Reducing prolonged sitting in the workplace

An evidence review: full report

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Executive summary

Background: workplace sitting

Sedentary behaviours involve sitting or reclining, resulting in little or no physical activity energy expenditure. In this report, the term 'sitting' should be interpreted as the broader 'time spent in sedentary behaviour'. New research findings show time spent sitting is associated with being overweight or obese, unhealthy blood-glucose and blood-lipid profiles and with premature death from heart disease. Adverse relationships have been observed even among those who meet public health recommendations on participation in moderate-to-vigorous physical activity.

The workplace has been identified as a key setting in which to measure and implement changes to reduce workplace sitting. Australians spend most of their adult life in the workplace. For many Australian workers, workplace sitting is ubiquitous in their occupational environment. In particular, the number of work tasks focused around sitting at a computer has increased markedly over the past few decades. The increase in time spent in front of the computer and the availability of email has meant that many of those previous office-based tasks that involved intermittent standing and some physical activity, such as filing or walking over to see a colleague, are no longer required.

To date, the majority of evidence pertaining to the health impact of prolonged workplace sitting comes from the ergonomic literature. Specifically, the focus has been on musculoskeletal disorders, where a part of the musculoskeletal system is injured over time through repetitive overuse. Jobs that require constrained sitting or standing postures are associated with an elevated incidence of musculoskeletal disorders, with estimates of the prevalence of musculoskeletal symptoms in computer users as high as 50 per cent. There is limited evidence on the relationship of workplace sedentary time with other health outcomes (such as cardio-metabolic health and mental health). Similarly, the proliferation of email and the routine use of internal telephone systems have reduced the amount of time that workers have face-to-face contact with each other; the impact of such changes on social wellbeing outcomes has not been investigated.

Currently, there is no strong evidence available on the direct influence of workplace sitting on economic outcomes such as productivity, absenteeism and presenteeism. However, with the emerging evidence linking workplace sitting to adverse health profiles, it has been postulated that prolonged sitting at work may contribute indirectly to detrimental economic outcomes, through increasing the risk of developing chronic diseases (such as type 2 diabetes, cardiovascular disease) and other long-term health conditions (such as musculoskeletal disorders) amongst workers.

There is now increased recognition that these chronic conditions are related to lower labour-force participation among some groups in Australia. While the evidence to date has stimulated new thinking on the potential contribution of workplace sitting to adverse health outcomes and reduced productivity among Australian workers, considerable gaps exist in the evidence base relating to the specific influence of workplace sitting on economic outcomes. Direct evidence from intervention trials conducted in the workplace to examine the impact of reductions in prolonged sitting time and the impact on economic markers is warranted.

Key target groups for workplace sitting reduction initiatives

Compared to other sectors, office workers are one of the most sedentary occupational groups. Office workers are also one of the largest single occupational groups, with more than 12 per cent of all Australian workers employed in offices. Office workers, for whom prolonged occupational sitting time is ubiquitous, provide an excellent starting point from which to address the broader problems of workplace sitting.

Alongside office workers, those working in the transportation industry (such as taxi drivers, truck drivers, bus drivers, aeroplane pilots) and highly mechanised trades (such as crane operators, bulldozer operators) are also at risk of exposure to prolonged sedentary time. However, unlike office workers, there is potentially less opportunity for intervening on sedentary time in these sectors.

Objectives of review

The rising prevalence of risk factors for chronic diseases is expected to have significant effects on the potential productive capacity of the future Australian workforce. Much of the rise in the prevalence of chronic disease in the past decades has been attributed to changes in behavioural risk factors: in particular, physical inactivity, poor nutrition and, most recently identified, workplace sitting. The potential economic and health impact of beneficial changes in these risk factors and the importance of the workplace as a setting in which to deliver the relevant programs and other innovations were highlighted in the 2009 National Preventative Health Taskforce report. This included a specific recommendation to 'fund, implement and promote comprehensive programs for workplaces to support healthy eating, promote physical activity and reduce sedentary behaviour' (Action 3.2).

With this background, the particular objective for our evidence-based review for VicHealth is to identify best-practice workplace intervention strategies that reduce workplace sitting at organisational and systems levels. This report describes the findings of a review of the relevant evidence and presents case studies from Australian and international organisations.

Main findings

Overall, based on the as yet limited available findings and case studies, the evidence from this review supports the use of strategies to reduce prolonged workplace sitting, particularly in relation to reduced incidence and/or severity of musculoskeletal symptoms (the most commonly measured outcome). Workplace sitting reduction strategies have typically had a beneficial or neutral impact on productivity, absenteeism and injury costs, where the relevant evidence could be identified. No studies suggested likely harm from sensibly-implemented breaks from, or reductions in, workplace sitting time.

The studies were grouped under five categories: four of which were distinct strategies and one that used a combination of strategies.

(1) increasing the number of breaks from sitting time
(2) implementing strategies around postural change
(3) focusing on ergonomic changes to the individual workspace
(4) altering the built design of the broader workplace
(5) using multiple strategies (combinations of the strategies outlined above).

The majority of studies utilised the first two strategies: increasing the number of breaks and implementing strategies around postural change. These two strategies are also those most formally acknowledged in Occupational Health and Safety (OHS) guidelines.

There were several limitations within the existing literature that need to be taken into consideration when interpreting the findings. These include:

- The quality of the studies was mixed, ranging from field studies to controlled-experimental studies.
- All studies approached the research question from an OHS and ergonomics perspective. As such, there was no measurement of the cardiovascular or metabolic health biomarkers that are known to be precursors of major chronic diseases.
- Reliable and valid measures of sedentary time generally were not used. Accordingly, it is not possible to draw strong conclusions about the actual outcomes.

- Social-related impacts of reducing workplace sitting time (such as acceptability, employee interactions and perceived privacy) usually were not reported.
- All eligible studies were conducted with populations that could broadly be defined as office workers (including data entry operators, computer workers and bank tellers). To ensure that studies from other high-risk occupational sectors (such as drivers) were not missed, an additional search was conducted using more specific search terms (for example, blue collar worker sedentary, factory sedentary, truck driver reduce sitting). No further studies that met the eligibility criteria were found, despite the high prevalence of workplace sitting in these groups.

As a cautionary note it is important to acknowledge that that the review was not conducted as a traditional systematic review. Due to the short timeframe of the project and the area of research (where much of the evidence exists within the grey literature), it is possible that relevant articles may have been inadvertently missed. Given the emerging interest in this field of research, it is anticipated that the evidence base for occupational workplace sitting research will become considerably stronger in the next few years.

Considering all the relevant evidence and case study experience, this review recommends that high quality studies (ideally cluster-randomised controlled trials, which are feasible across multiple workplace settings) be conducted in workplaces that incorporate organisational, systems and individual change elements. Such studies should assess multiple health, economic and social outcomes and use validated measurement methods (and ideally the objective measurement techniques that are now available).

1. Scope and aims of the review

Scope

The focus of this review is identifying evidence from the Australian and international literature that could suggest initiatives with the potential to impact on reducing workplace sitting (prolonged, unbroken sitting time).

Specifically, the aim of this review is to identify best-practice workplace strategies that can have a positive influence at organisational and systems levels. International and Australian case studies are included to highlight examples of real-world applications.

Aims

- Describe the scope and nature of workplace sitting.
- Describe the impacts (health, social and economic) of workplace sitting.
- Describe the benefits (social and economic) to the workplace of addressing workplace sitting.
- Identify specific population groups who are most at risk of engaging in workplace sitting.
- Identify and document best-practice workplace interventions and strategies to reduce workplace sitting at organisational and systems levels.

2. Scope and nature of workplace sitting

Prolonged workplace sitting is an independent risk factor for poor health and early death

Regular participation in moderate-to-vigorous intensity physical activity (e.g. brisk walking, jogging, lap swimming – typically referred to as 'exercise') is one of the cornerstones of chronic disease prevention and management. In addition to the physical and psychological benefits, there is considerable evidence that regular exercise reduces the risk of the most common major chronic diseases – type 2 diabetes, cardiovascular disease and breast and colon cancer (Haskell, Lee et al. 2007).

As a consequence of this approach to health promotion through increasing voluntary exercise, public health campaigns and recommendations have typically focused on moderate-to-vigorous intensity physical activity, with current recommendations supporting the accumulation of at least 30 minutes of moderate-to-vigorous activity on at least five days of the week (Haskell, Lee et al. 2007).

However, even if the current physical activity and health guidelines are met, they constitute only a small proportion of waking hours. The reminder of the day is spent in either light-intensity activities (such as gentle walking or standing; see Glossary of terms) or sedentary.

