

BMJ Open Evidence base of economic evaluations of workplace-based interventions reducing occupational sitting time: an integrative review

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To cite: Akhavan Rad S, Kiwanuka F, Korpelainen R, *et al*. Evidence base of economic evaluations of workplace-based interventions reducing occupational sitting time: an integrative review. *BMJ Open* 2022;**12**:e060139. doi:10.1136/bmjopen-2021-060139

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-060139>).

Received 22 December 2021
Accepted 10 June 2022



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ABSTRACT

Objective To review the evidence on the economic evaluations of workplace-based interventions that are designed to reduce prolonged periods of occupational sitting.

Design An integrative review.

Data sources The search was conducted in 11 databases, including PubMed, Scopus, PsychINFO, NHS-EED, Cumulative Index to Nursing and Allied Health Literature (CINAHL), ProQuest, Cochrane library, Sportdiscus, Research Paper in Economics (RePeC), the International Health Economic Association (IHEA) and EconLit. The databases were searched for articles published from inception to January 2022. Subsequent citation searches were also conducted in Google Scholar. The items of the Consensus Health Economic Criteria (CHEC) checklist were used for quality appraisal of the included studies.

Results This review included five randomised control trials, including 757 office-based workers in high-income countries. The median quality appraisal score based on the CHEC items was 14 points (a range of 9–18). The mean duration of interventions was 33 weeks (a range of 4–52 weeks). Overall, the studies reported economic benefit when implemented to reduce occupational sitting time but no effect on absenteeism. From the societal perspective, the interventions (eg, the use of a sit–stand desk) were cost-effective.

Conclusion The economic impact of workplace interventions implemented to reduce occupational sitting time is evident; however, the existing evidence is limited, which precludes strong conclusions. Cost-effectiveness is not often evaluated in the studies exploring workplace interventions that address occupational sitting time. Workplace interventions are still in the development and testing phase; thus, the challenge for future studies is to include economic evaluation of interventions addressing sedentary behaviour in workplaces.

PROSPERO registration number CRD42021226275.

BACKGROUND

Office-based work environments account for the most common occurrence of prolonged occupational sitting time (POST), accounting for 47.2% of the total sitting time among office-based workers.¹ Work environments can

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This integrative review is comprehensive and includes evidence from the studies reporting on any of the three types of economic evaluations: cost-effectiveness, cost-utility and cost-benefit analysis.
- ⇒ We appraised the evidence presented in the review using the Consensus Health Economic Criteria tool.
- ⇒ The existing evidence of the economic evaluation of workplace interventions that reduce prolonged occupational sitting time is limited, which precludes strong conclusions.

lead to long periods spent in a sitting posture among office-based workers.² Prolonged sitting (PS) is commonly defined as an energy expenditure below 1.5 Metabolic Equivalent Tasks in a sitting posture for at least 30 min.³

Currently, there is substantial evidence on the detrimental effects of PS, with some authors⁴ arguing that PS seems relatively more harmful than smoking. The risk of neurodegenerative diseases increases with consistent PS due to compromised cerebrovascular blood flow.⁵ PS also gradually promotes exercise intolerance, which consequently reduces employees' ability to perform physical tasks.⁶ Moreover, PS can lead to gradual clinical deformities in the lower back, hip, thigh and buttock areas,⁷ reducing passive hip extension.⁸ Conclusive evidence is indicated in a review⁹ on the association of PS and increased mortality: sitting for more than 4 hours/day is attributed to 12%–59% mortality.¹⁰ In addition, the health costs associated with physical inactivity contributed a substantial economic burden of approximately US \$13.7 billion in production loss costs in 2013 and 13.4 million disability-adjusted life years (DALY) globally.¹¹

