Title: Reducing occupational sedentary time: a systematic review and meta-analysis of evidence on activity-permissive workstations

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Summary (current word count: 207 words)

Excessive sedentary time is detrimentally linked to obesity, type 2 diabetes, cardiovascular disease and premature mortality. Studies have been investigating the use of activity-permissive workstations to reduce sedentary time in office workers, a highly sedentary target group. This review systematically summarises the evidence for activity-permissive workstations on sedentary time, health-risk biomarkers, work-performance, and feasibility indicators in office-workplaces.

In July 2013, a literature search identified 38 relevant peer-reviewed publications. Key findings were independently extracted by two researchers. The average intervention effect on sedentary time was calculated via meta-analysis.

In total, 984 participants across 19 field-based trials and 19 laboratory investigations were included, with sample sizes ranging from n=2 to n=66 per study. Sedentary time, health-risk biomarkers, and work performance indicators were reported in 13, 23, and 23 studies respectively. The pooled effect size from the meta-analysis was -77 minutes of sedentary time/8-hour workday (95% CI= -120, -35 minutes). Non-significant changes were reported for most health- and work-related outcomes. Studies with acceptability measures reported predominantly positive feedback.

Findings suggest that activity-permissive workstations can be effective to reduce occupational sedentary time, without compromising work performance. Larger and longer-term randomised-controlled trials are needed to understand the sustainability of the sedentary time reductions and their longer-term impacts on health- and work-related outcomes.

Introduction

High volumes of sedentary time - time spent sitting or lying down while expending little energy[1]- are associated with excess adiposity and other aspects of chronic disease risk, particularly when the sedentary time is accumulated in prolonged unbroken bouts [2-4]. Much of the documentation of the detrimental health consequences of too much 'static sitting' originates from the field of ergonomics, with a focus on musculoskeletal outcomes[5]. More recently, the broader public health implications of excessive sedentary time have been examined in the context of chronic disease risk. Here, studies have documented detrimental associations with several indicators of poor health including obesity[6], cardiovascular disease[7], type 2 diabetes[8], and some cancers[9, 10], and with premature mortality[11].

In industrialised countries, most working adults spend a high proportion of their waking hours in the workplace[12], in increasingly sedentary occupations[13]. Using objective measures, it has been observed that white-collar workers sit for the majority of their work hours and often in long, unbroken bouts[13-17]. Accordingly, intervention studies conducted from both ergonomic and public-health perspectives have focused on reducing sedentary time in this occupational sector. Along with rapid advances in technology, office work increasingly involves (desk-based) computer work[14]. Many of the studies aiming to reduce workplace sedentary time have therefore used activity-permissive workstations. These include treadmill desks, stepping or pedal devices that are fitted underneath the desk, and height-adjustable workstations, which enable office workers to stand, walk, or pedal while working at their usual computer- and other desk-based job tasks. Overall, findings from both laboratory and field-based studies using such workstations suggest a range of positive benefits including reductions in workplace sedentary time[18], lower body mass index[19], and reduced musculoskeletal discomfort[20]. A recent (narrative) literature review concluded that workstations such as treadmill or pedal desks have the potential to elevate office workers' energy expenditure by approximately 2-4 kcal/minute[21]. That review further reported that the use of activity-permissive workstations is generally well accepted among participants, with mixed impacts regarding work-performance measures. However, to date, the extant evidence has not been systematically summarised, in particular with regard to sedentary time, adiposity and other health-related outcomes.

The objective of our review was thus to systematically review the impact of activity-permissive workstations on office workers' sedentary time, adiposity and other health- and work-related outcomes; and, feasibility outcomes (acceptability to workers and potential adverse events).

Methods

Definitions

Sedentary behaviour is defined as any waking behaviour characterised by sitting or reclining while expending little energy (≤1.5 metabolic equivalents)[1]. Given the considerable variation in sedentary behaviour terminology and the measurement methods thereof across the relevant publications, two overarching terms are used throughout this review: 'overall sedentary time' and 'workplace sedentary time'. Overall sedentary time refers to changes across the whole day (i.e. not just in the workplace) while 'workplace sedentary time' specifically refers to sedentary time occurring in the workplace. Notably, in two studies a direct measure of sedentary time was not available[22, 23]. Here, increases in activity (i.e. via the use of the workstations) were presumed to reflect reductions in workplace sedentary time.

The following workstations were regarded as activity-permissive: fixed standing desks (with or without provision of height-adjustable chairs), workstations adjustable to full standing height, treadmill desks, cycle ergometers, and pedal devices fitted underneath the desk that can be used while doing usual desk-based job tasks.

Inclusion and exclusion criteria

Studies were included in this review if they: evaluated overall and/or workplace sedentary time, health-related (e.g., weight, musculoskeletal symptoms, blood risk markers), work-related (e.g., productivity, absenteeism), or feasibility outcomes (e.g., acceptability, adverse events) following the provision of an activity-permissive workstation; included an adult sample (aged ≥18 years); engaged in administrative (i.e. not manufacturing, but with reliance on engagement with a computer) tasks while using the activity-permissive workstations; reported at least two data collection points (i.e. baseline and follow-up); and, were published in an English-language peer-reviewed journal. As much of the documentation from the ergonomics research field is published in conference proceeding papers only, relevant studies published in peer-reviewed conference proceedings papers were also included.

Search strategy

The following databases were searched on 18th July 2013: Web of Knowledge, Medline (through PubMed), Embase, CINAHL, SPORTDiscus, CENTRAL, Scopus, PsychInfo, and AMED. An initial search was divided into two categories, separated by the Boolean phrase 'AND': (i) activity-permissive workstations (e.g., treadmills, height-adjustable desks), and (ii) workplace settings (e.g., workplace, office). There was no limiter on publication years. This search resulted in a total of 1655 peer-reviewed publications. A second search was run to identify any papers related to workplace sedentary time that did not mention activity-permissive workstations specifically in the abstract and/or title. This search contained two clusters pertaining to sedentary time occurring in the workplace (e.g., office sitting, sedentary workplace) and the study design (e.g., intervention, study). A summary of the search strategy is provided in Supplementary Table 1.

Study selection and data extraction

The study selection process is shown in Figure 1. The search identified a total of 4633 publications, of which 2707 were initially excluded for being duplicates (n=2309), not being peer-reviewed (n=159), and for being published in a language other than English (n=239). This step was conducted by MN. Consecutively, NR and MN independently excluded irrelevant publications by screening titles and/or abstracts. This resulted in n=78 unique publications remaining, which were screened in full text by MN and GNH independently, with an agreement regarding inclusion of 96% (calculated as studies agreed upon/studies screened in full text). Any disagreements (n=2) were resolved through discussion.

**** INSERT FIGURE 1 ABOUT HERE ****

Outcomes included in the review

Overall and workplace sedentary time: as defined above. If both subjective and objective measures of sedentary time were reported, objective measures were prioritised for the summary and meta-analysis in this review. Similarly, reported changes in workplace sedentary time were prioritised over overall sedentary time. Workplace sedentary time changes reported in percentage were standardised to an eight-hour work day (if not already done so in relevant publications). If studies included a further assessment in addition to a pre- and post-intervention assessment, the end-of-intervention outcomes are included in the main summary, with additional assessment outcomes reported separately.