Sedentary behaviours involve sitting or reclining, resulting in little or no energy expenditure (Ainsworth, Haskell et al. 2000). Common sedentary behaviours include sitting or reclining while watching television, driving a car, or sitting in the workplace. Collectively, time spent in these behaviours is referred to as sedentary behaviour time or simply, sedentary time. Sedentary time can be measured across the whole day (total time) or as time spent across specific domains: work, leisure, domestic and transport. Sedentary time is typically estimated by self-report questionnaires (non-objective), though more recently, objective measures of sedentary time such as accelerometers and inclinometers are being utilised (see Glossary of terms). In this report, the term 'sitting' should be interpreted as the broader 'time spent in sedentary behaviour'.

Time spent sitting has been shown to be associated with premature all-cause and cardiovascular disease mortality and elevated biomarkers of cardio-metabolic risk, including waist circumference, serum triglycerides, blood glucose, insulin and systolic blood pressure (Dunstan, Salmon et al. 2004; Dunstan, Salmon et al. 2005; Dunstan, Salmon et al. 2007; Healy, Dunstan et al. 2008b; Dunstan, Barr et al. 2010; Thorp, Healy et al. 2010; Patel, Bernstein et al. 2010). For example, each one hour per day increase in television viewing time was associated with an 11 per cent increase in all-cause mortality and an 18 per cent increase in cardiovascular disease mortality (Dunstan, Barr et al. 2010).

All of these deleterious health consequences and relationships with risk biomarkers have been shown to be independent of (i.e. not influenced by) moderate-to-vigorous physical activity levels and deleterious associations have been observed even in those meeting, or exceeding, the Australian National Physical Activity Guidelines (Dunstan, Salmon et al. 2005; Healy, Dunstan et al. 2008b). These findings highlight that time spent sitting and time spent in exercise need to be considered as distinct health behaviours, with both needing to be addressed in their own right (Owen, Healy et al. 2010).

Recent studies with Australian (Australian Diabetes, Obesity and Lifestyle Study; AusDiab) and US (National Health and Nutrition Examination Survey; NHANES) populations have confirmed earlier self-report findings by using objective measures (accelerometers). These studies have not only shown that total objectively derived sitting time is detrimentally associated with a number of cardio-metabolic biomarkers (waist circumference, glucose, triglycerides, insulin) (Healy, Dunstan et al. 2007; Healy, Wijndaele et al. 2008; Healy, Matthews et al. 2011) but also that the manner of sitting time accumulation may be important (Healy, Dunstan et al. 2008a; Healy, Matthews et al. 2011). Specifically, breaks in sitting time (such as standing up from a seated position) have been shown to be beneficially associated with several of the above-mentioned biomarkers of cardio-metabolic health, independent of total sitting time and exercise levels (Healy, Dunstan et al. 2008a; Healy, Matthews et al. 2011).

Although the majority of evidence in relation to the health impacts of sitting has examined cardio-metabolic outcomes, time spent in some specific sitting behaviours (i.e. television viewing time and/or computer use) has also been adversely linked to depression (Teychenne, Ball et al. 2010) and a higher risk of being in poor mental health (physician diagnosis of depression, anxiety or stress and/or the use of antidepressant medication or tranquilizers) (Sanchez-Villegas, Ara et al. 2008).

Sitting and health: A unique underlying biology?

In terms of energy expenditure, there is a relatively small differential between sitting and static standing (Beers, Roemmich et al. 2008). However, while energy expenditure is important for preventing weight gain, it is proposed that sitting may impart other deleterious health-related consequences. During standing, postural muscles (predominately those of the lower limbs) are continually contracting in order to keep the body upright and prevent loss of balance. Frequent contractions in these large muscle groups are largely absent while sedentary. This leads to changes in two key physiological responses that can promote poor metabolic health. First, skeletal muscle lipoprotein lipase (LPL) production is suppressed. The LPL enzyme is necessary for breaking down blood fats (triglycerides) in the body. Suppression of LPL induced through the sedentary state can lead to elevated blood fat levels.

Second, the breaking down and use of glucose (blood sugar) is reduced, thereby contributing to elevations within the blood. The decline in LPL activity observed with being sedentary does not appear to exist when incidental, light-intensity activity (including standing) is introduced (Hamilton, Hamilton et al. 2007). The chronic, long-term effects of being sedentary on LPL activity and the extent to which this may be counteracted by regular bouts of incidental activity is unknown. While these findings showing rapid changes in some of the body's regulatory processes have largely come from animal studies, they do provide a compelling body of evidence that 'chronic muscular unloading' (i.e. absence of muscle contraction), such as occurs with prolonged periods of time spent sedentary, is highly likely to have deleterious health consequences. Extensive experimental research is presently being undertaken at Baker IDI in Melbourne and in the USA, in order to better understand such adverse physiological consequences of prolonged sedentary time in humans.

The level of scientific and popular interest in this newly identified phenomenon has escalated over the past two to three years. Already, risk reduction approaches are being advocated in relation to sitting at work that often are not grounded in the realities of what is desirable or feasible in this context. Thus, while they are highly-plausible hypotheses about underlying mechanisms and evidenced from population-based epidemiological studies, there is an urgent need to make sense of what is known about workplace sitting, with reference to these new perspectives.

The majority of adult life is spent at the workplace

Australians spend most of their adult life in the workplace. They are also working some of the longest hours in the developed world with men in full-time employment working an average of 45.9 hours per week (Baxter & Gray 2008). For many Australian workers, sitting is ubiquitous in their occupational environment. In particular, the number of work tasks focused around sitting at a computer has increased markedly over the past few decades. For example, in Australia, the proportion of businesses with internet access rose from 29 per cent in 1994 to 90 per cent in 2008–2009 (ABS 2000; ABS 2010). In 2009, 97–98 per cent of small to medium businesses owned a computer, with 95 per cent having internet connectivity (Sensis 2009).

The increase in time spent in front of the computer and the availability of email has meant that many of those previous office-based tasks that involved intermittent standing and some physical activity, such as filing or walking over to see a colleague, are no longer required. Despite the absence of empirical data, there is strong speculation that sedentary time at work has risen in recent decades, largely due to the widespread availability of computers and labour-saving devices.

However, it appears that the suspected rise in workplace sedentary time has not been compensated for by increased physical activity outside of work, as evidenced by relatively unchanged or even declining, prevalence levels of Australian adults meeting the physical activity guidelines (Bauman, Armstrong et al. 2003; Bauman, Allman-Farinelli et al. 2008). In contrast, television viewing time and car ownership has increased markedly (Brownson, Boehmer et al. 2005).

3. The impacts of workplace sitting

Posture at work has long been recognised as a potential occupational hazard (Franco 1999). Current OHS guidelines and ergonomists recommend adopting a variety of postures throughout the day including both sitting and standing (National Occupational Health and Safety Commission 1996). Specifically, the 2006 Victorian WorkSafe publication *Officewise: A Guide to Health and Safety in the Office* (Worksafe Victoria 2006) advocates the importance of breaks (with a recommendation to break every 20–30 minutes), task variety (with variety in both the type of work and the mental and postural demands of the work) and work pauses with frequent short pauses preferable to infrequent longer pauses. While there are ACTU guidelines relating to breaks from time spent in front of a computer, to our knowledge, there is currently no requirement under Victorian OHS legislation to provide specific breaks to computer/VDU users.

To date, the majority of evidence pertaining to the health impact of prolonged workplace sedentary time comes from the ergonomic literature. Specifically, the focus has been on musculoskeletal disorders, where a part of the musculoskeletal system is injured over time through repetitive overuse. Musculoskeletal disorders are costly (an average of $7,400 per case) (Straker 1998); not uncommon in the workplace (44 per cent of compensation cases) (Straker 1998); account for a significant proportion of workplace sick leave (15–22 per cent across industry in general) (Cakir 1988); and have an adverse impact on employee morale, productivity and wellbeing (Roelofs & Straker 2002).

Jobs that require constrained sitting or standing postures are associated with an elevated incidence of musculoskeletal disorders, with estimates of the prevalence of musculoskeletal symptoms in computer users as high as 50 per cent (Westgaard & Winkel 1996; Gerr, Marcus et al. 2002). Prolonged computer time without breaks is also associated with an increased prevalence of eye strain (Balci & Aghazadeh 2004).

The potential importance of prolonged workplace sedentary time on cardio-metabolic health outcomes has been the topic of a recent systematic review. In that review, the evidence regarding the associations of occupational sitting with the health outcomes of body mass index (BMI), cancer, cardiovascular disease (CVD), diabetes mellitus and premature mortality was examined (van Uffelen, Wong et al. in press, accepted 30 May 2010). In the review 43 studies were included, of which the majority (65 per cent) were prospective in nature. Occupational sitting was associated with a higher risk of diabetes mellitus and premature mortality. The associations for BMI and cancer, however, have been equivocal. The authors of the review concluded that there was limited evidence to support a detrimental relationship of occupational sitting with health risk and that the wide variety in the study designs, measures and findings made it difficult to draw definitive conclusions (van Uffelen, Wong et al. in press, accepted 30 May 2010).

