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Interventions to reduce sedentary behavior and increase physical activity during productive work: a systematic review

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Objectives Many current jobs are characterized by sedentary behavior (SB) and lack of physical activity (PA). This review addresses the effectiveness of workplace interventions that are implemented during productive work and are intended to change workers' SB and/or PA.

Methods We searched Scopus for articles published from 1992 until 12 March 2015. Relevant studies were evaluated using the Quality Assessment Tool for Quantitative Studies and summarized in a best-evidence synthesis. Primary outcomes were SB and PA, both at work and overall (ie, during the whole day); work performance and health-related parameters were secondary outcomes.

Results The review included 40 studies describing 41 interventions organized into three categories: alternative workstations (20), interventions promoting stair use (11), and personalized behavioral interventions (10). Alternative workstations were found to decrease overall SB (strong evidence; even for treadmills separately); interventions promoting stair use were found to increase PA at work while personalized behavioral interventions increased overall PA (both with moderate evidence). There was moderate evidence to show alternative workstations influenced neither hemodynamics nor cardiorespiratory fitness and personalized behavioral interventions did not influence anthropometric measures. Evidence was either insufficient or conflicting for intervention effects on work performance and lipid and metabolic profiles.

Conclusions Current evidence suggests that some of the reviewed workplace interventions that are compatible with productive work indeed have positive effects on SB or PA at work. In addition, some of the interventions were found to influence overall SB or PA positively. Putative long-term effects remain to be established.

Key terms activity-permissive workstation; alternative workstation; best-evidence synthesis; physical inactivity; sitting; stair use; personalized behavioral intervention; workplace.

Physical inactivity and sedentary behavior (SB) both entail health risks. Physical inactivity, ie, performing insufficient amounts of moderate-to-vigorous-intensity physical activity (1) is associated with, among others, type II diabetes, cardiovascular diseases, obesity, depression and some types of cancer (2). The health risks of SB, ie, any waking behavior characterized by an energy expenditure at or below 1.5 metabolic equivalents (MET) while in a sitting or reclining posture (1), are still a subject of study. So far, strong evidence has been found for an association of SB with premature death in general, independent of the level of physical activity (PA) (3, 4), and there is moderate support for an association of SB and type II diabetes (5) and cardiovascular disorders (5, 6). Effects of SB on cancer (7), weight gain in adult life (8), and depression (9) have been suggested but so far based on limited research (10).

A median self-reported sitting time of 5.8 hours/day was reported for 20 countries worldwide except Africa

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(11). Studies using accelerometer have shown Australian adults to be sedentary for an average of 57% of their waking hours, corresponding to just over 9 hours per day (12), while US adults were sedentary for 7.3–7.9 hours per day, depending on age (13). For many people of working age, a considerable part of the total sedentary time on a workday occurs during working hours (14, 15). Thus, too much sitting and too little PA during working hours has been raised as an emerging major public health concern by several authors (16–18), and recommendations have been proposed to ensure sufficient PA at work (19).

Addressing this concern, interventions at the workplace have been suggested to be an effective approach to decrease SB and/or increase PA (20, 21). Thus, workplace health promotion programs focusing on changes in SB and PA are a rapidly evolving area of research. These programs often encourage employees to be physically active during lunch or other (short) breaks from work, or to commute in physically active ways (22–24). While such initiatives may be effective in reaching the target population of workers, they are not intended to be practiced during *productive* work. Productive work is defined here as those activities that are a natural part of the work flow, including activities, like walking to a colleague, that may not be considered "value-adding" in a strict analysis of loss time (25). Interventions meant to be compatible with maintained productive work might be particularly attractive to companies and employees, and they may also have the advantage of tackling sedentariness at its major occupational source, ie, working while seated.