Health-related outcomes: these included weight, waist circumference, blood-derived biomarkers, musculoskeletal symptoms, fatigue and other physiological measures reported. Given that the primary interest was in the implementation of activity-permissive workstations in real-world contexts, and the acknowledgement of a recently published review on the impact of such workstations on energy expenditure[21], studies exclusively examining energy expenditure were not considered for inclusion.

Work-related outcomes: defined as work-performance (e.g., concentration or production levels), presenteeism, absenteeism, or cultural-organisational outcomes (e.g., time spent in face-to-face interactions).

Feasibility outcomes: any quantitative or qualitative employee ratings of the acceptability of the activity-permissive workstations as well as reported adverse events related to their use.

Quality assessment

Study quality of the included publications was evaluated independently by MN and GNH using a published scoring system[24]. Quality assessment was based on eight criteria relating to the reporting of study methods (description of recruitment, participants, allocation, measures, sample size) and results (description of variance, confounding, detail of results) with answer categories being 'yes', 'partial', 'no', and not applicable ('N/A'). The summary score was calculated as: total sum [(number of "yes"*2) + (number of "partial"*1)] / total possible sum [16-(number of "N/A"*2)], with a maximum possible total score of 1. Inter-rater agreement was calculated as [proportion of quality scores given the same score by the reviewers/ all quality scores provided]. Any discrepancies between the assessors were resolved through discussion.

Meta-analysis

Studies using a controlled design and reporting overall and/or workplace sedentary time were eligible for inclusion in the meta-analysis. Between-group changes in sedentary time following intervention were entered as changes in minutes during work hours and standardised to an eight-hour work day. The DerSimonian–Laird method was used to estimate the pooled effect of included studies[25]. Statistical heterogeneity was tested using the Eggers test[26]. The small number of studies included, along with high heterogeneity precluded investigation of publication bias. All analyses were conducted using STATA 12 (StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP).

Results

A total of 26 relevant publications were identified by the database search[16, 18, 19, 22, 27-48]. A search of the authors' personal libraries and reference lists of identified papers resulted in an additional twelve relevant publications (n=10[20, 23, 49-56] and n=2[57, 58], respectively). Thus, this review included a total of 38 peer-reviewed publications meeting the inclusion criteria, reporting on 45 independent comparisons (i.e. comparison of one or more activity-permissive workstations with a control or usual practice comparator). Seven publications were peer-reviewed proceedings of conference papers[31, 40, 42-44, 53, 55]. All relevant data were extracted by GNH and MN independently and discussed in the event of disagreement. Corresponding authors of included publications were contacted to request any relevant data not reported in the published article (details were followed up for four publications).

Study and sample characteristics and range of outcomes assessed

Table 1 provides a description of the included publications. Studies included a total of 984 participants across the 38 studies (one study did not report sample size), with an average sample size of 27 per study (range: 2-66). Twenty-three studies included samples of office workers. Other groups included 'adults' (not otherwise specified; n=7), students (n=5), 'university staff' (not otherwise specified; n=2), and medical practitioners (n=1).

Studies were conducted in North-America (n=23), Europe (n=4), Asia (n=3), and Australia (n=8). Half of the studies were laboratory-experimental, with the other half being field-based (i.e. conducted within the workplace setting). Across the 45 independent comparisons, 17 evaluated height-adjustable desks (of which twelve were fully adjustable desks and five were height-adjustable desk-mounts for the computer only), two evaluated standing desks with height-adjustable chairs, eight evaluated standing desks without height-adjustable chairs, twelve evaluated treadmill desks, two evaluated pedal-devices, two evaluated cycle-ergometers, one evaluated a stepping device, while one study[54] evaluated both treadmills and cycle ergometers. Of the studies evaluating height-adjustable desks, only six (of 15) reported whether these were electric or operated via alternative mechanisms[16, 18, 34, 43, 45, 56].

In the experimental studies, the duration of the workstation exposure protocols was typically short: <1 day (range 1 hour to 2 weeks). In the field studies, the mean intervention duration was 15 weeks (range: 1 day to 12 months). Three of the field studies included an additional follow-up assessment taken at 3 months[18], 9 months[37], and 12 months[38] post baseline. Twelve field studies implemented strategies in addition to the installation of activity-permissive workstations (e.g., instructions to stand for certain durations during the day; provision of pedometers; and/or motivational messages to increase physical activity/ reduce sedentary time)[16, 18-20, 22, 33, 42, 43, 45, 54, 56].

Sedentary time was reported in 13 studies (across 14 independent comparisons). These were reported as overall sedentary time (n=3), workplace sedentary time (n=6), or both (n=5). Health-related outcomes were reported in 23 studies. These included musculoskeletal symptoms (including body part discomfort, muscle load, spinal shrinkage, and bone mineral density), cardio-metabolic biomarkers (weight, body mass index, waist circumference, body composition, and blood profile), fatigue, psychological well-being (stress, emotional well-being, mood, and nervosity), leg/foot swelling, and other (eye strain, headache, digestion problems, sleep problems, physical well-being). Work-related outcomes were reported for 23 studies. Due to overlap in the terminology across included publications, for the purpose of this review, most work-related outcomes were summarised as a compound-category of 'work-performance'. This included reports of cognitive performance (e.g., selective attention), attention control/ concentration, accuracy, maths and reading comprehension, short-term auditory verbal memory, work pace, work-performance, production levels, typing performance, and productivity. Three other work-related outcome categories were separately summarised as absenteeism, presenteeism, and cultural-organisational (quality of interactions with co-workers, perceived group interaction, and time spent in face-to-face interaction with co-workers). Feasibility outcomes were reported for 19 studies. These included acceptability (including preference, tolerance, and enjoyment) and adverse events.

Study quality scores ranged from 0.21 to 1 (Table 1 and Supplementary Table 2), with an inter-rater agreement of 96%. On average, most studies provided an adequate description of the study participants (0.84), measurement methods used (0.80), and results (0.93). However, group allocation procedures, sample size calculations, and methods to control for confounding were less well reported and were only rated a 'yes' by four, eight, and four studies respectively.