Evidence on the impact of prolonged workplace sitting on workplace mental wellbeing issues, including perceived job stress, depression and fatigue is relatively limited. In a cross-sectional study of 6,995 white collar workers, prevalence of sitting most of the time and not needing to walk much was not associated with decision latitude or psychological demands in either men or women (Brisson, Larocque et al. 2000).

In a case-control study, a sedentary work situation was associated with higher burnout score in women, but no such associations were found for men (Stenlund, Ahlgren et al. 2007). While the proliferation of email and the routine use of internal telephone systems have probably reduced the amount of time that workers have in face-to-face contact with each other, the impact of such changes on social wellbeing outcomes has not been investigated.

Potential economic impact

Currently, there is no strong evidence available on the direct influence of workplace sitting on productivity, absenteeism (an employee's time away from work due to illness) and 'presenteeism' (typically decreased on-the-job performance due to physical or mental health conditions). However, with the emerging evidence linking prolonged sitting to adverse health profiles, it is possible to speculate that prolonged periods of time spent sitting at work could contribute indirectly to detrimental economic outcomes, through increasing the risk of developing chronic diseases amongst workers.

Potentially preventable chronic diseases like type 2 diabetes and cardiovascular disease, in addition to other long-term health conditions, such as musculoskeletal disorders, contribute substantially to the health expenditure in Australia (estimated to be >$11 billion) (AIHW 2005).

There is now increased recognition that these chronic conditions are related to lower labour-force participation among some groups in Australia. A recent report by the Australian Institute of Health and Welfare has highlighted the important relationship that exists between the presence of chronic disease in the workforce and lost productivity, with the overall loss to the workforce associated with chronic diseases estimated to be approximately half a million person-years (AIHW 2009).

Additionally, prolonged periods of time spent sitting in the workplace may also be an important contributor to one of the greatest public health challenges confronting Australia and many other industrialised countries – what is now described in some quarters as 'the obesity epidemic'. It is estimated that approximately five million Australian workers are overweight, with 1.3 million of these obese (National Preventative Health Taskforce 2009). According to the *Burden of Disease and Injury in Australia* study, in 2003, being overweight or obese was responsible for 7.5 per cent of the total burden of disease and injury, ranked second behind only tobacco and high blood pressure (Begg, Vos et al. 2007). Furthermore, it is estimated that overweight and obesity were associated with over four million days lost from Australian workplaces in 2001 (National Preventative Health Taskforce 2009). The total direct financial cost of overweight and obesity for the Australian community was estimated to be $8.3 billion in 2008 (Access Economics 2006). Importantly, of these costs, $3.6 billion (44 per cent) has been attributed to costs associated with lost productivity in the workforce (Access Economics 2006).

While the evidence to date has stimulated new thinking on the potential contribution of workplace sitting to adverse health outcomes and reduced productivity among Australian workers, it is recognised that there are considerable gaps in the evidence base relating to the specific influence of workplace sitting on economic outcomes. Direct evidence from intervention trials conducted in the workplace to examine the impact of reductions in prolonged sitting time and the impact on economic markers is warranted.

4. The benefits of reducing workplace sitting

The rising prevalence of risk factors for chronic diseases (particularly overweight and obesity) is expected to have significant effects on the potential productive capacity of the future Australian workforce (Schofield, Shrestha et al. 2008; AIHW 2009). Much of the rise in the prevalence of chronic disease in the past decades has been attributed to changes in behavioural risk factors: in particular, physical inactivity, poor nutrition and, as recently identified, time spent sitting (AIHW 2009; Hamilton, Healy et al. 2008; Dunstan, Barr et al. 2010).

The potential economic and health impact of beneficial changes in these risk factors and the importance of the workplace as a setting in which to deliver relevant programs and other innovations was highlighted in the 2009 National Preventative Health Taskforce report. This included a specific recommendation to 'fund, implement and promote comprehensive programs for workplaces to support healthy eating, promote physical activity and reduce sedentary behaviour' (Action 3.2) (National Preventative Health Taskforce 2009). To our knowledge, no studies have assessed the impact of reducing prolonged workplace sitting on economic and social outcomes.

A recent systematic review from Sydney University on the effectiveness of workplace interventions for reducing sitting time revealed a dearth of relevant evidence (Chau et al. in press, accepted 20 August 2010). In that review, workplace intervention studies (up to April 2009) were included if they increased energy expenditure (either through increased physical activity or decreased sitting time); were conducted in a workplace setting and specifically measured sitting as a primary or secondary outcome.

It is noteworthy that, of the six studies that were included in the Sydney University review, all had the primary intention of increasing physical activity (that is, they did not focus specifically on reducing sitting time). All used self-report measures of sitting time and notably, only one specifically measured occupational sitting time. Not surprisingly, none of the studies identified by the Sydney University review showed that sitting decreased significantly in the intervention group compared to the control or comparison group. Given the methodological constraints of the included studies, further research is required to address this research question.

With this background, the particular objective for our evidence-based review for VicHealth is to identify best-practice workplace intervention strategies that aim to reduce workplace sitting at organisational and systems levels. As such, this review differs significantly from the Sydney University review described above, whose primary focus was randomised control trials of interventions to reduce sedentary time at the individual level (Chau et al. in press, accepted 20 August 2010). The methods and results from our review focus on initiatives at the organisational and systems levels and are explained later.

5. Population groups most at risk

Office workers are a key target group for workplace sitting reduction initiatives

Compared to other sectors, office workers are one of the most sedentary occupational groups. Overall, it is estimated that the average office worker spends about 80,000 hours seated in the course of their working life (German Federal Institute for Occupational Safety and Health 2008). In the Netherlands, those working in computerised offices reported sitting for four times longer than those from the catering sector (Jans, Proper et al. 2007). Similarly, office workers in New Zealand walked about half as many steps (5,400 steps) compared to blue collar workers (10,300 steps) (Schofield, Badlands et al. 2005). In the recent *Stand Up Australia* studies undertaken by Baker IDI and The University of Queensland using accelerometers in a sample of office-based employees, it was found that on work days, an average 75 per cent (SD 7.3 per cent) of work hours was spent in sedentary time, significantly more than during non-work time (61 per cent, SD 7.5 per cent, $p<0.001$). The *Stand Up Australia* office-based participants also took fewer breaks in sedentary time during work hours (7.9 breaks per sedentary hour, SD 3.5) compared to non-work hours (10.3, SD 3.4, $p<0.001$).

Office workers are also one of the largest single occupational groups, with more than 12 per cent of all Australian workers employed in offices (Wood 2010). This suggests that there are at least 324,000 office workers in Victoria (of the 2.7 million in the Victorian workforce) (Australian Government: DEEWR 2010). This figure is likely to be far higher if all workplaces in which some computer time is required are considered. The high risk of exposure to sedentary time in office-based settings, along with office-based settings being a high proportion of the total workforce, means that office workers are a key target group for workplace sitting reduction initiatives.

Sedentary time in other occupational sectors

Alongside office workers, those working in transportation (such as taxi drivers, truck drivers, bus drivers, aeroplane pilots) and highly mechanised trades (such as crane operators, bulldozer operators, single driver garbage collectors) are also at risk of exposure to prolonged sedentary time. In the Netherlands those from the transportation industry reported sitting at work an average of 177 minutes per day compared to 207 minutes per day for those in computerisation and 81 minutes per day for those in health care (Jans, Proper et al. 2007).

Other sectors where there is high risk of exposure to sedentary time include sewing machine operators, where the prevalence of musculoskeletal disorders has been reported to be 75 per cent (Blader et al. 1991).

6. Best practice workplace interventions and strategies at organisational and systems levels

Methods

Search strategy

A preliminary search strategy was conducted using the search terms listed in the Appendix. Given the extensive amount of articles identified (72,859 for any term; 2,135 if a term required was in a title) from a single database and because any potential grey literature was of particular interest, the authors approached this literature search using a broader strategy than would typically be employed in a systematic review of peer-reviewed research studies. Specifically, in June 2010, an extensive search was conducted using the online search engine Google. Search terms used were: *sedentary, workplace sitting, healthy workplace, healthy workplace program, reduce workplace sitting, height adjustable desk, sit/stand desk, stand at work, treadmill at work, standing workstation, workplace with standing workstation.*

Websites, organisational reports and policies, authors and research groups of potential relevance identified by the search were subsequently pursued through the internet and tracked down in scientific databases such as Web of Science and PubMed if available.

Articles and reports were retained and reviewed based on their broad relevance to workplace sitting interventions. Articles were restricted to those of English language. Searches were followed by a review of abstracts, the collection of relevant full-text articles and a scan of the reference sections of included articles. Furthermore, as the relevant scientific papers mostly appeared in three peer-reviewed journals (*Journal of Applied Ergonomics*, *Applied Ergonomics* and *Ergonomics),* the archives of these journals were searched online for further reports relevant to the review topic. The search strategy was limited to online searching – approaches such as key informant interviews were not conducted due to the timeframe of the report.