Thus, the present paper systematically reviews current evidence on the issue of whether SB can be effectively reduced and/or PA increased by interventions that can be implemented at the workplace *during productive work* and that are intended to change workers' behavior *while doing productive work*. In strictly taking this perspective on interventions that are compatible with working, the review differs from other recent reviews of relevance to occupational SB and/or PA. The review of Prince et al (26), for instance, focuses on reducing sedentary time in general, including but not limited to work, while Barr-Anderson et al (27) have reviewed the effectiveness of introducing short interruptions from productive work to increase PA. In requiring the intervention to be implemented during productive work, the present review differs from that of Shrestha et al (28), which included studies of counselling in separate non-productive sessions. As suggested by its focus on production, the present review only considers interventions in the field and does not address experimental studies, such as those included in the reviews by Tudor-Locke et al (29) and Neuhaus et al (30). Also, the present review searched for any kind of intervention that can be practiced as part of productive work, ie, not restricting the literature search to interventions focusing on workstations (29–32) or stair use (33). The present review shares Chau et al's (34) focus on "workplace setting" but expands on it by reporting data not only on the occurrence or temporal structure of SB and/or PA but also on outcomes such as work performance and metabolic and physiological responses, to the extent that they are included in studies reporting SB and PA.

Methods

Literature search

We searched Scopus for potentially relevant articles published from 1992 through March 12, 2015, with a search string including the text words ("exercise therapy" OR "physical activity" OR "exercise training" OR "resistance training" OR "aerobic training" OR "sedentary behavior/behavior" OR "sedentary time") AND (workplace OR worker* OR occupation* OR labour/labor OR employment OR employee*) AND (intervention OR review OR "literature search"). Furthermore, the authors' personal databases and the reference lists of review articles on this topic were checked manually for additional relevant articles.

Inclusion criteria and selection process

A study was accepted for inclusion if it fulfilled the following five criteria: (i) addressing an intervention aimed at decreasing SB and/or increasing PA; (ii) addressing an intervention implemented at the workplace with the aim of having effects during productive work, ie, during activities being a necessary part of the work flow. This includes, eg, walking to a colleague's desk or the printer, but does not include activities during lunch breaks, explicit PA breaks, or commuting to and from work; (iii) using a design including a control group and/or control condition; (iv) being published as a full-length paper in a peer-reviewed scientific journal in English; and (v) reporting data on the effect of the intervention with respect to SB and/or PA. We also noted effects on work performance and metabolic or physiological outcomes, but that was not a mandatory inclusion criterion. In addition, any job type and location (eg, office, industry) was accepted for inclusion.

Two reviewers each screened the titles of half of the papers identified in the Scopus search to select studies for abstract checking, and they each screened the abstracts of half of the selected papers to select studies for fulltext reading. In order to synchronize the selection procedure, they first discussed their arguments for in- or exclusion using the first 40 titles of the Scopus list and, in the next step, the first 20 abstracts selected. After that, the reviewers considered their agreement about in- or exclusion to be high enough to continue the screening process separately. In cases of doubt, the decision to include a title or abstract was discussed with a third reviewer. Next, two other reviewers each assessed the fulltext of half of the eligible papers to exclude articles that did not meet the criteria. Reasons for exclusion at this stage were explicitly noted. In case of doubt, the decision was discussed with a co-author not otherwise involved in the selection process.

Data extraction and quality assessment

Two reviewers extracted descriptive data from half of the included papers each, while both assessed the methodological quality of all studies. A third reviewer checked the extracted data at random. The methodological quality was assessed using the Quality Assessment Tool for Quantitative Studies (35). After independently having reviewed five papers following the guidelines from the Quality Assessment Tool, the reviewers compared their ratings and discussed discrepancies. This resulted in an adjustment of the tool; the blinding component was never scored because this criterion was irrelevant for the included intervention studies. Chau et al (34) made the same decision in their review of workplace interventions to reduce sitting. An overall rating was not provided if ≥3 of the quality assessment components were rated "not applicable" or "can't tell".

Levels of scientific evidence

A best-evidence synthesis was conducted in line with previous reviews (8, 36) using the following levels of evidence: (i) strong evidence: consistent findings in ≥2 studies of high quality; (ii) moderate evidence: consistent findings in 1 study of high quality and ≥1 study of medium or low quality; or consistent findings in multiple studies of medium or low quality; (iii) conflicting evidence: inconsistent findings in ≥2 studies; (iv) insufficient evidence: no studies available or only 1 high quality or 2 medium or low quality studies available.