The diverse effects of sedentary behaviour have attracted a growing research interest. Within the current literature on workplace-based interventions, systematic reviews and meta-analyses have shown the benefits of

diverse interventions that reduce sitting time. A systematic review¹² of workplace interventions to reduce sitting at work indicated that workplace interventions reduced sitting time by 100 min/day at work. Some scholars¹³ have attempted to answer the question *are office-based work interventions designed to reduce sitting time cost-effective?* The results of a meta-analysis and Markov model included only one multicomponent intervention that consisted of sit and stand desk with an 85.2% probability of being cost-effective.¹³ Another review¹⁴ highlighted that although the effect is small, workplace interventions increase physical activity and reduce sedentary behaviour. However, cost-evaluation of such interventions remains uncertain.¹⁴ This issue is underpinned by findings that the nature, intensity and frequency of physical activity required to alleviate PS are unique in different population.¹⁵ Thus, the essence of specifying interventions is delivered in workplaces for office-based workers to reduce sitting time. Arguably, the literature on impact of workplace interventions to increase physical activity is dominant but does not indicate economic evaluations of such interventions. A review¹⁶ highlighted a need for focus cost-effectiveness analysis of chair interventions at workplaces despite their potential in reducing sitting time. Recently, the 2018 Physical Activity Guidelines Advisory Committee¹⁷ emphasised the need to gather evidence on cost-effectiveness of workplace-based interventions to better inform physical activity promotion. Other scholars have argued that occupational sitting time should be addressed as a specific niche in the realm of sedentary behaviours.^{18 19} Sustainable implementation of workplace-based interventions designed to reduce longed periods of occupational sitting can be promoted with such evidence. Withal, it is likely that the available literature on economic evaluations has increased. This review will focus on economic evaluation of workplace interventions for reducing prolonged occupational sitting.

METHODS

Design

To allow for a combination of diverse methodologies (experimental and non-experimental), the integrative review method²⁰ was adopted for this review. This method included a five-step approach: review question formulation; literature on economic evaluations, quality appraisal, results and the discussion of findings. The protocol was registered in the Prospective Register for Reviews.

Data sources and searches

We conducted an initial scoping search in the Google Scholar database to ensure that no review was already available or in progress that addressed our review question. We conducted electronic searches in Scopus, PubMed, Scholar, PsycINFO, EconLit, Cumulative Index to Nursing and Allied Health Literature (CINAHL), the UK National Health Service economic evaluation database (NHS-EED), the Cochrane library, ProQuest and

SPORTDiscus (EBSCO). To complement these searches, hand searches were conducted in the following resources for any other grey literature: the International Health Economic Association (IHEA) and Research Paper in Economics (RePEc). We also conducted forward and backward searches of citing studies and reference lists of included studies to identify other pertinent literature in Google Scholar. Finally, we contacted the authors and requested information on the publications from the protocols discovered during our initial search.

Search terms

The search terms used included 'intervention', 'trials', 'workplace', 'occupational sitting behaviour', 'occupational sedentary behaviour', 'cost-effectiveness' and 'cost benefits'. We also substituted keywords, such as 'workplace', for 'occupational'. In addition, we checked the reference lists of the identified papers for any pertinent literature relevant to our study, which were then tested using a combination of terminology derived from free text and subject headings. The search in the NHS-EED used the MeSH descriptors 'cost-benefit analysis' and 'occupational health' with the 'explode all trees' option, and we applied filters for the years of publication (from inception to 31 January 2022). The NHS-EED search yielded 11 studies (online supplemental table S1) provides an overview of the search syntax.

Inclusion and exclusion criteria

Table 1 shows the description of the inclusion criteria. Different study designs were considered if they reported about costs as the primary or secondary outcome of interventions aimed at reducing sitting time at workplaces. The characterisation of cost-effectiveness and/or cost benefits of an intervention considered intervention costs, production loss costs/absenteeism, presenteeism (eg, expressed in monetary values: euros, dollars, etc) or the costs

Table 1 Criteria for the studies considered in this review

Criteria	Description
Types of studies	To be included, a study must be conducted using one of the following designs: a randomised controlled trial (RCTs), a quasi-experimental design or any observational study design.
Participants recruited in a study	A study was included if it recruited participants aged 18 years or more, whose occupations involve working while sitting at a desk.
Types of interventions	A study was considered for inclusion if there was an intervention delivered at the workplace specifically to reduce sitting time. The intervention is multicomponent (eg, including behavioural approaches such as counselling) or physical activity only interventions (eg, including sit-stand desks).
Types of outcome measures	A study was considered for inclusion in the review if it reported any economic evaluation in terms of cost-effectiveness, cost-utility, or cost benefit.