Study inclusion criteria

Studies were included if they were field studies, quasi-experimental or experimental investigations conducted in the workplace with employees and involved either direct or indirect attempts to change workplace sitting. In order to meet our inclusion criteria, studies were also required to have assessed outcomes relating to workplace sitting, psychosocial or physical health-related variables, or social or economic variables.

Categories of studies

The studies were grouped under five categories: four of which were distinct strategies and one that used a combination of strategies. These categories were:

(1) increasing the number of breaks from sitting time
(2) implementing strategies around postural change
(3) focusing on ergonomic changes to the individual workspace
(4) altering the built design of the broader workplace
(5) using multiple strategies (combinations of the strategies outlined above).

The findings of the studies were grouped by these broad characteristics and components of the interventions and strategies, the specific outcomes for participants and the social and/or economic cost/benefit of the intervention.

Case studies

Case studies were included in the review to provide real world examples of how the five intervention strategies targeting reductions in workplace sitting had been applied in an Australian and international context. These case studies emphasise the feasibility and acceptability of initiatives to reduce sitting at work, both for organisations and for employees.

Results

Overview of all studies reviewed

The search produced 34 articles/papers/reports/book chapters of interest, which were independently assessed by two researchers. Overall, 14 articles, describing 11 distinct studies that met the search criteria were included in the review (see Table 1). Four addressed an increase in the number of breaks in sedentary time, three implemented strategies around postural change, four implemented ergonomic changes to the individual workstation, one made changes to the built design of the broader workplace (this study also made ergonomic changes to the individual workstation) and three had multiple strategies that incorporated breaks in sedentary time, postural change and ergonomic changes (these three publications were from one study).

Included in the review were studies with experimental designs (n=9) and field studies (n=5). Study participants were data-entry operators (three studies), computer workers (seven studies), bank tellers (one study), or were generically defined as office workers (three studies). Sample sizes ranged from six to

92. The majority of participants were women, with the proportion of men in the studies ranging from zero to 56 per cent (proportion not reported in two studies). The mean age ranged from 25 to 44 years.

Excluded were those studies conducted within a laboratory setting (n=5) (Henning, Kissel et al. 1994; Kopardekar & Mital 1994; Pitman & Ntuen 1996; Hasegawa, Inoue et al. 2001; Husemann, Von Mach et al. 2009), those with an ineligible study design (n=4) (Lee, Swanson et al. 1992; Hägg 2003; Dohrmann 2008; Straker & Mathiassen 2009), case studies (n=1) (Thompson 1991), interviews (n=1) (Wilks, Mortimer et al. 2006), those whose intervention would not necessarily directly impact on sitting time (n=3) (Beynon & Reilly 2001; Smith & Bayeh 2003; van den Heuvel, de Looze et al. 2003) and those conducted with students (n=5) (Helander & Quance 1990; Henning, Kissel et al. 1994; Kopardekar & Mital 1994; Balci & Aghazadeh 2004; Husemann, Von Mach et al. 2009).

With the exception of those conducted with students and a single study conducted in a sample of nurses (excluded as sitting time was not the intervention target) (Beynon & Reilly 2001), all other studies (both included and excluded) were conducted with a group that could broadly be defined as office workers (though this search term was not explicitly stated).

Table 1: Organisational and systems level interventions to reduce workplace sedentary time

Author **Year**	**Study type:** **Sample size** **% Attrition** **% Male** **Age**	**Intervention**	**Intervention components**	**Outcome assessed**	**Results:** **Sedentary** **Health** **Social/economic**
1. INCREASING THE NUMBER OF BREAKS					
(Galinsky, Swanson et al. 2000)	Experimental 42 data-entry operators 58% attrition 26% male Mean age 30 years	Comparing two rest break schedules: conventional (2 x 15 min rest breaks per day) and supplementary (2 x 15 min breaks and a 5 min break for each hour which did not already contain a break, totalling 20 minutes extra of break time). Intervention was 16 weeks divided into 4-week phases.	Encouraged to take a short walk away from their workstations during break. Given small electrical timers to remind when to take a break and a copy of their rest-break schedule.	Breaks, musculoskeletal discomfort, eyestrain, productivity	Supplementary breaks group reported ↑ number of breaks compared to conventional group. ↓ discomfort in right forearm, wrist, hand and ↓ eyestrain under supplementary breaks than conventional breaks. No differences for productivity and accuracy.
(Galinsky, Swanson et al. 2007)	Experimental 51 data-entry operators 43% attrition 8% male Mean age 36 years	All workers spent 4 weeks with conventional breaks (2 x 15 min breaks per day) and 4 weeks with supplementary breaks (2 x 15 min breaks and a 5 min break for each hour which did not already contain a break, totalling 20 minutes extra of break time). Then randomly assigned to a stretching group or a 'no stretching' (control) group.	Stretching involved standing for about 2 min (9 exercises, of which the last 3 required standing; or walking).	Musculoskeletal discomfort, eye soreness and visual blurring, headache, cheerfulness, energy, tension and fatigue; break activities questionnaire (compliance); data entry performance	Low compliance with stretching ↓ Discomfort and eye strain with supplementary breaks ↑ Data-entry speed with supplementary breaks. No significant effects of stretching on discomfort or performance.

Author Year	**Study type: Sample size % Attrition % Male Age**	**Intervention**	**Intervention components**	**Outcome assessed**	**Results: Sedentary Health Social/economic**
(Henning, Jacques et al. 1997)	Experimental 92 computer workers (2 work sites n=73, n=19) % attrition differs depending onsite and outcome 13% Male Mean age 25 years	All workers received conventional breaks (30 minutes for lunch, 15-min morning and afternoon breaks). Experimental group also received four breaks each hour (i.e. one every 15 min). Three of these breaks were 30s in length and the fourth break was 3 min in length. Some operators were asked to perform stretching exercises during the breaks. Intervention 4 weeks at large worksite and 3 weeks at smaller worksite	Lights were mounted on the screen to signal operators when to take short breaks.	Mood; musculoskeletal discomfort; productivity	Operators complied with about half of the added breaks and favoured 3 min breaks over 30s breaks. No intervention effect on musculoskeletal discomfort, mood or productivity at the larger work site. Smaller work site, productivity, eye, leg and foot comfort all improved when the short breaks included stretching exercises.
(McLean, Tingley et al. 2001)	Experimental 15 computer workers Attrition not reported 0% Male Median age 34 years	Three experimental groups: microbreaks at their own discretion (control), microbreaks at 20 min intervals and microbreaks at 40 min intervals. Participants took part in the study over a 4-week period. First two weeks No Break protocol and second 2-weeks each subject performed their assigned microbreak protocol.	Ergobreak software installed. Participants were prompted to get out of their chair during each microbreak.	Objective and perceived musculoskeletal discomfort, productivity	Microbreaks had a positive effect on reducing discomfort in all musculoskeletal areas studied during computer terminal work, particularly when breaks were taken at 20 min intervals. Microbreaks showed no evidence of a detrimental effect on worker productivity.

Author **Year**	**Study type:** **Sample size** **% Attrition** **% Male** **Age**	**Intervention**	**Outcome assessed**	**Results:** **Sedentary** **Health** **Social/economic**
2. STRATEGIES AROUND POSTURAL CHANGES				
(Paul 1995b)*	Field Study 6 VDT operators No attrition 16% male Mean age 39 years	Participants first worked in offices with nonadjustable sitting workstations, then in offices furnished with sit-stand adjustable furniture for six weeks, where they stood for 15 minutes every hour. In both settings, the foot swelling was measured four times over the day. Between 12 and 1pm, subjects walked for 20 minutes and sat for 40 minutes.	Foot swelling measured by a foot volumeter	Results showed the average right foot swelling in offices with sit-stand adjustable furniture was significantly less than that in offices with nonadjustable furniture, 12.3 ml (1.1%) compared to 21 ml (1.8%).
(Paul & Helander, 1995)	Field Study 13 office employees, ten healthy and three with spinal disorders No data for attrition, % male or age.	Schedules for standing and sitting assessed. From 12pm to 1pm all subjects sat for 40 minutes and walked for 20 minutes. Out of the ten healthy employees, six were instructed to stand for 30 minutes four times during the day. The remaining four subjects stood eight times 15 minutes each. No data on whether they had sit-stand workstations or what they were required to do while standing.	Spinal shrinkage measured by a stadiometer four times throughout the day.	Office workers who stood in 30 minute sessions experienced significantly less shrinkage than those who stood in 15 minute sessions. Office workers with spinal disorders also stood eight times 15 minutes each. They incurred a greater variability in the shrinkage pattern.
(Roelofs & Straker 2002)	Field Study 30 bank tellers Full-time workers No attrition 20% Male Mean age 26.5 years	Three Conditions: 'just sit', 'just stand' and 'sit/stand'. The 'sit/stand' posture required subjects to alternate between a sit and a stand posture every 30 minutes. All subjects were instructed to ensure that they were aware of the time throughout the day so as to change posture at the required 30 minute interval. Participants required to work for one day in each of the three postures.	Musculoskeletal discomfort	Greatest discomfort in the upper limb was noted in the just sitting posture and greatest discomfort in the lower limb and back was reported for the just standing posture. Alternating between sitting and standing resulted in the least discomfort and was reported as the preferred posture by 70% of participants.