Results of individual studies were considered to be consistent if, in the case of ≥4 studies, >75% of the studies showed statistically significant effects ($P<0.05$) in the same direction. For 3 studies, ≥2 studies had to show statistically significant results in the same direction. For 2 studies, the statistically significant findings of both studies had to be in the same direction.

Results

Study selection

The publication selection flow is presented in figure 1. About 80% of the papers considered relevant for fulltext reading were excluded. A main reason was that the intervention, even though organized at the workplace, was not intended to be practiced during productive work, but aimed at increasing PA during commuting or leisure time (37) or during explicit breaks from work (38). The list of all fulltext articles assessed for eligibility is provided in an online-only appendix (table A, www.sjweh.fi/data_repository.php).

Forty papers finally met all the inclusion criteria. In the appendix, table B provides a description of the basic data of these papers, table C shows the results of the quality assessment, and table D presents specific effects reported in each of these intervention studies (www.sjweh.fi/data_repository.php). Table 1 summarizes the evidence for the effectiveness of interventions aimed at reducing SB and increasing PA during productive work.

Categorization of interventions

As the study of Parry et al (52) contained two types of interventions, the total number of studied interventions was 41. Based on their main content, they fall into three categories: (i) Alternative workstation interventions (N=20): interventions aiming at reducing SB and/or increasing PA by changing the traditional workstation to a sit–stand workstation or an "active" workstation, ie, a workstation allowing working while walking or pedaling.

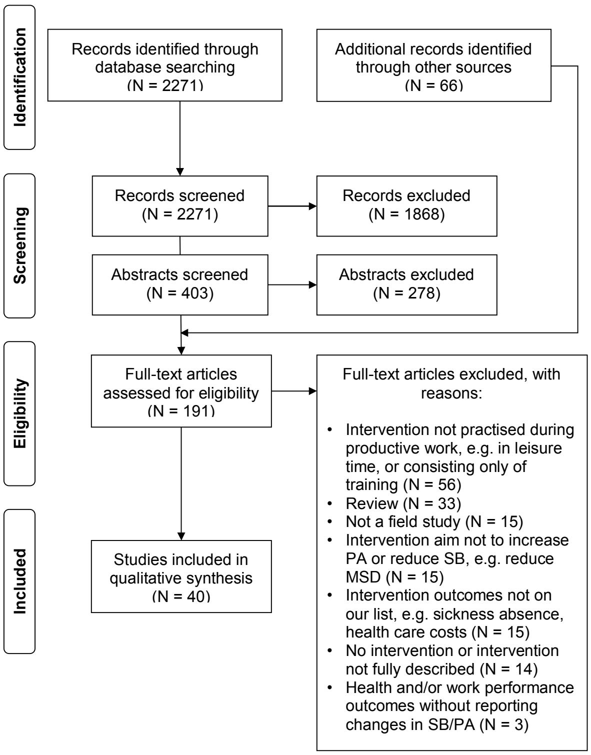

Figure 1. Flow diagram of search and selection procedure.

(ii) Interventions promoting stair use (N=11): interventions with the main aim to promote stair use, and thus PA, by encouraging workers to choose the stairs rather than the elevator at work; (iii) Personalized behavioral interventions (N=10): interventions aiming at reducing SB and/or increasing PA by motivating workers to change behavior, as encouraged by personalized goals and/or by feedback on behavior using prompts or messages.

A few interventions contained elements from more than one category, and they were placed in the category of what we considered to be the major initiative. The majority of these interventions involved office workers, while a few addressed hospital employees or blue-collar workers. As many of the reviewed studies differed with respect to using SB and PA at work or overall SB and PA (SB and PA during work and leisure time combined), the present review also adopted this distinction.

Alternative workstation interventions

Of the 20 workstation interventions, 10 involved the introduction of a sit–stand workstation, 8 concerned a treadmill workstation, and 2 studied a pedal machine (table B). Of these, 4 studies were scored to be strong 15 moderate, and 1 weak (table C), with the "selection bias" component as the main driver of the overall rating.