****INSERT TABLE 1 ABOUT HERE****

Sedentary time outcomes

Of the 14 comparisons reporting sedentary time at both baseline and follow-up, eleven used objective methods (n=5 ActivPAL [a thigh-worn activity monitor that derives sedentary time from both posture and motion][16, 18, 37, 44, 56]; n=2 hip-worn accelerometer [sedentary time derived from motion only][38, 54]; n=1 wrist-worn accelerometer [sedentary time derived from motion only][33]; n=2 software linked to workstation[22, 23]; and, n=1 CUELA system [consisting of seven inertial accelerometers and gyroscopes placed on the back, arms, and legs][19]) and three used self-report measures (n=1 'Occupational Sitting and Physical Activity Questionnaire'[34], n=1 questionnaire about work patterns [not further specified][55], and n=1 experience sampling methodology and participants' estimates of time spent sitting per day'[45]). A significant intervention effect for sedentary time was reported in 11/14 comparisons with an average reduction in workplace sedentary time of 90 minutes per 8-hour workday (range: -8 to -143 minutes; n=8) and in overall sedentary time of 111 minutes per day (range: -59 to -182 minutes; n=3). One study reported a reduction of workplace sedentary time through the use of portable pedal exercise machines on 12/20 days for 23 minutes each day (no further data regarding statistical significance or average workplace sedentary time reduction across the 20 days were available)[22]. One study, using manually height-adjustable desk mounts, reported a (non-significant) reduction in workplace sedentary time of 33 minutes/8-hour workday (95% CI= -74, 7 minutes, p=0.285)[56]. One study reported no change in workplace sedentary time following installation of height-adjustable ('hot') desks[33].

Eight independent comparisons (derived from seven studies) were suitable for inclusion in the meta-analysis, with all of them reporting workplace sedentary time[16, 18, 19, 22, 45, 54, 56]. The observed pooled effect size on workplace sedentary time was -77 minutes per 8-hour workday (95% CI= -120, -35 minutes). Heterogeneity was high and statistically significant (I^2= 91%, $p<0.001$; Supplementary Figure).

Of the three studies including an additional assessment of sedentary time, all reported sedentary time occurring during work hours[18, 37, 38]. One reported average workplace sedentary time reductions of 143 minutes per workday from baseline to 1 week (95% CI= -184, -102; $p<0.001$), and of 137 minutes per workday (95% CI= -179, -95; $p<0.001$) from baseline to 3 months[18]. While the other two studies reported somewhat attenuated intervention effects at the additional follow-up, they also observed statistically significant workplace sedentary time reductions: One study reported reductions of 182 minutes from baseline to 3 months and of 88 minutes from baseline to 9 months[37]; and the other one reported -91 minutes from baseline to 6 months and -42 minutes from baseline to 12 months[38].

Adiposity and other health- and work-related outcomes

Table 2 shows a summary of the findings for the health- and work-related outcomes. Twenty-three studies included measures of health across a total of 239 outcomes. For the majority of outcomes, no significant change was observed. Notable improvements were seen for waist circumference and psychological wellbeing in 5/6 and 12/15 studies, respectively. Worsening of outcomes was observed in two (of ten) health-related outcome categories: musculoskeletal outcomes and leg/foot swelling. Musculoskeletal outcomes worsened in 16/122 outcome reports among 6/17 studies, of which two used standing desks without height-adjustable chairs, three used standing desks with height-adjustable chairs, and one used height-adjustable desks. An increase in leg circumference was observed in 1/5 leg/foot swelling outcomes, with standing desks without height-adjustable chairs being used in this study. Twenty-three studies reported work-related outcomes across a total of 112 outcomes. The majority of work-performance outcomes (84/112) remained unchanged following installation of activity-permissive workstations. Deleterious impacts were observed in 21/99 work-performance outcomes across 7/23 studies, of which six used treadmill desks and one cycle ergometers.

**** INSERT TABLE 2 ABOUT HERE ****

Feasibility outcomes

Nineteen studies reported on the feasibility of activity-permissive workstations in the workplace setting. Due to the typically qualitative nature of the measures used, it was not possible to summarise them numerically. However, studies reported overall positive feedback from participants, with only 1/19 studies specifically reporting less 'liking' of standing posture when compared to sitting[49]. Three studies reported negative feedback from participants regarding the workstation design[16, 18, 56]. Seven studies collected data on adverse events with one study reporting an incident of a participant asking for removal of the workstation for reasons of body pain[56] and one study reporting leg discomfort in three participants[46]. One study qualitatively examined the acceptability and usability of height-adjustable desks in the workplace as a main outcome and reported high acceptability feedback from participants[34]. In this study, the use of activity-permissive workstations was strongly driven by perceived health benefits and improved productivity and suggestions for successful implementation and continued use were given (e.g., re-arrangement of surrounding office furniture to standing height, and use of electric rather than wind-up mechanisms for height-adjustable desks).

Discussion

This is the first systematic literature review and meta-analysis to collate the evidence on the impact of activity-permissive workstations on office workers' sedentary time, health- and work-related outcomes, and their feasibility in office-based settings. It builds on an earlier narrative review that specifically focused on the potential of such workstations to increase energy expenditure, and on their use and acceptability among office workers[21]. Our findings suggest that the installation of such workstations can lead to substantial reductions in sedentary time without impacting negatively on work-related outcomes; and, that they are acceptable to workers. As many of the findings regarding adiposity and other health-related outcomes were based on evidence from short-term studies with weak-to-moderate designs and/or insufficient statistical power, the impact of activity permissive workstations on health-related parameters is at this point inconclusive and warrants further attention. While only three studies included an additional assessment of workplace sedentary time (i.e. 3-12 months), all of these studies observed sustained behaviour change suggesting the potential for long-term benefits.

The pooled intervention effect on workplace sedentary time of -77 minutes per 8-hour workday across studies included in the meta-analysis is markedly higher than what has been observed in intervention studies without an environmental support element (ranging from -21 minutes/8-hour workday, p=0.084[22] to -48 minutes/ 16-hour waking day, $p<0.05$[22])[59-61]. Furthermore, the intervention effect seen in this review may be clinically relevant, with a recent meta-analysis reporting that the risk of all-cause mortality increased by 5% for each 1-hour increment in daily sitting time per day for adults who sit seven or more hours per day[11]. However, our findings should be interpreted with caution, given the methodological quality and sample size issues in many of the studies included in this review.

Strikingly few detrimental effects on health-related outcomes were reported across included studies and only in those with a short duration (i.e. <12 weeks), suggesting that the use of activity-permissive workstations is unlikely to cause harm in the workplace. However, as few of the studies included were sufficiently powered to detect changes in health-related outcomes[16], this finding should be interpreted with caution. Predominantly positive findings were observed on psychological wellbeing and waist circumference. The positive impact on psychological wellbeing is consistent with findings from epidemiological studies showing an association of sedentary time with lowered mood and depression[62, 63]. Whether this is mediated through increased perceived behavioural control (i.e. self-control in relation to work posture without being constrained to the chair) as suggested by occupational health psychology literature[64], remains to be examined. The reduction in waist circumference observed across several studies is consistent with epidemiological findings showing beneficial associations of breaks in sedentary time (i.e. regular postural transitions) with waist circumference[65], and may be the result of higher skeletal muscle activation of the postural muscles through more frequent postural changes and higher volumes of standing time[66-68]. However, the evidence is still limited and more studies are needed to confirm these results.