Author Year	**Study type: Sample size % Attrition % Male Age**	**Intervention**	**Outcome assessed**	**Results: Sedentary Health Social/economic**
3. ALTERING THE DESIGN OF THE INDIVIDUAL WORKSPACE				
(Winkel & Oxenburgh 1991)	Experimental 25 female data-entry operators (Study A: n=16, Study B: n=9) Attrition – not reported 0% male Study A mean age 32 years Study B mean age 23 years	Study A: Inactive condition (standard chair and subjects remained seated except for official breaks) and active condition (a sit or stand chair for unadjustable standing height desk. Subjects encouraged to change between sitting and standing at least four times per hour. Each subject worked 5 whole days in each of the conditions Study B: Participants exposed to same two situations as in Study A, but experimental period reduced to 1h for each condition and both performed on the same day for each subject.	Productivity, physical activity (measured by a photoelectric cell connected to an Event recorder and mounted across the chair), discomfort ratings, heart rate, foot volume, change in total plasma volume, skin temperature, EMG on select groups of muscle	Mixed findings: Study A: Inactive spent 99% of day sitting, active spent 59% of day sitting, frequency of movements out of chair per hour – inactive 0.33, active 6.05. Some reductions in musculoskeletal discomfort ratings in active compared to inactive. No differences in foot swelling. Productivity: active significantly lower keystrokes/day and lower computer time compared to inactive. Study B: For EMG readings – frequency and force of contractions for back extensor and ankle extensor significantly higher for active compared to inactive. No significant differences between groups for keystrokes/hour.

Author **Year**	**Study type:** **Sample size** **% Attrition** **% Male** **Age**	**Intervention**	**Intervention components**	**Outcome assessed**	**Results:** **Sedentary** **Health** **Social/economic**
(Nerhood & Thompson 1994)	Field Study Employees at UPS No further data	Introduction of sit-stand workstations. Users of computers were classified into different groups based on ergonomic risk of discomfort – frequency of use of the computer (infrequent, frequent, constant); mode of use of computer (entry, inquiry, combination); and frequency that employees are required by their job to leave their seat (light, medium, heavy). The furniture needs of each level of ergonomic risk were determined. 'Heavy' risk employees were given sit- to-stand workstations. All employees were given some element of workstation improvement and training around ergonomics and working safely. Outcomes tracked for one-year after introduction of sit-stand workstations.	Training an important part of the program	Body part discomfort; productivity; absenteeism; injuries and illnesses	Employees with sit-stand workstations adjusted workstations to a standing position an average of 3.6 times per day, on average employees spent 23% of their day standing. 91% of employees adjusted their workstation at some point throughout the day. Body part discomfort ↓ by an average of 62%. Occurrence of injuries and illnesses decreased by more than half. Productivity: short-term improvement. Absenteeism: no significant changes. Positive feedback from employees who enjoyed the opportunity to stand as they pleased.
(Hedge 2004)	Experimental 33 computer workers from 2 companies 38% attrition % male not reported mean age not reported	Participants were assigned to either fixed-height work surfaces or electric height-adjustable work surfaces (EHAW). All participants experienced working on the fixed height and the height-adjustable workstations for at least one month.		Work patterns (% day using mouse, % day using keyboard, % day standing at work surface, % day sitting at work surface, etc.); musculoskeletal discomfort; productivity; ease-of-use; location convenience (of features of the height-adjustable workstations); preference.	Significant ↑ in standing to do work with EHAW 21.2% vs. 8.3% Significant reduction in sitting 71.4 vs. 87.7% ↓ in the severity of musculoskeletal discomfort for must upper body regions. Slight ↓ in frequency of musculoskeletal discomfort. For electric height-adjustable workstation condition – daily discomfort ratings were lower in the afternoon. For electric height-adjustable workstation condition – productivity ratings improved.

Author **Year**	**Study type:** **Sample size** **% Attrition** **% Male** **Age**	**Intervention**	**Intervention components**	**Outcome assessed**	**Results:** **Sedentary** **Health** **Social/economic**
4. ALTERING THE BUILT DESIGN OF THE BROADER WORKSPACE					
(Paul 1995a)*	Field Study 12 office employees No attrition 25% male Mean age 37 years	12 office employees were monitored during the redesign of their work environment. Before office redesign, they worked in closed offices and sitting non-adjustable workstations. Then in more open offices and sit-stand adjustable workstations, where they stood for 2 hours every day.		Job content, environmental satisfaction, perceived group; interaction; stress level. Mood states.	In the offices with sit-stand adjustable furniture, subjects felt more energetic and less tired by the end of the work day. Change in the office layout, i.e. open versus closed, increased the interaction and communication between employees but significantly decreased employees' perceived privacy and increased the amount of visual and noise distractions. No change in environmental satisfaction.

*These studies fit across a number of categories, but have been assigned to the category that the study is most in line with.

Author **Year**	**Study type:** **Sample size** **% Attrition** **% Male** **Age**	**Intervention**	**Intervention components**	**Outcome assessed**	**Results:** **Sedentary** **Health** **Social/economic**
5. MULTIPLE STRATEGIES					
(Bernaards, Ariens et al. 2008) (Bernaards, Ariens et al. 2006) (Bernaards, Ariens et al. 2007)	Experimental 466 computer workers with frequent or long-term neck and upper limb symptoms 16% attrition at 6 months 32% attrition at 12 months 56% male Mean age 44 years	Participants were assigned to one of three groups: work style group, work style and physical activity group; or usual care. The two intervention groups attended 6 group meetings over a 6 month period that focused on behavioural change for body posture, workstation adjustment, use of sufficient breaks and coping with work stress. The work style and physical activity intervention also included physical activity. Group meetings were about a month apart. The first 4 meetings had a maximum of 10 participants and the last 2 meetings had a maximum of 3 participants. The meetings lasted an average of one hour. Meetings took place at the workplace during work time.	Specifically trained counsellor led the group sessions. Work style and physical activity Intervention group received an elastic band and exercises for the upper body. Physical activity plans also made for those wanting to change physical activity. Specific guidelines for workplace and ergonomics and body posture are given in the meetings.	Body posture, neck and upper limb symptoms, pain, workstation adjustment, breaks during computer work, physical activity, work stress, absenteeism, worker productivity, health care system use.	Intervention group reported taking more breaks than usual care. The work style intervention, not the work style plus physical activity intervention, was effective in reducing all pain measures. For neck and shoulder the work style only intervention showed an increased recovery rate for neck and upper body symptoms. Inconsistent outcomes for body posture and workstation adjustment. Total physical activity increased in all groups. No significant findings for work stress. During the 6 month intervention, groups reported lower use of the health care system than the usual care group. Outcomes for absenteeism and worker productivity not reported.

Summary of findings for the respective intervention categories

1. Increasing the number of breaks in sedentary time

All of the interventions using this strategy compared the introduction of an additional number of structured breaks (i.e. set time for the break) on top of the conventional breaks already scheduled (mid-morning, mid-afternoon breaks and lunch). Four experimental studies were identified. Schedules varied but included a five minute break during each hour (outside the conventional break period) (Galinsky, Swanson et al. 2000; Galinsky, Swanson et al. 2007); four breaks each hour (three were 30 seconds in length and the fourth was three minutes) (Henning, Jacques et al. 1997); and microbreaks (~30 seconds) at 20 minute intervals or 40 minute intervals (McLean, Tingley et al. 2001). Stretching during the breaks was advocated in two of the studies (Henning, Jacques et al. 1997; Galinsky, Swanson et al. 2007). The other two studies advocated getting up from the chair and taking a short walk away from the workstation (Galinsky, Swanson et al. 2000; McLean, Tingley et al. 2001). Two studies specified how the breaks were prompted, with prompts via small electronic timers and a copy of the rest-break schedule in one study (Galinsky, Swanson et al. 2000) and Ergobreak software in the other (McLean, Tingley et al. 2001).

Workplace sitting outcomes

Given that all the studies used structured breaks, the reductions in time spent sitting were dictated by the specific intervention schedule. Only two of the studies actually reported the level of compliance with the break schedule. One reported an increase in the number of breaks in the intervention group (Galinsky, Swanson et al. 2000) while the other reported that 50 per cent of people in the intervention group complied with the new break schedule (Henning, Jacques et al. 1997).