Results showed strong evidence for a reduction in overall SB; moderate evidence for no effect on hemodynamic outcome measures and cardiorespiratory fitness; and conflicting evidence for effects on SB at work, PA at work, overall PA, WP, lipid and metabolic profiles and anthropometric outcome measures (table 1).

Considering that different types of alternative workstations were addressed in the 20 intervention studies, we performed separate subgroup analyses for sit–stand stations and treadmills (table E, www.sjweh.fi/data_repository.php). These analyses reveal that the strong evidence for alternative workstations on overall SB seems to be ascribed entirely to studies of treadmill workstations. Furthermore, the conflicting evidence for an effect of alternative workstations on SB at work, PA at work, and overall PA, changes to moderate evidence for a positive effect of sit–stand workstations on SB and PA at work, while for treadmill workstations there is moderate evidence for a positive effect on PA, both at work and overall.

Interventions promoting stair use

The content of the 11 included staircase interventions differed substantially. In some interventions, benefits of stair use were communicated to all employees in a promotional campaign, eg, by sending emails. In others, stair use was promoted by using motivational prompts, such as posters on the wall, while still others reshaped the appearance of the stairwell to make it more attractive. Most interventions combined some of these initiatives and one study aimed to increase stair use through financial incentives (table B).

Of the 11 staircase intervention studies, 2 were of

Table 1. Summary of evidence for interventions to reduce sedentary behavior and increase physical activity during productive work. [S (strong): study of high quality; M (moderate): study of medium quality; W (weak): study of low quality; *: global quality rating was not scored because three of the individual components were rated not applicable; +: positive effect in favor of the intervention group/condition; -: Negative effect for the intervention group/condition; =: similar effect for intervention and control group/condition.]

	Alternative workstation interventions	Interventions promoting stair use	Personalized behavioral interventions
Sedentary behavior			
At work	Conflicting evidence (+: SMMMMMMMMW, =: SMMM)	Insufficient evidence (no studies)	Conflicting evidence (+: SM, =: SMM)
Overall	Strong evidence for positive effect (ie, reduction SB) (+: SSSMMM, =: SM)	Insufficient evidence (no studies)	Insufficient evidence (=: S)
Physical activity			
At work	Conflicting evidence (+: SMMMMMMMMMM, =: SMMM)	Moderate evidence for positive effect (+: SM*********)	Conflicting evidence (+: MW, =: SSMM)
Overall	Conflicting evidence (+: SSMMM, =: MW)	Insufficient evidence (=: M)	Moderate evidence for positive effect (+: SMMW, =: S)
Work performance	Conflicting evidence (+: SMM, =: SMMMMMM, -: M)	Insufficient evidence (no studies)	Insufficient evidence (no studies)
Metabolic and physiologic outcomes			
Lipid and metabolic profiles	Conflicting evidence (+: SMMM, =: SMM)	Insufficient evidence (+: M)	Insufficient evidence (no studies)
Hemodynamic measures and cardiorespiratory fitness	Moderate evidence for no effect (+: S, =: SMM)	Insufficient evidence (+: M)	Conflicting evidence (+: W, =: S)
Anthropometric measures	Conflicting evidence (+: SSMM, =: SSMM)	Insufficient evidence (+: M)	Moderate evidence for no effect (=: SW)

high and medium quality, respectively (table C). Overall study quality was not rated in the other 9 studies; they did not involve individual workers making the quality assessment components "selection bias", "confounders", "withdrawals and dropouts" not applicable. Rather, these studies compared the number of people using elevator and stairs during a specified timeframe before versus after the intervention.

Results showed moderate evidence for an increase in PA at work; insufficient evidence for effects on SB at work, overall SB and overall PA; and insufficient evidence for effects on work performance and metabolic and physiological responses (table 1).