Worsening of health-related outcomes was only observed in 2/10 categories (musculoskeletal symptoms and leg swelling). Notably, increases in musculoskeletal symptoms were predominantly observed in studies using standing (i.e. not height-adjustable) desks. While the amount of standing time, (as well as the pattern of time spent sitting, standing, and moving throughout the working day) may be an important predictor of these or other adverse health outcomes[69, 70], none of the studies included in this review reported such information in detail. Furthermore, whilst provision of standing desks without access to a seated workstation enables office workers to decrease their workplace sedentary time, it is likely to result in increased discomfort as a result of the absence of postural variety opportunities[71, 72]. Standing-only workstations also do not conform to ergonomic recommendations encouraging postural variety through regular and frequent postural changes[14, 73]. Overall, to fully understand the impact of activity-permissive workstations and associated sedentary time reductions on health-related outcomes, larger-scale randomised controlled trials are needed[74].

Intervention effects were also statistically non-significant for the majority of work-related outcomes. However, our review findings suggest that the use of treadmill desks or cycle ergometers during work time may lead to some decreases in work-performance: Of the 112 work-related outcomes that were measured, 21 worsened. Of these, 16 were reported in studies using treadmill desks[36, 41, 46, 48, 51], with the other five reported in studies using cycle ergometers[46, 53].. A recent study suggested that a certain acclimatisation period may be necessary for the improvement of work-performance parameters when such activity-permissive workstations are used[75]. Notably, the studies reporting worsening of work-related outcomes were all of acute duration of either one[41, 46, 51, 53] or two days[36, 48]. Future studies using a longer-term follow-up should examine if a longer acclimatisation period will lead to an offset of these negative impacts.

Half of the studies included in our review assessed at least some aspect regarding the feasibility of the implementation of activity-permissive workstations in office-based workplaces, with predominantly positive feedback from participants reported. However, some studies identified some negative feedback from participants on aspects of workstation design, suggesting that a range of workstation models should be considered and tailored to individual needs and work tasks. In relation to this, it is notable that only a minority of included publications reported on the mechanisms (i.e. electric vs. non-electric) of the height-adjustable workstations used, or the time it takes to adjust their height.

Longer-term maintenance of health behaviour change has been challenging in the context of other prevalent health risk behaviours such as physical activity and diet and still not consistently measured and reported[76]. In this review, we identified only three studies in which an additional assessment of workplace sedentary time was included, beyond an initial intervention period. Extended follow-up (i.e. >1 year) in future studies will further enable evaluation of the impact of activity-permissive workstations on longer-term outcomes such as cardio-metabolic disorders, and productivity (including absenteeism and presenteeism), some of which are outcomes particularly relevant for informing the business case for their use.

The main strengths of this review include the extensive and cross-disciplinary literature search, the systematic summary of sedentary, health-related, work-related, and feasibility outcomes across several hundred outcome measures; and, the meta-analysis of sedentary time outcomes. However, when interpreting the results, the followinglimitations should be considered: 1) Non-English publications were excluded from review; the search was limited to peer-reviewed publications. 2) Twelve of 38 included publications were identified through the authors' libraries and cross-references rather than the database search. This speaks to the multi-disciplinary nature of the field and of the diverse and inconsistent use of terminology. While an extensive search strategy was applied to address this challenge, other relevant studies may have been missed. 3) Some relevant evidence is likely to exist in the grey literature (e.g., business reports[77]) and whilst not peer-reviewed, such evidence could provide further useful insights particularly into work-related and feasibility outcomes. 4) As most work-related outcomes were summarised as a compound category of 'work-performance', potential differences between aggregated outcomes may have been missed. 5) While four studies received the maximum quality score, the list of quality scoring categories was not comprehensive and items such as duration of follow up and generalisability of the study results were not explicitly scored. 6) As per inclusion criterion, all participants of included studies had to be engaged in administrative (i.e. not manufacturing, but with reliance on engagement with a computer) tasks while using the activity-permissive workstations. However, the work tasks performed may have slightly differed between laboratory-based studies (e.g., fine-motor skills test) and field studies (i.e. 'typical' administrative tasks), which may have influenced sedentary time as well as other outcomes. 7) Finally,as most work-related outcomes were summarised as a compound category of 'work-performance', potential differences between aggregated outcomes may have been missed.

Based on the findings from this review, the following recommendations are provided for future studies. 1) In relation to the second limitation above, the use of common terminology for the reporting of outcomes is needed to facilitate comparability of future studies. 2) Most studies including sedentary time measures reported on reductions in total sedentary time only. However, the pattern through which sedentary time is accrued throughout the day (i.e. through multiple smaller bouts and frequent posture changes) is also important for health-related outcomes[4, 78] and should be reported in future studies. 3) Larger-scale randomised controlled trials with long-term follow up (≥1 year) assessments are needed to fully understand potential long-term impacts of activity-permissive workstations and related reductions in sedentary time on health-related and work-related outcomes. 4) Finally, a number of different workstation types were included in this review, with models varying in both functionality and cost. Considering that the incorporation of activity-permissive workstations is likely to depend on both office design and work tasks undertaken, it is important for future studies to describe details on the make, model, target population, and typical work tasks conducted during workstation use.

Conclusion

The installation of activity-permissive workstations in office-based workplaces is likely to be a feasible and acceptable means to reduce office workers' sedentary time, with mostly neutral or positive impacts on adiposity and other health- and work-related outcomes. Further intervention trials are required, particularly with more-rigorously controlled study designs, adequate statistical power, and longer term follow-ups to identify impacts on health-related outcomes as well as long-term maintenance of sedentary time reductions.

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Figure 1. Study selection process