Health outcomes

All four studies reported improvements in perceived musculoskeletal discomfort. Henning and colleagues (1997) included both a small and a large worksite in their study and only the small worksite showed improvements in this outcome. These findings are consistent with a previously published review on the effects of exercise and rest breaks on musculoskeletal discomfort during computer tasks (De Vera Baredo & Mahon 2007).

Within that review it was concluded that while the evidence base is relatively poor, it does support the use of exercise and rest breaks in reducing musculoskeletal discomfort in computer tasks (De Vera Baredo & Mahon 2007). Two studies reported improvements in eyestrain (Galinsky, Swanson et al. 2000; Galinsky, Swanson et al. 2007). Only one study assessed mood and found no intervention effect (Henning, Jacques et al. 1997).

Social/economic outcomes

Importantly, increases in breaks showed no detrimental effect on productivity, with two studies reporting increases in productivity (Henning, Jacques et al. 1997; Galinsky, Swanson et al. 2007) and two showing no differences between conventional and supplementary breaks (Galinsky, Swanson et al. 2000; McLean, Tingley et al. 2001).

Strengths/limitations and future research required

The studies reviewed were all short-term interventions with no follow-up data. There was inconsistency in the reporting of the break data and there was no reporting on the social outcomes of the interventions. Incorporating more breaks in sedentary time during the work day is considered to be a relatively inexpensive strategy, potentially easy to implement and builds on existing OHS policy. Notably, it can be inclusive of all employees and if instigated by the employer, can provide valuable reinforcement (at the organisational level) for behaviour change. However, the break schedules of the interventions included in our review were all structured, which could impact on an employee's sense of autonomy over their job.

It is important to acknowledge that challenges may exist in some workplaces, particularly those that do not currently implement rest breaks that may make it difficult to implement such breaks on an organisational level. As emphasised by McLean and colleagues (2001), to gain support by the workers, microbreaks must increase the level of comfort experienced during work tasks and must assist with productivity when incentives or quotas are in place (McLean, Tingley et al. 2001). In order to gain support from management, the concept of microbreaks must show no detrimental effect on worker productivity while preferably causing an increase in long-term productivity or a reduction in costs related to worker turnover or absenteeism (McLean, Tingley et al. 2001).

Further research is needed to examine the acute and chronic physiological and biological impacts of the conventional break schedule and the impact of modifications to this schedule. Future qualitative and quantitative research should examine the effectiveness of unstructured breaks on health, social and economic outcomes.

Case study: Increasing the number of breaks

Site: Public Utility, California, USA

Source: Thompson, D.A. Effect of exercise breaks on musculoskeletal strain among data-entry operators: a case study

In 1985, a large northern Californian public utility undertook a one year intervention to improve worker health by introducing paid exercise breaks. A group of data-entry operators (n=85) working in the cash management section of the organisation were targeted due to the high incidence of reported musculoskeletal injuries in this group.

Exercises were developed by a qualified exercise physiologist and intended to counteract the musculoskeletal stresses from occupational tasks routinely performed by the data-entry operators. The exercises were designed to relieve postural strain and involved stretching of the arm, wrist, lower legs and back.

During the intervention, employees' eight hour work day was restructured to include two five-minute exercise breaks, undertaken at mid-morning and mid-afternoon. Data entry operators were also encouraged by the organisation to utilise time during their normal rest breaks to exercise instead of spending time sitting. All data operators engaged in the breaks program and cited the support of the organisations' labour-management taskforce as one of the main reasons for its successful adoption.

Both data entry operators and management received direct pay-offs as a results of the breaks program. Operators reported reduced discomfort at work and improved physical condition outside of work, while management observed an immediate improvement in worker productivity with the average number of items processed by the operators increasing by 25 per cent after the introduction of the program. The increase in worker productivity was also reflected in a significant decrease in paid overtime.

2. Strategies around postural changes

Three field studies examined the health impact of implementing postural changes (Paul 1995b; Paul & Helander 1995; Roelofs & Straker 2002). The first study utilised computer operators and assessed foot swelling four times over a day (Paul 1995b). Participants first worked in offices with nonadjustable sitting workstations and then in offices with sit-stand workstations, where they stood for 15 minutes every hour. Foot swelling was less in offices with sit-stand workstations, than with the nonadjustable sitting workstations. The second study utilised computer operators and measured spinal shrinkage four times over a single day (Paul & Helander 1995). Participants were required to stand for two hours during the day, either four times for 30 minutes, or eight times for 15 minutes. They also walked for 20 minutes. Spinal shrinkage was significantly less in those that stood for 30 minutes, rather than 15 minutes. No other outcome measures were assessed (Paul & Helander 1995). The third study, conducted with 30 bank tellers, involved a cross-over trial in which participants completed one day each in the following postures: 'just sit', 'just stand' and 'sit/stand' which required participants to change posture every 30 minutes. The sole outcome measure was musculoskeletal discomfort, which was reported to be significantly lower in the sit/stand posture. Importantly, this posture was preferred by 70 per cent of participants.

Strengths/limitations and future research required

All three studies were of short duration and thus only give an indication of the acute impact of changes in posture. They were also relatively limited in the number of participants, in the outcomes measured and the changes in posture were regulated by set times, rather than employee driven. The key benefits of introducing postural changes relate to being relatively inexpensive to implement and an approach that is consistent with OHS guidelines in regards to regular changes in posture. The potential benefits of other strategies to reduce workplace sedentary time, such as standing or walking meetings, have been acknowledged on several work websites – primarily in terms of reducing meeting times and also feeling more energised following the meeting.

However, to date, there have been no intervention and/or evaluation studies that measured the impact of these strategies on other health, social and/or economic benefits. Qualitative and quantitative feedback on the impact of organisational change policies relating to the promotion of postural changes should be addressed in future research studies. For example: what was done, what was the impact on physical and mental health of the employees, what was the impact on workplace characteristics such as productivity and job control, and how sustainable were the changes.

Case study: Postural change

Site: Bankwest, Perth Australia

Source: Leon Straker, Andrea Roelofs. 'The experience of musculoskeletal discomfort amongst bank tellers who just sit, just stand, or sit and stand at work'; Curtin University of Technology: Perth, WA

Bankwest (Bank of Western Australia) is a wholly owned subsidiary of the Commonwealth Bank of Australia and a full service bank. In its home state of Western Australia, Bankwest is a market leader with about one quarter of all bank advances and deposits. With more than 50 branches Australia-wide, the company has in excess of 900,000 customers.

In 2002, the company was interested in investigating whether postural variation during work hours could reduce musculoskeletal discomfort of staff by reducing the amount of time they spend sitting at their desk. Across 16 branches in the Perth metropolitan area, 30 bank tellers were recruited to see whether a 'sitting only', 'standing only' or 'sitting and standing' working posture could alleviate musculoskeletal pain. The bank tellers were asked to work in each of the three working postures for one entire work day (total = three days). They were also asked to complete Visual Analogue Discomfort Scales (VADS) describing the amount of pain they were experiencing in the upper and lower extremities and total body when working in each of these three postures.

Results from the study revealed that alternating between sitting and standing every 30 minutes yielded the least discomfort and was the preferred working posture of Bankwest employees (70 per cent).

3. Altering the design of the individual workspace

Here the focus was on ergonomic modifications that promoted less sitting, rather than modifications to the chair and workstation to ensure correct postural alignment. The main tool used was the sit-stand desk. There were two experimental studies and three field studies that altered the design of the workstation. Participant numbers were relatively small, ranging from six to 33, with numbers unknown in one study (Nerhood & Thompson 1994). Four studies used height-adjustable desks (Nerhood & Thompson 1994; Paul 1995a; Paul 1995b; Hedge 2004) and one used a stool with the desk at a fixed height (Winkel & Oxenburgh 1991). All options enabled the worker to continue working regardless of postural change. The timeframe for outcome assessment ranged from one hour to one year. Furthermore, one interview study was conducted with 165 employees across four companies that had recently installed sit-stand workstations (Wilks, Mortimer et al. 2006).

Although not included as part of the intervention review, this paper provided important insights into the employer- and employee-perceived benefits of these workstations. Aspects from this study are incorporated into the sections below.

Workplace sitting outcomes

Within those interventions involving employee (rather than intervention) driven changes, significant increases in time spent standing and significant decreases in time spent sitting were observed (Winkel & Oxenburgh 1991; Nerhood & Thompson 1994; Hedge 2004). In the year-long study, workers adjusted their desk on average 3.6 times per day, with 91 per cent of participants adjusting it at least once per day (Nerhood & Thompson 1994).

In the one-month cross-over study, the average number of adjustments to the workstation was 1.5 times per day (Hedge 2004). The interview study reported relatively low utilisation of the sit-stand workstations, with only 20 per cent of users classified as frequent users (Wilks, Mortimer et al. 2006). The most common reason for low utilisation (once a month or less) was ‘did not bother to use the function’, with the next common reason ‘table surface too small while standing’ (Wilks, Mortimer et al. 2006). The company that gave the most instructions and motivation for use had the highest number of frequent users (Wilks, Mortimer et al. 2006).