Personalized behavioral interventions

Ten studies investigated interventions aiming at reducing SB and/or increasing PA through some kind of personalized goal setting and/or activity feedback, such as using pedometers in combination with activity logbooks for self-monitored PA, or providing personalized feedback via a website. Other initiatives were, eg, personal coaching sessions, motivational meetings, and advice via email messages or brochures. Most of the interventions included two or more of these motivational components (table B). Interventions in this category could also include stair-use promotion but only as a part of a more comprehensive personalized behavioral intervention.

Overall quality was rated as high for four studies, four were rated as medium, and two as low (table C). None of the studies scored strong on the "selection bias" component. The two studies rated as weak reported completion rates lower than 60%, and thus scored weak on "withdrawals and dropouts".

Results showed moderate evidence for a positive effect on overall PA; moderate evidence for no effect on anthropometric measures; conflicting evidence for an effect on SB and PA at work, and on hemodynamic measures and cardiorespiratory fitness; insufficient evidence for an effect on overall SB, on work performance and on lipid and metabolic profiles (table 1).

Within the personalized behavioral interventions, two types of interventions were distinguished: those including self-monitoring of SB and/or PA (eg, using pedometers) (N=6) and those not including self-monitoring (N=4). Self-monitoring appeared to be ineffective in increasing PA at work (moderate evidence for no effect), while moderate evidence for a positive effect on overall PA was found (table E). Subgroup analyses did not lead to other conclusions regarding intervention effects on overall SB. Personalized behavioral interventions with self-monitoring seemed to be ineffective in reducing SB at work (moderate evidence).

Discussion

This review examined literature describing interventions aimed at reducing SB and/or increasing PA. In contrast to several previous reviews on interventions addressing SB and/or PA, this one focused specifically on initiatives that can be implemented at the workplace during productive work, which are intended to change workers' behavior while doing their usual work; not excluding that effects may also occur outside work. Describing in total 41 interventions, 40 papers met our inclusion criteria and were organized in three categories: (i) alternative workstation interventions, (ii) interventions promoting stair use and (iii) personalized behavioral interventions. A few interventions contained elements from more than one category, and they were placed in the category representing what we considered to be the major initiative.

Alternative workstation interventions

Strong evidence supported the reduction of overall SB by alternative workstation interventions, while conflicting evidence was found for their effect on SB at work, PA at work and overall PA. However, the conclusions regarding conflicting evidence for SB at work, PA at work, and overall PA were sensitive to the type of workstation. For sit–stand workstations, moderate evidence for a reduction of SB at work was concluded. This conclusion is in line with a recent review and meta-analysis of 38 field and laboratory studies (30), showing that activity permissive workstations (mostly sit–stand workstations) led to a substantial reduction in sedentary time, with a pooled intervention effect of -77 minutes in an 8-hour workday. The evidence of an effect of alternative workstations on overall PA was conflicting, but subgroup analyses showed moderate evidence for a positive effect of treadmill workstations on overall PA; whereas the two studies using sit–stand workstations (47, 53) did not find an effect on overall PA (table E). This adds to the conclusion of Tudor-Locke et al (29) that treadmill (and pedal) desks have the greatest potential to influence energy expenditure, with an effect that does not seem to be limited to working hours. Conflicting evidence was found for the effect of alternative workstations on WP, but a majority of 7 (of 11) studies found no effect on WP, and only 1 found a negative effect. This is consistent with two recent reviews, concluding no effects on WP other than a minor decline when working while walking or cycling, but not while standing, and mainly when performing computer mouse tasks (29, 30).

The positive effects of alternative workstations on SB, or more specifically the positive effects for standing workstations on SB at work and treadmill workstations on overall SB, and the absence of negative effects on self-reported WP in 10 of 11 studies, makes a strong case for recommending companies to consider introducing such workstations, preferably accompanied by individual coaching of employees and education of managers (78). It is, however, important to realize that most of the studies had selective populations, eg, university employees or workers at a health department, and only 4 of the 20 intervention studies had follow-up periods longer >3 months. Thus, we note that the initial positive effect on behavior may not be sustainable, as suggested in a study on Swedish office workers being equipped with sit–stand stations for several years (79).