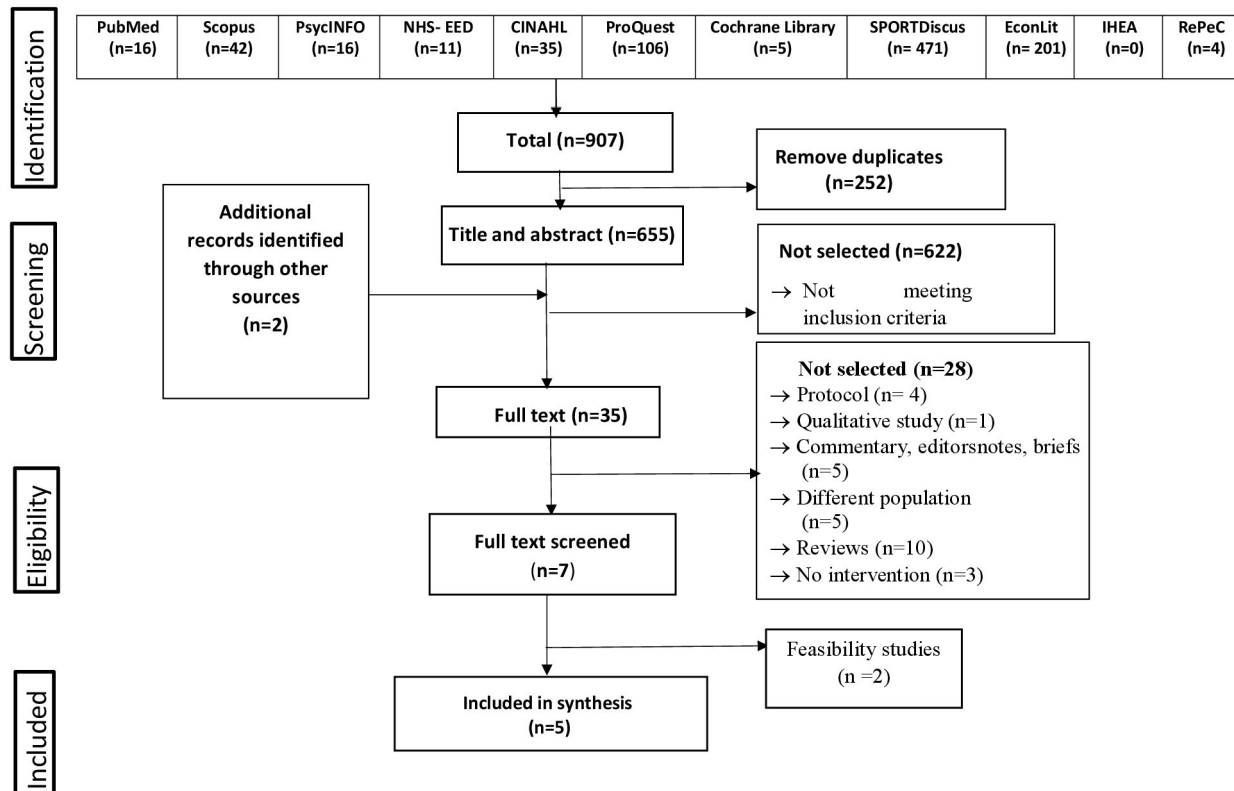


Figure 1 PRISMA flow diagram showing the study selection process. PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses.

relative to the clinical benefits of the outcome, measured in non-monetary values: for example, costs/life years (LY) gained; cost/ health-adjusted life years (HALY); quality-adjusted life years (QALY); DALY; health-related quality of life (HRQoL).²¹

Search outcomes

The database search identified 907 documents. After excluding duplicates, we screened the titles and abstracts of 655 documents, excluding studies that did not meet the inclusion criteria. As the result, full texts of 35 studies were obtained and further screened (first independently by each author, and then collaboratively). If any doubt arose, two of the authors (SAR and FK) discussed the studies in question. Two studies were included in the final analysis (figure 1).