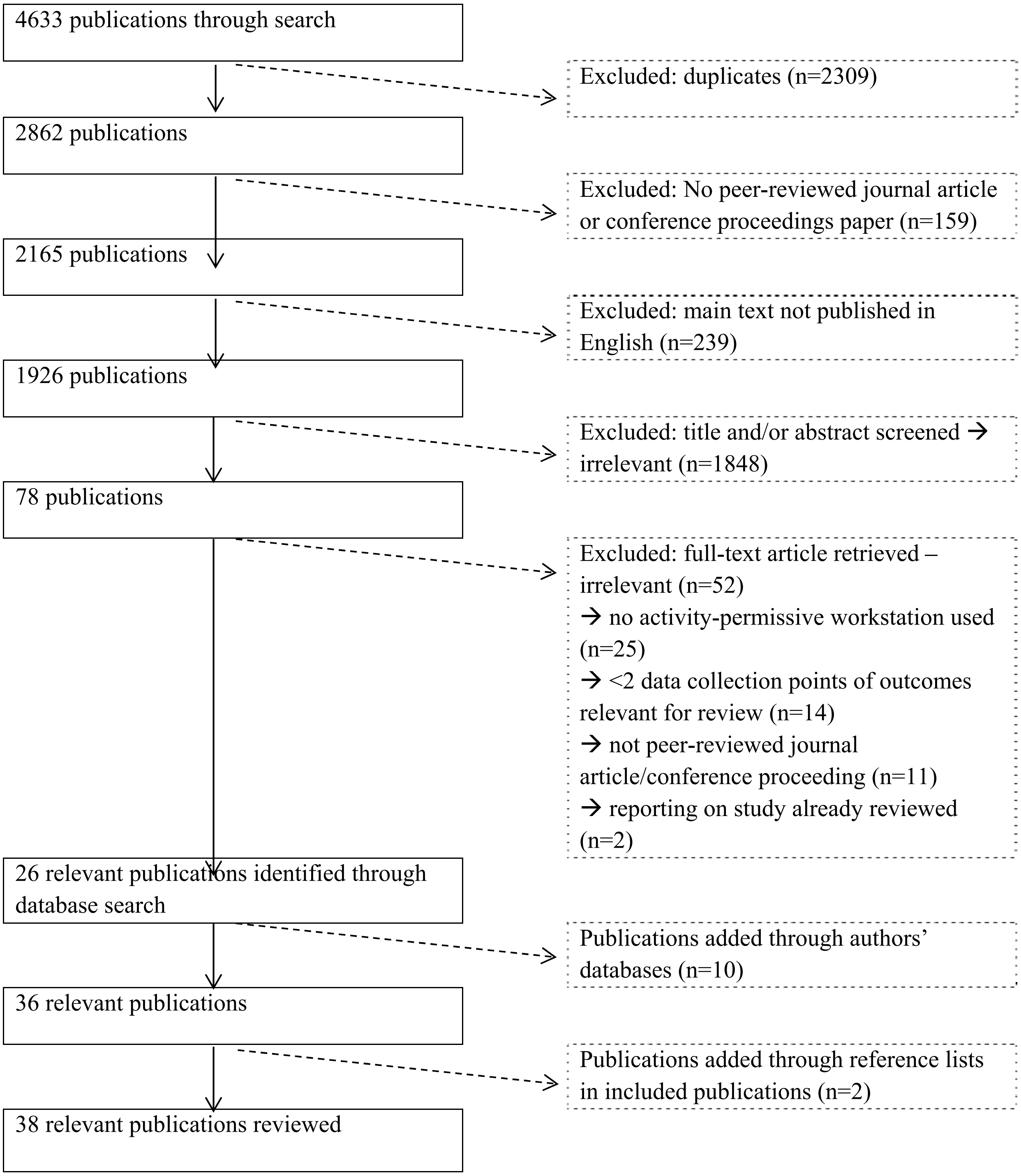

Table 1. Summary of included publications

First author, year; country	Sample (n; description; gender; age)	APW, design, duration	Overall findings	Quality score (0-1)
Laboratory-based studies				
[27]Aaras, 1997; Norway	20 experienced VDU workers aged 26-60 (15%F; mean age 52.5yrs)	Standing desks without access to height-adjustable chair; block-randomized; 1 day	Sedentary: NA Health: posture when using keyboard ns; muscle load when using keyboard ns; upper trapezius 10%le ns; lumbar erector spinae 10%le ns; 3x head flexion (10%le ns, 50%le ns, 90%le ns), 3x head side flexion (10%le ns, 50%le ns, 90%le ns); upper arm flexion 50%le +, upper arm abduction ns; low shoulder moment periods ns; back flexion ns; side flexion ns Work: work pace ns Feasibility: NA	0.79
[28]Alderman, 2013; USA	66 students (59%F; 21.1yrs SD 1.6)	Treadmill desks; cross-over; 2 days	Sedentary: NA Health: NA Work: 2x cognitive performance: both ns; reading comprehension ns Feasibility: NA	0.86
[49]Beers, 2008; USA	24 office workers (50%F: mean age 31.3yrs SD 9.1; 50%M: mean age 26.3yrs SD 6.2)	Standing desk without access to height-adjustable chair; cross-over; 1 day	Sedentary: NA Health: musculoskeletal comfort -, fatigue + Work: work-performance ns Feasibility: choice -, liking -	0.83
[29]Chester, 2002; USA	18 students (39%F; mean age 21.9yrs)	Standing desk without access to height-adjustable chair; cross-over; 2 days	Sedentary: NA Health: leg volume ns; leg circumference -; body comfort: upper back ns, lower back ns, hips -, upper legs -, knees -, lower legs -, ankles -, feet -; fatigue ns Work: NA Feasibility: NA	0.57
[30]Cox, 2011; USA	31 adults (71%F; mean age 37yrs SD 2.5)	Standing desk without access to height-adjustable chair; cross-over; 1 day	Sedentary: NA Health: NA Work: 2x speech quality both ns Feasibility: NA	0.63
[30]Cox,	31 adults (71%F;	Treadmill desk; cross-	Sedentary: NA	0.63

2011; USA†	mean age 37yrs SD 2.5)	over; 1 day	Health: NA Work: 2x speech quality both ns Feasibility: NA	
[31]Davis, 2009; USA	35 call centre employees (77%F)	HAD; pre-post; 2 weeks	Sedentary: NA Health: body discomfort: overall ns, shoulders ns, hands and wrists +, upper back ns, lower back + Work: work-performance: average number of calls/hour ns, average time until call is answered ns, average time unavailable for calls ns Feasibility: NA	0.64
[31]Davis, 2009; USA†	35 call centre employees (77%F)	HAD (plus software reminder); pre-post; 2 weeks	Sedentary: NA Health: body discomfort: overall +, shoulders +, hands and wrists +, upper back +, lower back + Work: work-performance: average number of calls/hour +, average time until call is answered ns, average time unavailable for calls ns Feasibility: NA	0.64
[32]Ebara, 2008; Japan	24 adults aged 20-29yrs and 60-69yrs (50%F; mean age 21.2yrs SD 1.1 and 62.7yrs SD1.6)	Standing desk with access to height-adjustable chair; cross-over; 1 day	Sedentary: NA Health: body discomfort: right forearm -, right wrist/hand -, both lower legs -, neck both sides ns, shoulders ns, left forearm ns, left wrist/hand ns, upper and lower back ns, hip/thighs both sides ns; fatigue ns Work: work-performance ns Feasibility: NA	0.86
[57]Edelson, 1989; USA	5 adults with minimum typing speed of 50 word/min (80%F; mean age 26yrs)	Treadmill desk; cross-over; 2 weeks	Sedentary: NA Health: stress +, body complaints ns Work: work-performance ns Feasibility: NA	0.64
[51]Funk, 2012; USA	24 university students and staff (63%F; mean age 23.2yrs SD 3.2)	Treadmill desk; cross-over; 1 day	Sedentary: NA Health: NA Work: typing performance: while walking at 1.3 km/hour -, while walking at 2.25 km/hour ns, while walking at 3.2 km/hour - Feasibility: NA	0.79
[52]Hasegawa,	16 adults (0%F; aged 19-25yrs)	Standing desk without access to height-	Sedentary: NA Health: fatigue: 2x dullness & drowsiness: + and ns, 2x body fatigue both ns	0.31