Interventions promoting stair use

All 11 studies examining interventions promoting stair use showed positive effects on PA at work, ie, increased stair use. However, we conclude that the evidence is moderate, rather than strong, because none of the studies were of high quality. Our results are in line with Soler et al (80), finding strong evidence that point-of-decision prompts can increase the proportion of people choosing stairs instead of the elevator or escalator. In our review, a majority of the interventions used point-of-decision prompts, but positive effects on PA were also observed in those 3 studies including environmental changes (61, 66, and 68) and 1 using financial incentives (65).

Most of the studies promoting stair use did not follow individual workers over time, but used a "before versus after" design in which they compared the counted number of subjects using the stairs in specific periods during the day. Thus, effect sizes of increases in stair use could not be estimated at the individual level. None of the reviewed studies measured the effect on SB, most likely because a staircase intervention does not specifically address the problem of SB during work, but rather PA during transfers at the workplace. Since point-of-decision prompts are fairly easy to implement at a worksite, these could be introduced as a promising initiative, even if the quantitative effect on PA may be small, and the sustainability has not been confirmed.

Personalized behavioral interventions

We found conflicting evidence for the effect of personalized behavioral interventions on SB and PA at work, while evidence for an increase in overall PA was moderate. Kwak et al (75) also addressed this possible dissociation between PA at work and during leisure-time, showing that an increase in overall PA did not necessarily include a change in work time PA. Since in many of the reviewed interventions, workers were provided with a pedometer and a logbook to support individualized goals of increasing PA, it is likely that despite the main intervention goal to increase PA during working hours, the effects of the interventions were not limited to working hours. Subgroup analyses did indeed show that – for interventions including self-monitoring of PA (often with pedometers) – no effect was found on PA at work, but that these interventions were effective in increasing overall PA (moderate evidence). This is a likely result of the fact that, in many occupational settings, the opportunities to substantially increase especially moderate and vigorous PA will be limited due to constraints set by workstations or work tasks.

Previous reviews summarizing the literature promoting PA through active commuting and/or through exercise during breaks from productive work have not separated effects on overall PA from those at work (24, 27, 81–83). In general, these reviews conclude that multi-component interventions containing individualized initiatives in combination with organizational and/or environmental changes, are more effective in increasing PA than single-component interventions. Direct comparison of our results with those in the cited reviews is discouraged due to our decision to focus only on interventions that could be implemented during productive work, with the intention to change the behavior of the individual while working. Notably, the six multi-component PA interventions included in our review (52, 70, 72, 74–76) were not more effective than the interventions with individualized initiatives only (69, 73, 77).

As for SB, three out of six studies included components specifically targeting a reduction of SB (71, 74, 77), and only two found a significant effect (71, 77). In a review of interventions specifically targeting PA, Chau et al (34) argued that PA interventions do not necessarily reduce SB. This view was supported in a meta-analysis by Prince et al (26), emphasizing that clinically meaningful reductions in sedentary time require that the intervention includes components focusing specifically on reducing SB.

Strengths and limitations of the review

A major strength of the present review is its specific relevance for occupational practice, in particular for employers willing to influence the SB and PA of their employees. To secure this relevance, we chose to address only interventions that were implemented at the workplace during productive work *and* were intended to change workers' behavior while performing productive work. We deliberately chose to review only interventions that intended to change gross-body SB and PA, even though some ergonomic interventions for other purposes may also have some effect on one or both of these outcomes. One example is to replace an ordinary office chair with a sitting ball for the purpose of creating more variation in sitting posture. An additional strength of our review is the systematic procedure used throughout, from the comprehensive search of the literature using Scopus, to the systematic rating of the methodological quality of studies by two independent reviewers, and the application of best-evidence synthesis to reach overall conclusions.

One limitation of the review may be that it only includes peer-reviewed articles in English, leaving relevant conference proceedings, reports and studies in other languages unassessed. Also, we chose to include studies with weak designs, such as uncontrolled trials or studies with inadequate comparison groups in the best-evidence synthesis, while of course being critical to their quality (cf. table C). The conclusions of our review would, however, not change if these studies of low quality were disregarded, and the presentation of their design and results in our data extraction tables gives readers the opportunity to judge for themselves on their relevance and quality. Another limitation of this and any other review addressing SB and PA is that the body of literature on interventions in this area is rapidly growing, especially in the area of alternative workstations, where 13 of the 20 reviewed studies have been published in the last two years. Thus, our review will likely – as any other review in this area – be incomplete in the not-too-distant future, nevertheless it can still serve as a basis for identifying prioritized research directions.