Data extraction and charting

The search outcomes were exported into the Rayyan software.²² Two of the authors (SAR and FK) then inspected the titles and abstracts of each identified document, applied the inclusion criteria and obtained the full texts of the relevant publications, where applicable.

Data items

The author(s), year, country, study specific data (eg, design, participants, setting, sample and outcome measures) and the information relevant to our research questions were charted in a piloted Microsoft Word document.

Quality appraisal

Two reviewers used the Consensus Health Economic Criteria (CHEC)²³ tool to collaboratively evaluate the rigour of the included studies. The CHEC tool is recommended for the appraisal of studies, assessing the economic impact of interventions. It consists of 19 signalling questions. In this review, a score of at least 16 signalling questions of the CHEC was rated as strong evidence. Online supplemental table S2 provides information quality appraisal of included studies.

Data analysis

We used a narrative approach to synthesise the findings in this review. A quantitative analysis was not possible due to the differences in terms of the perspectives and outcomes reported across studies. Moreover, a meta-analysis was not appropriate as only two studies included in our final analysis had methodological and perspective similarities. The summary measures included differences in costs per reduction in sitting time, absenteeism/production loss cost and presenteeism. The clinical benefits of workplace physical activity interventions aimed at reducing the PS time measured in monetary values (eg, QALY, DALY and HRQoL) were considered.

Patient and public involvement

There is no patient involved in the study.

RESULTS

Included studies

Out of 655 titles and abstracts, 35 full texts were screened (see figure 1). Five studies^{2 24–27} were included in the final analysis. All included studies were randomised control trials (RCTs) across different countries: Australia,² Canada,²⁷ the Netherlands,²⁵ the UK²⁶ and the USA²⁵ (see table 2 for a summary of included studies). A total of 757 participants were included in the studies. The sample sizes ranged from 29²⁵ to 244 participants.²⁴ The mean duration of interventions was 33 weeks (ranging from 4²⁵ to 52).^{2 26}

Quality evaluation of two studies^{2 26} had a well-described economic evaluation of the interventions, with a score of more than 15 for the signalling questions on the CHEC. Extrapolation to infer future costs and discounting was not conducted in the study.²⁵ The generalisability of the study results was also not discussed in four studies.^{24–27} Online supplemental table S2 provides information on the quality appraisal of the included studies.

Interventions

Altogether, five workplace-based interventions were identified. These included multicomponent interventions commonly involving sit-stand desks (SSD).^{2 24–27} One study evaluated a multicomponent intervention entitled dynamic work (DW)²⁴ compared with the prompts that alerted controls to use stairs, walking routes, telephone routes and take lunch walks. The DW intervention consisted of face-to-face meetings between occupational physiotherapists and department managers, SSD, cycling workstations, sit-balls and sitting trackers with a self-usage booklet.

Another RCT with a cross-over design²⁵ included the use of SSD over a 4-week period, followed by a cross-over to usual work habits. The intervention was compared with usual work habits.

Height-adjustable workstations with supporting behaviour change—Stand More at Work (SMaRt)—were evaluated in another study.²⁶ The multicomponent intervention SMaRt comprised of three elements: individual, environmental and organisational. In the individual elements, the participants were provided with a DARMA cushion (Darma, California) to enable them to regularly track and self-monitor their sitting time (total and prolonged), and they were prompted (in the form of vibration) to regularly interrupt sitting. The environmental elements involved two models of height-adjustable desks (60% of the participants used the VariDesk platform and 40% of the participants used the electric workstation), which were installed at workplaces. The intervention also involved behavioural change, such as an educational seminar, feedback and regular interaction among the research team through progress discussions. The organisational elements included management support for the intervention through a regular e-newsletter sent to all staff and clinical management groups, who were requested to provide support, encourage involvement

and allow time to participate in the intervention and deliver the message about the intervention to other team leaders. *Follow-up:* the outcomes of the intervention were evaluated over a 52-week period at three intervals (3, 6 and 12 months). The primary outcome measure was occupational sitting time measured using a thigh-worn accelerometer (ActivPAL3; PAL Technologies, Glasgow UK). The non-monetary benefits of the intervention included reduced aches and pains, improved cognitive functioning, increased productivity and energy and positive feelings about general health.²⁵

