessed in a handful of studies. Also, many studies failed to provide sufficient information about length of follow-up. Those studies that did report longer-term outcomes also reported high rates of attrition. Despite this, very few of the studies mentioned the use of intention-to-treat analyses. It may be that several of these studies did in fact conduct an intention-to-treat analysis but failed to report this in their publication. Thus, it is unclear whether the reported results are only applicable to those who reported for all assessments, and there is a possibility that the findings may be subject to selection bias.

Recommendations for future research

Although there have been 12 more recently published studies which met our criteria, we identified many of the same methodological issues highlighted in earlier systematic reviews. Consequently, it can be concluded that despite the recent focus on research in this area, there remains a need for more well-designed studies to evaluate the effectiveness of workplace interventions with regards to promoting physical activity.

Given the propensity of studies that used non-validated measures to assess physical activity behaviour, future research should endeavour to include only valid and reliable self-

report measures of both workplace and leisure-time physical activity, and where possible, use these in conjunction with an objective measure of physical activity (e.g., step counts). That said, there is evidence to suggest that usage of a pedometer or accelerometer may serve as an intervention in itself and thus make it difficult to know what intervention component served as the prompt to behaviour change (Bravata *et al.*, 2007; Pal, Cheng, Egger, Binns, & Donovan, 2009; Rooney, Smalley, Larson, & Havens, 2003). Secondly, given the high rates of attrition reported in several studies, the feasibility and acceptance of different types of workplace interventions may also be a direction worth exploring in future research. This will allow researchers and policy makers to determine whether certain types of interventions are more suited to particular types of organizations.

Future research should also seek to evaluate which theories of behaviour change are of most value when designing workplace physical activity promotion interventions and compare the efficacy of different types and formats of workplace physical activity interventions. Efforts should be made to ensure that physical activity outcomes are assessed at both the end of the intervention and regular follow-ups to see whether any positive interventions effects can be maintained 6–12 months after the end of the intervention.

Limitations

Limitations to this review should be taken into account when interpreting the findings. First, our literature search was limited to academic articles published in the English language; thus, we may have missed some relevant studies published in other languages or in grey literature sources. Our search of academic databases alone resulted in the retrieval of 23,717 article abstracts, the majority of which were excluded because they did not include a physical activity intervention; future research should therefore consider narrowing the search strategy by including a specific ‘intervention’ component in the key word search. Second, as with most systematic reviews, there remains a risk of publication bias, as interventions yielding a negative or insignificant outcome are less likely to be published (Dwan *et al.*, 2008). Finally, due to the heterogeneity of the identified studies, it was not feasible to quantitatively synthesize the results through a meta-analysis. Consequently, we were unable to compare the size of effect across different types of intervention.

Conclusions

In summary, this systematic review provides a comprehensive overview of research literature pertaining to workplace interventions and physical activity outcomes. Despite the growing body of research in this area, our findings highlight several methodological shortcomings in the current evidence base as identified in previous systematic reviews. Consequently, it remains difficult to draw robust conclusions regarding whether workplace interventions are indeed effective for increasing physical activity among employees. While the studies included in this review do show some evidence that workplace physical activity interventions can be efficacious, overall the results are inconclusive and more work is needed to ascertain which elements of workplace physical activity interventions are most likely to increase efficacy and adoption within the workplace setting. Given the positive outcomes of some of the studies in this field, there is a strong argument for pursuing research efforts in this field to support national and global public health policy to increase physical activity levels in working-age adults.

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Supporting Information

The following supporting information may be found in the online edition of the article:

Table S1. Characteristics and results of selected studies: physical activity/exercise interventions.

Table S2. Characteristics and results of selected studies: counselling/support interventions.

Table S3. Characteristics and results of selected studies: health promotion messages/information.

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