Implications for practice and future research

The present review found moderate or strong scientific evidence for the effectiveness of some interventions offered during productive work in reducing SB and/or increasing PA. These interventions may therefore be recommendable initiatives in occupational life, even if the literature gives insufficient evidence for the effects to be sustainable. Interventions with a likely potential to lead to positive results include supplying workers with alternative workstations to reduce SB, especially since work performance does not appear to be negatively affected. In order to increase PA at work, the use of treadmill workstations or stair use should be promoted. Personalized behavioral interventions, while showing inconsistent effects on PA at work, appear to have a positive effect on the overall PA of workers, especially when including self-monitoring of PA.

Observing that only 8 out of 30 studies were considered to be of high quality, we recommend an increased emphasis on studies with sufficiently large samples, adequate control conditions and longer duration of interventions and of follow-up periods allowing investigation of sustainability. We also recommend including research on behavioral change processes associated with implementing the intervention, including factors determining compliance and acceptance at the individual level (70, 84), as well as supportive and obstructive factors in the organization. Furthermore, we point to the need to understand effects on SB and PA of interventions that lie outside the three categories we found in the present literature. Examples are interventions such as job rotation and enrichment that redistribute tasks between workers or introduce new tasks in the job (85, 86) and interventions rebuilding the workspace, such as designing offices to promote PA (47, 87, 88) and furnishing offices with equipment facilitating standing and PA (89). In both cases, effects on SB and/or PA are likely. Finally, the present body of evidence mainly concerns SB and PA in office settings, and we encourage studies of interventions implemented in other occupations associated with sedentariness and limited PA, such as bus and truck drivers, cashiers, or assembly-line workers. In suggesting these new directions of research, we wish to emphasize that an ample variation between seated and standing postures, and between periods of PA and rest, is likely more favorable in terms of health and well-being than, for instance, replacing all sitting by standing (90). Thus we encourage documenting intervention effects on SB and PA not only in terms of overall durations, but also using metrics describing the temporal pattern of SB and PA (91).

Concluding remarks

The present review shows that some interventions to reduce SB and/or increase PA that are implemented and practiced at the workplace during productive work may, indeed, have the intended effect. Thus, while our review demonstrates a need for more prospective large-scale and high quality studies with long-term follow-ups, it also provides evidence that access to alternative workstations might reduce workers' SB, without negative effects on work performance. Promoting stair use is effective in increasing PA at work, and personalized behavioral interventions appear to have a positive effect on overall PA. For several other possible effects of SB and PA interventions, for instance changes in physiological variables or fitness, evidence is inconclusive or insufficient, mainly due to the lack of specific research. Considering the likely public health impact of too much SB and too little PA at work, we encourage further research aiming at identifying effective drivers for changing behavior (including investigations of the sustainability of intervention effects on attitudes, behavior, and physiological and psychological outcomes) and studies of intervention approaches beyond those already addressed, such as job rotation, job enrichment and rebuilding the worksite.

Conflicts of interest and financial disclosure

Dianne Commissaris has initiated and supervised the development of a device, the Oxidesk (www.oxidesk.com), which facilitates PA during productive work in offices. That project was funded by the Dutch Ministry of Economic Affairs, and the manufacturer Markant Office Furniture contributed with in-kind resources. The current review does not include studies about the Oxidesk. Neither Dr. Commissaris nor TNO receive any fee for every Oxidesk sold. Authors Huysmans and Srinivasan were supported by grants from the Swedish Research Council for Health, Working Life and Welfare (Forte Dnr. 2009-1761 and Dnr. 2011–0075, respectively). Authors Mathiassen, Koppes and Hendriksen have no conflicts of interest nor financial disclosures.

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