2001; Japan		adjustable chair; cross-over; 1 day	Work: Work-performance: 2x mental concentration: + and ns, 2x work load: + and ns, 2x error rate: + and ns; 2x miss rate both ns; 2x working motivation both ns Feasibility: NA	
[35]Husemann, 2009; Germany	60 students aged 18-35yrs (100%F; IG mean age 25.1yrs SD2.7; KG mean age 24.7yrs SD3.8)	HAD; RCT; 5 days	Sedentary: NA Health: physical well-being +, psychological well-being ns Work: work-performance ns Feasibility: NA	0.69
[36]John, 2009; USA	20 students (45%F; mean age 26.4yrs SD4.0)	Treadmill desks; cross-over; 2 days	Sedentary: NA Health: NA Work: work-performance: mouse clicking test -, drag-and-drop test -, typing speed -, math -, selective attention ns, processing speed ns, reading comprehension ns Feasibility: NA	0.79
[53]Koren, 2013; Slovenia	13 office workers (100%F; mean age 30.6yrs SD3.8)	Cycle-ergometer; cross-over; 1 day	Sedentary: NA Health: NA Work: work-performance: typing speed -, typing errors ns Feasibility: preference +	0.67
[39]McAlpine, 2007; USA	19 'sedentary' adults (42%F; mean age 27yrs SD9)	Stepping device; pre-post; 1 day	Sedentary: NA Health: NA Work: NA Feasibility: adverse events: none, tolerance +	0.75
[41]Ohlinger, 2011; USA	50 university staff (mean age 43.2yrs SD9.3)	HAD; cross-over; 1 day	Sedentary: NA Health: NA Work: work-performance: fine motor ns, 2x cognitive performance both ns Feasibility: NA	0.83
[41]Ohlinger, 2011; USA†	50 university staff (mean age 43.2yrs SD9.3)	Treadmill desk; cross-over; 1 day	Sedentary: NA Health: NA Work: work-performance: fine motor -, 2x cognitive performance both ns Feasibility: NA	0.83
[58]Seo, 1996; Japan	12 adults (33%F; mean age 24.1yrs SD1.2)	Standing desk without access to height-adjustable chair; cross-	Sedentary: NA Health: musculoskeletal symptoms: leg swelling +, lower leg dullness -, low back pain ns, whole body fatigue -	0.75

		over; 1 day	Work: NA Feasibility: NA	
[46]Straker, 2009; Australia	30 office workers (53%F aged 22-64yrs)	Standing desk without access to height-adjustable chair; cross-over; 1 day	Sedentary: NA Health: NA Work: work-performance: typing speed ns, typing errors ns; mouse pointing speed ns; mouse pointing errors ns; combined keyboard and mouse task speed ns; combined keyboard and mouse task errors ns Feasibility: user perception + (83% of participants thought it was feasible); adverse events: 3 reports of leg discomfort	0.93
[46]Straker, 2009; Australia †	30 office workers (53%F aged 22-64yrs)	Treadmill desks with participants walking at 1.6km/h and 3.2km/h,; cross-over; 1 day	Sedentary: NA Health: NA Work: work-performance: typing speed - (in both conditions), typing errors ns (in both conditions); mouse pointing speed - (in both conditions); mouse pointing errors - (in both conditions); combined keyboard and mouse task speed - (in both conditions); combined keyboard and mouse task errors ns (in both conditions) Feasibility: user perception: 50% of participants thought it was feasible; adverse events: 3 reports of dizziness, 2 reports of discomfort, 2 reports of leg discomfort	0.93
[46]Straker, 2009; Australia †	30 office workers (53%F aged 22-64yrs)	Cycle ergometers with participants cycling at 5 and 30 watts; cross-over; 1 day	Sedentary: NA Health: NA Work: work-performance: typing speed – (when cycling at 5 watts) and ns (when cycling at 30 watts), typing errors ns (in both conditions); mouse pointing speed - (in both conditions); mouse pointing errors ns (when cycling at 5 watts) and – (when cycling at 30 watts); combined keyboard and mouse task speed ns (in both conditions); combined keyboard and mouse task errors ns (in both conditions) Feasibility: user perception: 63% of participants thought it was feasible; adverse events: 9 reports of hip or gluteal discomfort	0.93
[48]Thompson, 2011; USA	11 medical transcriptionists	Treadmill desks; cross-over; 2 days	Sedentary: NA Health: NA Work: work-performance: tape completion ns, transcription errors ns, transcription time -, self-reported quality ns Feasibility: Preference for APW used 100%; 9/11 participants disagreed/	0.67

			strongly disagreed that they were more tired using the APW; no one agreed that the workstation was too noisy; mixed feedback on productivity levels, no one agreed that the workstation interfered with work quality	
Field-based studies				
[18]Alkhajah, 2012; Australia *	32 office workers (18 IG: 94.4%F, mean age 33.5yrs SD 8.7; 14 CG: 85.7%F, mean age 39.9yrs SD 7.2)	HADM; CT; 3 months	Sedentary (ActivPAL): 1 week: -143 minutes/8-hour workday (95% CI=- 184, -102); 3months: -137 minutes/8-hour workday (95% CI= -179, -95) Health: at 3 months: BMI ns; weight ns; body composition: fat-free mass ns, fat mass ns; waist ns; blood profile: total cholesterol ns, HDL +, triglycerides ns, glucose ns; fatigue ns, eye strain ns, headache ns, digestion ns, sleep problems ns, musculoskeletal symptoms ns Work: at 3 months: absenteeism ns, work-performance ns Feasibility: at 3 months: positive feedback on ease of use, comfortable, enjoyable; majority of participants agreed or strongly agreed that the workstations were easy to use (94%); enjoyable (94%); comfortable (83%); 83% disagreed/disagreed strongly that they would like rather return to their original workspace setup; some negative feedback on elements of workstation design	1
[22]Carr, 2011; USA	18 full-time office workers (88%F; mean age 40.2yrs SD 10.7)	portable pedal machines; pre-post; 4 weeks	Sedentary (workstation software): participants pedalled on 12.2/20 days (SD 6.6) on average for 23.4 minutes (SD20.4) Health: NA Work: NA Feasibility: majority of participants reported positive feedback (i.e. median ≥4/5) regarding preference, ease of use, comfort; no visual disturbance, no interference with work-tasks	0.83
[23]Carr, 2013; USA*	49 overweight and non-active uni staff working in desk-based jobs	portable pedal machines; blinded RCT; 12 weeks	Sedentary (workstation software): -58.7 minutes/day; participants pedalled for approx. 32 minutes in total on days they had access to pedal machines, with an average of 16 mins per pedalling bout Health: waist +; weight ns; BMI ns; blood profile: total cholesterol ns, HDL ns, LDL ns, triglycerides ns Work: NA Feasibility: Majority of participants (i.e. median ≥4/5) rated the pedal machines as helpful in reducing their workplace sedentary time	1
[19]Ellegast	25 office workers	HAD; RCT; 12 weeks	Sedentary (CUELA): -80 minutes/8-hour workday (95%CI= -123, -37)	0.56