The dual-screen sit-stand workstation (Ergotron WorkFit-S) was combined with work surface accessory and behavioural counselling (the Stand-Up Victoria study).² This multicomponent intervention comprised organisational, environmental and individual elements. The environmental elements included the installation of a dual-screen sit-stand workstation (Ergotron WorkFit-S) combined with a work-surface accessory. The individual elements involved behavioural counselling, such as face-to-face coaching sessions provided by trained health coaches. The participants were counselled on the appropriate posture and how to use the intervention. The intervention was guided by the cognitive theory and the ecological model of sedentary behaviour. The organisational elements entailed senior management consultations, a workshop for representatives, participant information, brainstorming sessions and consultations on the intervention. A low-cost (Canadian Dollars 20) standing desk convertor was complemented with a booklet on the health benefits of interrupting sitting time and usage information.²⁷

Types of control group interventions

In one study, the comparative intervention was a usual practice involving prompts to use stairs, walking routes and telephone routes with footsteps, and take a lunch walk.²⁴ Four studies^{2 25–27} used no control group.

Economic evaluation

Perspective of the economic evaluation

One study considered both societal and employer perspective.²⁴ Another study used only the societal perspective.² Another study considered intervention costs incurred by the employer,²⁶ while two studies reported no clear economic evaluation perspective.^{25 27}

Cost-analyses of interventions

In one RCT,² the intervention was estimated to cost EUR 134 million and approximately EUR 215 per capita for the national population of eligible office-based workers (n=624 318). Another study reported on cost benefits.²⁶ Despite the significant cost implications, all studies had seemingly unrelated analytical parameters for the economic evaluation of the interventions.

Across studies, there was an overall positive economic benefit or cost-effectiveness: one study indicated a net saving of EUR 1962.56 per person per year² and another

Table 2 Summary of included studies

Study	Aim of the study	Design and sample	Intervention, duration, comparison; perspective of economic	Outcomes and measurements	Summary results	Quality appraisal based on CHEC checklist
Ben <i>et al</i> , Netherlands ²⁴	To assess the cost-effectiveness and return-on-investment (ROI) of the dynamic work (DW) intervention, a worksite intervention aimed at reducing sitting time among office workers	Design: RCT Sample: assessed for eligibility; 304 office-workers Excluded=60 Completed the study: 244 from 14 departments. Intervention group: (n=121) , Control group: (n=123)	Intervention: dynamic work Duration of intervention: baseline, 4 months, 8 months Comparison: usual practice Perspective of economic evaluation: Both (Societal & employer)	Primary outcome: sitting time Secondary outcome: occupational movement behaviour, health-related outcomes, work-related outcomes. Tools: ActivePAL, EQ-5D-5L questionnaire, iMTA Medical Cost Questionnaire (iMCO), iMTA Productivity Cost Questionnaire (iPCQ)	Societal perspective: no difference in costs between groups ► Presenteeism costs were lower in the intervention group ► The intervention seemed 90% effective at a willingness-to pay- of 20,000€/QALY ► Thus, a financial saving of 86%. Employer perspective: the intervention was cost-beneficial.	14/19
Duttia <i>et al</i> , US ²⁵	To assess installing of sit-stand desks can lead to decrease sitting time during the workday among sedentary office workers	Design: Randomised crossover trial Sample: assessed for eligibility; 35 office workers excluded: n=6 Randomised sample=29 excluded=1 Analysed: n=28	Intervention: Sit-stand desks Duration of the intervention: 4 weeks Comparison: usual work habit Perspective of economic evaluation: not clear	Primary outcomes: sitting time, standing time, light activity Secondary outcomes: energy and relaxation levels, work productivity, fatigue, appetite, dietary intake Tools: accelerometer, self-reported Occupational Sitting and PA Questionnaire (OSPAQ), ecological momentary assessment (EMA), web-based 24 hours dietary recall (ASA-24, National Cancer Institute), Work Productivity and Activity Impairment Questionnaire (WPAIQ)	The intervention had no impact on productivity however, the workstations were popular among the participants and reduced sitting time at work by 21% and sedentary time by 4.8min/work hours, for a 40-hour workweek.	9/19
Gao <i>et al</i> , Australia ²	To assess the economic credentials of a workplace-delivered intervention to reduce sitting time among desk-based workers	Design: RCT Sample: assessed for eligibility: 278 Lost to follow-up: 47 Completed the study: 231 workers from 14 worksites. Intervention group (n=136), control group (n=95)	Intervention: Stand Up Victoria Duration of intervention: 12 months Comparison: usual practice. Perspective of economic evaluation: employer	Outcomes: workplace sitting time, BMI, health-related quality of life, absenteeism Measurement intervals: baseline, 3 and 12 months Tools: Assessment of Quality of Life-8D;	Greater cost per person, reduced workplace-sitting time and increased standing were associated with the intervention. No benefit on absenteeism.	18/19