Health outcomes

In general, a reduction in the severity of musculoskeletal symptoms was observed. In the year-long study, there was an average 62 per cent reduction in body part discomfort and the occurrence of illness and injuries decreased by half during this period (Nerhood & Thompson 1994). No difference in foot swelling was observed for a five-day cross-over study (Winkel & Oxenburgh 1991) but a significant reduction was observed with the standing condition in a six-week study (Paul 1995b).

Social/economic outcomes

Of the three studies that measured productivity, improvement was observed in two of these (Nerhood & Thompson 1994; Hedge 2004) while key strokes and time spent at the computer (as markers of productivity) was reduced in the active compared to inactive group in the third study (Winkel & Oxenburgh 1991).

The year-long study reported positive feedback from employees about the new workstations, with employees appreciating the opportunity/choice to stand as they pleased (Nerhood & Thompson 1994). The cost of injuries in this workplace also dropped to zero dollars (Nerhood & Thompson 1994). A key aspect of the successful implementation of the program in this workplace was the commitment from all groups involved (Nerhood & Thompson 1994). In the interview study, 78 per cent of respondents considered that the sit-stand workstation had improved their working environment (Wilks, Mortimer et al. 2006). For the companies, the key benefits of the introduction of the sit-stand workstations were the reduced floor space utilised and the open office landscapes for mobile and flexible personnel groups (Wilks, Mortimer et al. 2006).

Strengths/limitations and future research required

The key benefits of enabling both sitting and standing at a workstation are that: it is consistent with OHS guidelines regarding the importance of regular changes in posture; it has minimal interruption to the work task; it specifically encourages standing (as opposed to non-computer time, which could still involve sitting); and the frequency of the sit-stand movements can be controlled by the user. From the interventions included in our review, there were benefits in terms of increased productivity and reduced absenteeism, while employees reported reduced severity of musculoskeletal symptoms and feeling more energetic and less tired. Employers also noted the benefits of reduced floor space and a more flexible and mobile personnel.

The disadvantages of implementing sit-stand workstations are their potential cost, with estimates of $1,000 to $1,500 per desk for basic electric, height-adjustable models. Because of this, there may be inequity regarding the availability of the workstations. However, more cost-effective options (such as the stool that enabled sitting or standing, or adjustable monitor and keyboard arms) are possible alternatives. The benefits of changing a sit-only job to a sit-stand system are not always self-evident to participants who characteristically need personal instruction, discussion and preparation (Dohrmann 2008). Based on the evidence to date, it appears that a key recommendation should be that employees are informed of the benefits of alternating postures and also provided with practical instructions and demonstrations. Training (around ergonomics and working safely) was an important aspect of the successful introduction of sit-stand workstations at one workplace (Nerhood & Thompson 1994).

Case study: Altering the design of the individual workspace

Site: Drager Medical, Lubeck, Germany

Source: www.officeplus.de/en/ergonomic-knowledge/longterm-study/

Drager Medical is one of the world's leading manufacturers of medical equipment. With its headquarters based in Lubeck, Germany, the organisation employs nearly 6,000 people worldwide, half of whom work in customer sales and services.

In mid-2000, the organisation decided to try and decrease the level of sickness absence (sick leave) due to musculoskeletal disorders of their office-based employees. Enabling workers to interchange between a sitting and standing working posture, 38 workstations were modified with integrated standing desks (provided by ergonomic office furniture and fixtures manufacturer Officeplus). In addition to the introduction of height-adjustable desks, the organisation also arranged ergonomics training for all staff. Of employees who had access to the standing desks, 90 per cent used them more than 10 times a day, with the majority utilising the height adjustable feature when reading and using the telephone.

Drager Medical conducted staff surveys (n=17 workers) three months after introducing the desks and again after six years. Results from the three month survey revealed 65 per cent of workers felt their wellbeing had improved at work as a result of the standing desks, whilst 3 per cent said it had significantly improved. Similar results were observed after six years with 70 per cent reporting improved wellbeing at work despite a significant increase in computer usage. Sickness absence of workers who reported using the standing desks regularly significantly decreased. There was also a decline in the number of reported musculoskeletal injuries with 33 per cent of employees reporting less back pain and 60 per cent less neck and shoulder pain from changing between a seated and standing working posture. The number of employees taking days off for musculoskeletal related injuries also significantly declined over the six year period. Additional benefits from the introduction of the standing desks included staff reporting increased confidence at work (60 per cent), with some staff citing a significant increase (5 per cent) as a result of using the desks.

Overall the exercise of modifying 38 workstations cost the organisation €10,200 (equivalent to approximately AUD $15,000) of which the benefit to employees resulted in a company profit of €100,800 (approximately AUD $143,000). Essentially, for every one Euro spent by Drager Medical on the cost of the desks and ergonomics training, the return on investment was equivalent to 10 Euros.

4. Altering the design of the broader workspace

We identified one study that evaluated the impact of modifications of the workplace environment on employee outcomes (Paul 1995a). Here, 12 office employees were monitored during the redesign of their work environment from a closed office with non-adjustable workstations, to a more open office with sit-stand adjustable workstations. Participants stood for either 15 minutes every hour or 30 minutes every two hours for a total of two hours of standing a day. It was unclear if this was regulated or employee-driven. The outcomes, assessed at three months, found that in the offices with sit-stand adjustable furniture, subjects felt significantly more alert and energetic and less tired and sluggish. The open office also increased the communication and interaction between employees. However, it significantly decreased perceived privacy and increased the amount of visual and noise distractions.

Strengths/limitations and future research required

Several workplaces modified their physical built environment to encourage more movement. The benefit of modifying the built environment is that it can impact on all employees, as well as visitors to the workspace. However, changing the built environment of a workplace is likely to be costly for organisations and the health benefits of making such changes have not yet been measured. There is a clear need for more research to evaluate the health, social and economic impacts of these 'natural' experiments occurring within workplaces.

Case study: Altering the design of the broader workspace

Site: Macquarie Group, Sydney Australia

Sources: Personal communication with Trisha Harding, Macquarie Group. Indesign Magazine Australia, Issue 41 (2010) pp 75–102

Macquarie Group (Macquarie) is a global provider of banking, financial, advisory, investment and funds management services. In late 2009, the company's Banking and Financial Services Group (BFS) relocated its multiple sites within the Sydney CBD to a single 30,000 square metre premises at One Shelley Street in Sydney. Senior management were conscious that the new workplace should promote 'Activity-Based Working' (ABW) for its employees. The concept of ABW was first developed by Dutch consultant Veldhoen & Co. for a Netherland-based insurance company (Interpolis) in 1996. ABW uses a flexible work platform whereby a variety of work and meeting settings are provided, allowing workers to be completely mobile and occupy these work settings depending on the particular tasks they need to undertake. By providing employees with a range of 'choices' where they may complete their tasks, it encourages them to move more freely about the workplace and take greater ownership of space during the work day rather than simply sitting at their own desk.

At their One Shelley Street building, Macquarie's new workplace environment was constructed such that there is no allocated desk space – a paradigm shift from the traditional office protocol. Height-adjustable desks have replaced 30 per cent of standard seated desks. High benches that allow multiple employees to collectively stand or sit on high chairs to work or hold meetings are also a prominent feature of the workplace. To ensure employees are able to work efficiently in any location in the building, staff are provided with laptops and wireless 'follow-me' printing. External glass-fitted stairwells feature prominently in the office design to encourage staff to use the stairs rather than elevators to commute between levels.

Since relocating to their new office, 93 per cent of Macquarie BFS staff surveyed said they were supportive of the organisation's decision to promote ABW and did not want to return to their former style of workplace. Internal surveys also reveal the flexible workplace environment has not impeded employees' levels of productivity (58 per cent) and in some instances led to an improvement (37 per cent). Feedback is highly positive regarding the use of the height-adjustable workstations and external stairwells. Macquarie believes the success of their new workplace, which ultimately increases activity and reduces sedentary time, is due to empowering staff from senior level right through to junior to implement the changes and by educating employees through a behavioural change program.

5. Multiple strategies

We identified one study that evaluated multiple outcomes in two well-structured intervention groups. There are multiple references for this one study that describe different aspects of the study (Bernaards, Ariens et al. 2006; Bernaards, Ariens et al. 2007; Bernaards, Ariens et al. 2008). In this study, 466 computer workers with neck and upper limb symptoms were assigned to one of three groups, where the two intervention groups received six face-to-face counselling sessions over a six-month period. Both intervention groups received information on behavioural change for body posture, workstation adjustment, use of sufficient breaks and coping with work stress. The work style and physical activity intervention also included information on physical activity. The meetings lasted an average of one hour. Meetings took place at the workplace during work time.