, 2012; Germany *	(24%F)		Health: BMI +, 2x emotional wellbeing both +, fatigue +, musculoskeletal health: maximum trunk strength: flexion ns, extension ns; muscle endurance: shoulders ns, back ns, abdomen ns Work: NA Feasibility: NA	
[50]Fidler, 2008; USA	2 radiologists (100%F)	Treadmill desk; cross-over; 8 months	Sedentary: NA Health: NA Work: work-performance + Feasibility: NA	0.75
[33]Gilson, 2012; Australia	11 office workers (64%F; mean age 46.9yrs SD 9.8)	HAD (shared 4/11); pre-post; 1 week	Sedentary (wrist-worn accelerometer): ns Health: NA Work: NA Feasibility: NA	0.83
[34]Grunseit, 2013; Australia	19 office workers (53%F; 27-59yrs; median age 46 yrs)	HAD; pre-post; 3 months	Sedentary (self-report): -102 minutes during workplace time (95% CI= -192, -14) Health: NA Work: NA Feasibility: main outcome; overall high usability and acceptability	0.83
[16]Healy, 2013; Australia *	43 office workers (56%F, mean age 43.2 yrs SD 10.3)	HADM; CCT; 4 weeks	Sedentary (ActivPAL): -125 minutes/8-hour workday (95% CI= -161, -89 minutes) Health: weight ns; body composition: fat mass ns, fat free mass ns; waist ns; blood profile: glucose +, cholesterol ns, triglycerides ns; fatigue ns, eye strain ns; headache ns; digestion ns; sleep problems ns; musculoskeletal symptoms ns Work: work-performance: overall ns, absenteeism ns, presenteeism ns Feasibility: no adverse outcomes	1
[55]Hedge, 2004; USA	33 office workers (42%F; mean age 38.6yrs SD2.1 across two companies)	HAD; RCT and cross-over; 4-6 weeks	Sedentary (self-report): -16.5% during work hours Health: 8x time-of-day and mean discomfort: home morning ns, start work ns, late morning ns, all other +; 28-item musculoskeletal symptoms scale: right eye ns, left neck ns, hip both sides ns, right thigh ns, both lower legs ns, both feet ns, both upper arms ns, left elbow ns, all other + Work: Productivity + Feasibility: workstation ratings: keyboard +, mouse +, chair +, workstation +; preference +	0.5
[37]John,	12 overweight/ obese	Treadmill desks; pre-	Sedentary (ActivPAL): 3 months: -182 minutes during total waking hours; 9	0.79

2011; USA	office workers (58%F; mean age 46.2yrs SD9.2)	post; 9 months	months: -88 (from baseline) during total waking hours Health: 3 months: weight ns; BMI ns; waist +; body composition: body fat (%) ns, fat mass (kg) ns, fat free mass ns, truncal fat ns; blood profile: LDL ns, VLDL ns, HDL ns, total cholesterol +, triglycerides ns, glucose ns, insulin ns, glycosylated haemoglobin +; 9 months (in comparison to outcomes at 3 months): weight ns; BMI ns; waist +; body composition: body fat (%) ns, fat mass (kg) ns, fat free mass ns, truncal fat ns; blood profile: LDL +, VLDL ns, HDL ns, total cholesterol +, triglycerides ns, glucose ns, insulin ns, glycosylated haemoglobin +) Work: NA Feasibility: NA	
[38]Koepp, 2013; USA	36 employees with sedentary jobs (69%F; mean age 42yrs SD9.9)	Treadmill desks; pre-post; 1 year	Sedentary (hip-worn accelerometer): 6 months: -91 minutes (SD66) during total waking hours; 12 months: -43 minutes (SD 67; from baseline) during total waking hours Health: 6 months: weight +; waist +; body composition: body fat ns, fat mass ns, fat free mass +; blood profile: glucose ns, haemoglobin A1c +, total cholesterol ns, triglycerides ns, HDL ns, LDL ns; 12 months (in comparison to outcomes at baseline): weight +, waist +; body composition: body fat ns, fat mass ns, fat free mass ns; blood profile: glucose ns, haemoglobin A1c ns, total cholesterol ns, triglycerides ns, HDL +, LDL ns Work: 6 months: work-performance: 2x overall both ns, 2x quality both ns, 2x quantity both ns; 2x interaction both ns; 12 months: work-performance: 2x overall both ns, 2x quality both ns, 2x quantity both ns; 2x interaction both ns Feasibility: adverse events: none, tolerance +	0.79
[40]Nerhood, 1994; USA	Office workers at UPS	HAD; pre-post; 9 months	Sedentary: NA Health: body part discomfort: eyes ns, neck ns, shoulders ns, upper back +, upper arm ns, middle back +, lower back ns, lower arms/elbows +, wrists ns, hands ns, buttocks +, thighs +, knees +, legs +, feet + Work: absenteeism ns; productivity + Feasibility: injuries +; cost of injuries +	0.21
[56]Neuhaus, 2014; Australia *	44 office workers (84% female; mean age 42.6yrs SD11.5)	HADM; RCT; 3 months	Sedentary (ActivPAL): -33 minutes/8-hour workday (95% CI= -74, 7) Health: weight ns; musculoskeletal ns Work: work-performance: overall ns, absenteeism ns, presenteeism ns Feasibility: adverse events: 1 (body pain); acceptability +; feasibility +	1

[56]Neuhaus, 2014; Australia *†	44 office workers (84% female; mean age 42.6yrs SD11.5)	HADM (plus additional strategies); RCT; 3 months	Sedentary (ActivPAL): -89 minutes/8-hour workday (95% CI= -130, -47) Health: weight ns; musculoskeletal ns Work: work-performance: overall ns, absenteeism ns, presenteeism ns Feasibility: no adverse events; acceptability +; feasibility +	1
[54]Parry, 2013; Australia *	62 office workers (80.6%F; mean age 43.5yrs SD6.4)	Treadmill desk or treadmill desk with cycle-ergometer (shared 1/9, 1/6, and 1/4); Cluster RCT; 12 weeks	Sedentary (hip-worn accelerometer): -1.7% during work hours Health: NA Work: NA Feasibility: no adverse events	0.88
[43]Paul, 1995a; USA	12 office workers (75%F; mean age 37yrs)	HAD; pre-post; 3 months	Sedentary: NA Health: psychological well-being: feeling bored ns, sluggish +, alert +, energetic +; fatigue + Work: NA Feasibility: NA	0.5
[42]Paul, 1995b ; USA	13 VDT operators	HAD; pre-post; 1 day	Sedentary: NA Health: spinal shrinkage - Work: NA Feasibility: NA	0.64
[44]Paul, 1995; USA	6 office workers (84%F; mean age 39yrs)	HAD; pre-post; 6 weeks	Sedentary: NA Health: foot swelling: at 12 pm +, at 1pm ns, at 5pm + Work: NA Feasibility: NA	0.42
[45]Pronk, 2012; USA*	34 office workers (IG: 96%F, mean age 38.4yrs SD11.4; CG: 80%F, mean age 44.2yrs SD11.9)	HADM; CT; 4 weeks	Sedentary (self-report): -83 minutes during work hours (95%CI= -173, 7) Health: musculoskeletal symptoms: upper back +, neck +, lower back ns; psychological wellbeing: vigour+, tension+, confusion+, depression+, total mood disturbance+, anger ns, self-esteem ns; fatigue+ Work: organisational-cultural: time spent in face-to-face interactions ns Feasibility: no adverse events; overall positive feedback: 87% felt more comfortable, 87% more energised, 75% healthier, 7% more focused, 66% more productive, 62% happier, 33% less stressed	0.63
[20]Roelofs, 2002; Australia	30 bank tellers (80F; mean age 27yrs)	Standing desk without access to height-adjustable chair; cross-	Sedentary: NA Health: musculoskeletal symptoms: body discomfort -, back ns, lower limb -, upper limb ns	0.79