Continued

Table 2 Continued

Study	Aim of the study	Design and sample	Intervention, duration, comparison; perspective of economic	Outcomes and measurements	Summary results	Quality appraisal based on CHEC checklist
Munir <i>et al</i> , UK ²⁶	To assess cost and cost-benefit analysis of the Stand More AT (SMART) Work workplace intervention designed to reduce sitting time.	Design: RCT- clustered-two arm Sample: 37 office cluster (n=146) intervention group (n=77), control group (n=69)	Intervention: Height-adjustable workstation with supporting behaviour change strategies. Duration of intervention: 12 months Comparison: usual office practices.	Outcomes: absenteeism, presenteeism, work productivity, activity impairment and mean per employee costs associated with the intervention Measurement intervals: baseline, 3, 6 and 12 months Tools: WPAl:GH V2.0; employer-recorded absence	The intervention was associated with reduction in sitting time with a net saving of £1770.32 per employee due to productivity increase. The intervention had no effect on absenteeism	16/19
Weatherston <i>et al</i> , Canada, ²⁷	To evaluate the impact of a low-cost standing desk on objectively measured occupational sitting and prolonged sitting bouts over 3 and 6 months	Design: RCT Sample: assessed for eligibility: 94 Excluded: 46 randomised: 48 participants withdrawals: 9 Completed study: 39 Intervention group (n=18); Control group (n=21)	Intervention: sit-stand desks Duration of intervention: 6 months Comparison: usual office practice Perspective of economic evaluation: not clear	Outcomes: primary outcome; occupational sitting and prolonged sitting bouts; secondary outcome: work engagement and occupational fatigue. Measurement intervals: baseline, 3 and 6 months Tools: activePAL3 for sitting time Participant activity logs; Utrecht work engagement scale (UWES-9); Need for recovery (NFR) survey	The low-cost standing desks were effective in reducing occupational sitting time: The costs associated with this intervention were modest, suggesting that similar reductions in sitting can be achieved with minimal expense, at least in the short term.	9/19
BMI, body mass index; CHEC, Consensus Health Economic Criteria; RCT, randomised controlled trial; WPAl:GH, Work Productivity and Activity Impairment Questionnaire—General Health V2.0.						

reported cost gains of EUR 263 per person per year.²⁶ In addition, both interventions yielded significant changes in the costs attributable to reductions in sitting time.^{2 26}

No study reported any significant changes in absenteeism in either the control or the intervention groups. The SMARt intervention²⁶ was the most expensive (EUR 761.64 per employee), followed by the DW intervention,²⁴ compared with another study (EUR 284 per worker).¹⁰ The least expensive intervention was delivered in the study conducted by Weatherson.²⁷

One study further performed long-term modelling for the intervention's cost-effectiveness and health outcomes if implemented by either private organisations or through public financing.² The incremental cost-effectiveness analysis for this intervention was expressed as cost per LY and HALY gain. The authors indicated that the intervention could contribute to the gain of 6243 (95% CI 5619 to 6867) LY with a gain of approximately EUR 21 526.9/LY. As for cost/HALY, the intervention would yield 7492 (95% CI 655 to 8428) HALYs and EUR 17 939.4/HALY would be gained if implemented over 5 years among the national population of 624318 desk-based workers in Australia.

Of the five interventions, evidence of financial return to employers driven by lower presenteeism costs due the intervention (the DW intervention) is presented in one study.²⁵ From the societal perspective, two interventions (eg, the SSD² and the DW)²⁴ are cost-effective.

DISCUSSION

Summary of main findings

This review specifically focused on the economic evaluation of workplace-based interventions aimed at reducing occupational sitting time among office-based workers. The identified interventions were more than physical activity strategies—for instance, they included work environment tools (eg, SSD,^{2 24–27} prompts)²⁴; supporting behaviour change (eg, face-to-face meetings between occupational physiotherapists and department managers); self-usage booklet.²⁴

Intervention elements and impact on sitting time

The findings of this review indicate that workplace-based interventions seem to reduce occupational sitting time and may induce substantial cost benefits compared with the usual practice. This is relevant to employers, employees and other stakeholders when selecting and allocating resources for the acquisition and instalment of interventions that reduce POST. The review indicates that five studies had conducted economic evaluations of workplace interventions from a monetary perspective. All interventions described across the studies were multicomponent, which could imply that various aspects, such as behavioural aspects, perpetuate sitting at workplaces.¹⁰ Thus, the interventions targeted not only interrupting long periods of sitting but also the psycho-element that instils prolonged sitting time. Workstations alone may

partly create significant benefits,²⁸ and counselling, teaching or education may further enhance the cost benefits. Thus, behavioural changes form an important element of interventions that aim to reduce PS time. The findings on the potential reduction in sitting time are consistent with those of other reviews.^{12 14}

Economic evaluations of workplace-based interventions

The costs related to the delivery of the interventions differed across the studies; this may be attributed to different reasons, such as different types of desks. Furthermore, other intervention components, although similar (eg, education), were implemented differently. This can also cause differences in the costs of the interventions. Some intervention costs were based on the actual facilitators²⁶ and participants' pay grades. Therefore, they may have fluctuated, depending on who facilitated the implementation and on the participants. The self-monitoring and prompting equipment also differ in costs. The costs of intervention delivery should be considered in future studies, comparing the difference in the costs of the materials used to develop and deliver the interventions. Moreover, the economic evaluations of interventions can be conducted using several approaches, but the cost-effectiveness analysis (usually cost per LY gained; QALY) is the most frequently used framework of economic evaluation.²⁹ The difference between the QALY gains in these studies may be due to the relatively healthy employee population involved.

The economic evaluation of costs generated by the interventions relative to costs per reduction in sitting time and health outcomes (eg, LY and HALY) favoured the interventions. Given the relatively high costs associated with none-communicable diseases and the production loss due to absenteeism, the strong evidence from this review reveals effective strategies (eg, the DW intervention) to reduce occupational sitting from a cost perspective.

The costs reflect lower economic benefits and higher intervention costs notwithstanding the difference in the nature of the interventions presented in similar workplace-placed health promotion interventional studies. For example, a yoga-based intervention in the workplace for prevention of musculoskeletal conditions³⁰ appeared to have cost-effectiveness of 95% and yielded a substantial cost-effectiveness ratio of Great Britain Pound (GBP) 2 103/QALY. Conversely, an eHealth module containing guidance on returning to work after a sick leave³¹ showed relatively more economic benefits compared with the studies included in the present review, with the incremental net benefits of EUR 3187 per employee over a single year, representing a return of investment of EUR 11 per invested Euro. These findings indicate that interventions targeting alleviation of PS time are relatively more complex and require more investments compared with other health promotion interventions at workplaces.