		over; 3 days	Work: NA Feasibility: sit/stand preferred by 70%, just sit 20%, just stand 10%	
[20]Roelofs, 2002; Australia	30 bank tellers (80F; mean age 27yrs)	Standing desk with access to height-adjustable chair; cross-over; 3 days	Sedentary: NA Health: musculoskeletal symptoms: body discomfort ns, back ns, lower limb ns, upper limb ns Work: NA Feasibility: sit/stand preferred by 70%, just sit 20%, just stand 10%	0.79
[47]Thompson, 2007; USA	25 employees in the executive health program	Treadmill desks; pre-post; 6 weeks	Sedentary: NA Health: NA Work: NA Feasibility: no adverse events; overall positive feedback: workstation is too noisy (mean score 1.8/5), productivity improved (mean score 2.9/5), increased fatigue at end of day (mean score3.0/5), workstation did not interfere with patient care (mean score 3.9/5), preference for APW (mean score 4.4/5)	0.64

* publications included in meta-analysis; † same study population as above; F= female; M= male; CT= controlled trial; RCT= randomised controlled trial; APW= Activity-permissive workstation; HAD= fully height-adjustable desk; HADM= Height-adjustable desk mount for computer only; %le= percentile; BMI= body mass index; LDL= low-density lipoprotein; VLDL= very low-density lipoprotein; HDL= high-density lipoprotein; NA= not applicable; + = statistically significant improvement in outcome; - = statistically significant worsening in outcome; ns=statistically non-significant

Table 2. Summary of health and work outcomes stratified by study duration

Outcome (n)	Number of studies		Worsening (n)		No change (n)		Improvement (n)	
Study duration*	short	long	short	long	short	long	short	long
Health-related								
Musculoskeletal (n=127)	13	4	16	0	56	15	32	8
Weight (n=9)	1	5	0	0	1	6	0	2
Body mass index (n=5)	0	4	-	0	-	4	-	1
Waist circumference (n=6)	1	3	0	0	1	0	0	5
Body composition (n=19)	1	3	0	0	2	16	0	1
Blood profile (n=34)	1	4	0	0	2	23	1	8
Fatigue (n=10)	6	3	0	0	4	1	3	2
Psychological well-being (n=15)	3	2	0	0	2	1	7	5
Leg/Foot swelling (n=5)	2	0	1	-	2	-	2	-
Other (n=9)	2	1	0	0	4	4	1	0
Total health-related (n=239)	**15**	**8**	**17**	**0**	**74**	**70**	**46**	**32**
Work								
Work-performance (n=99)	17	5	21	0	56	15	5	2
Absenteeism (n=5)	1	3	0	0	1	4	0	0
Presenteeism (n=3)	1	1	0	0	1	2	0	0
Cultural-organisational (n=5)	1	1	0	0	1	4	0	0
Total work (n=112)	**18**	**5**	**21**	**0**	**59**	**25**	**5**	**2**

*Study duration was defined as: short= < 12 weeks; long= ≥12weeks; ‘-‘ indicates that the outcome was not measured in any study of that particular duration;

Supplementary Table 2. Quality scores of included publications.

Study	Recruit.	Participants	Allocation	Measure	Sample size	Variance	Confounding	Results	TOTAL
Aaras, 1997	1	2	1	2	1	2	N/A	2	0.79
Alderman, 2013	2	2	1	2	1	2	N/A	2	0.86
Alkhajah, 2012	2	2	N/A	2	2	2	2	2	1.00
Beers, 2008	1	2	1	2	1	2	N/A	1	0.83
Carr, 2011	2	2	N/A	1	2	2	N/A	1	0.83
Carr, 2013	2	2	2	2	2	2	2	2	1.00
Chester, 2001	1	2	1	1	1	0	N/A	2	0.57
Cox, 2011	1	1	1	2	1	2	0	2	0.63
Davis, 2009	2	1	1	1	1	1	N/A	2	0.64
Ebara, 2008	2	2	1	1	2	2	N/A	2	0.86
Edelson, 1989	2	2	1	2	0	0	N/A	2	0.64
Ellegast, 2012	1	1	1	2	1	1	0	2	0.56
Fidler, 2008	1	2	N/A	2	1	1	N/A	2	0.75
Funk, 2012	1	2	1	2	1	2	N/A	2	0.79
Gilson, 2012	2	2	N/A	2	0	2	N/A	2	0.83
Grunseit, 2013	2	2	N/A	1	1	2	N/A	2	0.83
Hasegawa, 2001	0	1	0	1	1	0	0	2	0.31
Healy, 2013	2	2	N/A	2	2	2	2	2	1.00
Hedge, 2004	1	2	1	1	1	0	0	2	0.50
Husemann, 2009	1	1	1	2	1	2	1	2	0.69
John, 2009	1	2	1	2	1	2	N/A	2	0.79
John, 2011	2	2	N/A	2	1	2	0	2	0.79
Koepp, 2013	2	2	N/A	2	1	2	0	2	0.79
Koren, 2013	1	2	N/A	1	1	2	N/A	1	0.67
McAlpine, 2007	1	2	N/A	1	1	2	N/A	2	0.75
Nerhood, 1994	1	0	N/A	1	0	0	0	1	0.21
Neuhaus, 2014	2	2	2	2	2	2	2	2	1.00
Ohlinger, 2011	1	2	N/A	2	1	2	N/A	2	0.83
Parry, 2013	2	2	2	1	2	2	1	2	0.88
Paul, 1995a	1	2	N/A	0	1	0	N/A	1	0.42
Paul, 1995b	1	2	0	2	1	1	N/A	2	0.64

Paul, 1995	1	1	0	2	1	1	0	2	0.50
Pronk, 2012	2	2	1	2	1	0	0	2	0.63
Roelofs, 2002	2	2	1	1	1	2	N/A	2	0.79
Seo, 1996	1	2	N/A	1	1	2	N/A	2	0.75
Straker, 2009	2	2	2	2	1	2	N/A	2	0.93
Thompson, 2011	2	0	1	2	2	0	N/A	2	0.64
Thompson, 2007	2	0	N/A	2	1	1	N/A	2	0.67
TOTAL	0.74	0.84	0.55	0.80	0.57	0.71	0.33	0.93	