A study provided further long-term modelling for the interventions' cost-effectiveness and health outcomes for the entire cohort lifetime and for the population of



office-based workers across the country.² This finding provides a unique estimation that can be used to guide policymakers and organisations when estimating the desired total return on investment associated with changes in the LY and HALY gains. However, despite the elaborate sensitivity analysis, evidence from a single study is insufficient to apply in other settings that might differ in terms of population characteristics. The findings of this review are prone to limitations, such as the inclusion of only a few studies. This implies that most studies do not address assessments of the cost-effectiveness of workplace interventions to reduce POST. It may also imply that workplace interventions are still in the development and testing phase. Thus, the challenge for future studies is to broaden the scope and application of interventions addressing sedentary behaviour in different environments, such as workplaces. Furthermore, the non-blinded approach to the assessment of end points assessed in both included studies induced bias in the outcome assessment. Blinded outcome assessment is not feasible in trials evaluating the costs related to interventions at workplaces. It should be emphasised that the use of objective outcome measures is not a replacement for robust blinding in clinical trials. In addition, the non-blinded interventions described in both studies are prone to the Hawthorne effect and the placebo effect. The studies included in the review lacked a description of how the Hawthorne effect was minimised, which can reduce the applicability of the interventions in routine office environments. Controlling for the psychological stimulus (eg, extra attention by researchers and higher levels of surveillance) of office-based workers' awareness of sitting time created by workplace interventions remains a challenge for future studies.

Assessment of the efficacy of interventions should also consider their cost-effectiveness at workplaces. More studies, including economic evaluations of workplace interventions aimed at PS time, are needed. The findings included in this review were generated from well-conducted randomised controlled trials. This relates to the identified limitations of the reviews,^{32 33} according to which the evidence from workplace-delivered interventions is generated from studies that recruit small sample sized, non-randomised designs with short follow-ups. Both studies included in our meta-analysis had a follow-up time of 12 months. Moreover, the studies fulfilled at least 80% of the applicable signalling items in the CHEC appraisal tool.

Strengths and limitations

A key strength of the review is that it integrated both qualitative and quantitative results on economic evaluations of interventions. This may be crucial to understand, as future interventions may impact reducing sedentary behaviour and the cost of work-related musculoskeletal disorders from, for example, organisational or societal perspective. This review is comprehensive because it considered a wide range of data sources for economic evaluation of intervention and three types of economic

evaluations: cost-effectiveness, cost-utility and cost-benefit analysis in studies. Furthermore, the use of the CHEC tool for appraising the evidence was presented in the review.

The review's main limitation is the lack of sufficient evidence of economic evaluations of workplace interventions—this precludes strong conclusions. Future studies should consider robust presentation of cost-effectiveness or cost-benefit analyses. The review is also liable to language bias—articles published in English language were included in our review.

Conclusions

The economic evaluations of different workplace interventions are considered in the present review. Based on the results, existing workplace interventions aimed at reducing sitting time are multicomponent in nature. These include various elements such as height-adjustable workstations, prompts and behaviour change strategies. The interventions seem to reduce sitting time and create beneficial cost reductions through less occupational sitting time among office-based workers. However, as the data available so far are limited precludes strong conclusions. Thus, it is of interest to investigate the cost-effectiveness or other forms of economic evaluation of workplace interventions. This is needed to continue building a stronger economic case for organisations to focus on reducing sitting time at workplaces.

Contributors SAR, FK, RK and PT were responsible for the study design and intellectual content; they read and approved the final manuscript. SAR was responsible for the conception and data collection. SAK and FK conducted the methodological appraisal of the included studies. PT and RK conducted the overall supervision.

Funding SAR is supported with funding from Finnish National Agency for Education with an EDUFI fellowship grant and University of Helsinki. FK receives support from the Department of Nursing Science, University of Eastern Finland, Kuopio, the North Savo Regional Fund for his Doctoral research, and the Kuopio University Foundation.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data sharing not applicable as no datasets generated and/or analysed for this study.

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