As may be expected in such a large trial with multiple outcomes the findings were mixed, however, there were increased breaks from computer work and reduced health care system use in both intervention groups. The work style only intervention also reported improvement in all pain measures and a quicker recovery rate for neck and upper limb symptoms.

Strengths/limitations and future research required

This study was very well designed with a large number of participants in comparison to other studies in the review. However, the response rate for participation in the study was low (32 per cent). This is one of the few studies to carefully explain the intervention protocol and give data on implementation, as well as have a follow-up assessment six months after the intervention was completed.

A limitation is that no data was given on the cost to deliver the intervention and while some cost-related measures (absenteeism, worker productivity) were included in the methodology, no outcome data has yet been reported (Bernaards, Ariens et al. 2006; Bernaards, Ariens et al. 2007; Bernaards, Ariens et al. 2008).

Interventions that incorporate multiple workplace sitting reduction strategies provide flexibility for employers and employees to choose the most appropriate strategies for their workplace. Combining information sessions about the benefits of reducing workplace sitting time through regular breaks and changes in posture, along with visible evidence of organisational support (such as workstation and workplace modifications) would seem to be the ideal strategy for reducing occupational sitting time. However, such studies are yet to be implemented and evaluated.

Case study: Multiple strategies (increasing the number of breaks, strategies around postural change, altering the design of the individual workspace)

Site: Victorian Health Promotion Foundation (VicHealth)

Source: Personal communication with Jennifer Atkinson, VicHealth

Established by the Victorian Parliament as part of the *Tobacco Act 1987*, the Victorian Health Promotion Foundation (VicHealth) works in partnership with organisations, communities and individuals to promote good health and prevent ill health.

VicHealth is located in the inner city of Melbourne at Pelham Street, Carlton, and employs 55 staff (15 part time, 40 full time) in largely administrative roles. The organisation recently implemented a six-week intervention to reduce workplace sedentary time – a decision driven by both senior management and a willingness of employees to change their sitting behaviour during work hours.

Several strategies were implemented during the intervention phase including asking staff to change their printer default setting, instigating a 'standing meeting room' with a standing height table large enough for multiple staff members, modifying a proportion of the existing workstations (n=10) to allow employees to alternate between standing and sitting work posture, and daily email reminders to encourage staff to record their sitting/standing time. The decision to modify existing workstations of staff members proved a relatively inexpensive exercise (approximately $500 per desk) in comparison to the cost of purchasing new, electric height adjustable desks ($1,000–$1,500 each). Employees were supported in actively commuting into work by addressing bike storage security via the installation of secure bike lockers in the building.

Feedback from employees at the conclusion of the intervention was largely positive. The 'standing meeting room' was well accepted by employees. Approximately 40 per cent of staff regularly used the room and of those who did, some commented they felt meetings were shorter and more productive in this setting. Similarly, most employees who chose to adopt a standing workstation, which ranged from the company's CEO through to part-time workers, commented that they felt more active, energetic/ alert and had less musculoskeletal discomfort.

Due to the success of the standing workstations, VicHealth invited further participation in the project and is continuing to explore designs and products that meet the varying needs of staff (e.g. accommodating taller participants, options for raised document holders, wider platforms), as well as examining enablers and barriers to using the standing workstations over the longer term.

Summary and limitations of review findings

Overall, the evidence from this review, based on the as yet limited available findings and case studies, supports the use of strategies to reduce prolonged workplace sitting, particularly in relation to reduced incidence and/or severity of musculoskeletal symptoms (the most commonly measured outcome). Workplace sitting reduction strategies typically had a beneficial or neutral impact on productivity, absenteeism and injury costs, where the relevant evidence could be identified. No studies suggested likely harm from sensibly implemented breaks from, or reductions in, workplace sitting time.

Limitations of the review

This review was not conducted as a traditional systematic review. Due to the short timeframe of the project and the area of research (where much of the evidence exists within the grey literature), it is possible that relevant articles may have been missed. Given the emerging interest in this field of research, it is anticipated that the evidence base for occupational workplace sitting research will become considerably stronger in the next few years.

Limitations of studies included in the review

There are several limitations within the existing literature that need to be taken into consideration when interpreting the findings. These include:

- The mixed study quality, ranging from field studies to controlled-experimental studies. There was only one randomised controlled trial (encompassing three separate publications), which was conducted in The Netherlands (Bernaards, Ariens et al. 2008).
- All studies approached the research question from an OHS and ergonomics perspective. As such, there was no measurement of the cardiovascular or metabolic health biomarkers that are known to be precursors of major chronic diseases.
- Reliable and valid measures of sedentary time generally were not used. Accordingly, it is not possible to draw strong conclusions about the actual outcomes.
- Social-related impacts of reducing workplace sitting time (such as acceptability, employee interactions, perceived privacy) usually were not reported.

- All eligible studies were conducted with populations that could broadly be defined as office workers (including data entry operators, computer workers, bank tellers). To ensure that studies from other high-risk occupational sectors (such as drivers) were not missed, an additional search was conducted using more specific search terms (for example, blue collar worker sedentary, factory sedentary, truck driver reduce sitting). No further studies that met the eligibility criteria were found, despite the high prevalence of workplace sitting in these groups. The primary focus of any interventions for these occupational sectors was on ergonomic modifications and reduction of musculoskeletal discomfort associated with prolonged sitting (i.e. making sitting more comfortable), rather than on reducing sitting time. Regulations were applied to prevent/reduce fatigue (for example, the fatigue management code of practice for taxi drivers in Western Australia recommends a minimum 10 hour continuous break every 24 hours) (Government of Western Australia: Department for Planning and Infrastructure 2009) rather than interrupting and/or reducing sedentary time. The feasibility, acceptability, health, economic and social impact of reducing sedentary time in workers outside of the office sector is an important area for future research.

Practical implications to consider when implementing workplace interventions

There were several important practical issues arising from the review that should be considered when conducting studies targeting the reduction of workplace sitting in real-world settings. These include the following:

- Adherence to the workplace sitting reduction protocols or the use of sit-stand desks varied substantially among the studies, but was higher when specific guidelines were provided and health implications were made explicit to employees.
- Giving employees overly-structured break schedules (for example, prescribed times or timing of breaks from sitting time) can be constraining and may interrupt work tasks, while unstructured breaks (chosen or planned by individual workers themselves) are more likely to be acceptable, providing flexibility and a sense of control.
- Documenting broader outcomes presents significant challenges: for example, productivity is difficult to measure and can be quite workplace-specific; absenteeism and injury cost estimates require long-term follow-ups.

Conclusion from review

Considering all the relevant evidence and case study experience, this review recommends that high quality studies (ideally cluster-randomised controlled trials, which are feasible across multiple workplace settings) be conducted in workplaces that incorporate organisational, systems and individual change elements. Such studies should assess multiple health, economic and social outcomes and use validated measurement methods (and ideally the objective measurement techniques that are now available).

Additional useful resources

Ergonomic success stories

A repository of ergonomic studies and a summary of their cost-benefits across a variety of workplaces is available at http://www.pshfes.org/cba.htm

These were accounts submitted to the Occupational Health and Safety Administration (OSHA), or that were based on information obtained by OSHA from secondary sources, where employers have implemented ergonomics programs or utilised best practices and reported successful results.

Guidelines for screen based work

Although there is no requirement under Victorian OHS legislation to provide specific breaks to computer/VDU users, all workers are entitled to breaks under their award/agreement. Furthermore, an employer is obliged to provide safe and healthy systems of work. The ACTU *Guidelines on Screen Based Work* (ACTU OHS UNIT 1998) recommends that job design should be used to limit both the length of continuous periods spent and the total time spent at screen based work. Designing breaks between periods of screen based work allows for periods of recovery following periods of exposure and limits the total exposure to the hazards of screen based work.

Specific recommendations from the ACTU guidelines are:

(1) Workers should be provided with other work that takes them right away from the screen for at least half their working time.
(2) There should be regular breaks of at least 15 minutes per hour for concentrated screen based work and 15 minutes per two hours for less strenuous work, though there is evidence to suggest that more frequent but shorter breaks are more beneficial (ACTU OHS UNIT 1998).

Websites

The website www.juststand.org provides a link to research, resources, tools and success stories about standing and moving more at work. It provides some simple behavioural tips to increase standing, as well as links to companies that manufacture sit-stand workstations. Furthermore, it uses social networking devices, such as Facebook and Twitter, to connect similarly minded people and workplaces.

Useful guiding frameworks for future intervention initiatives

In recognition that the workplace provides a large audience for cardiovascular disease prevention, in 2009 the American Heart Association (AHA) published a policy statement presenting a framework for worksite wellness programs for cardiovascular disease prevention (Carnethon, Whitsel et al. 2009). Within this framework, specific emphasis is given to the importance of an integrated approach that includes both organisational level and individual behavioural change elements.

A brief summary of the AHA recommendations pertinent to the establishment of sitting time reduction initiatives are provided below.

1. Components of wellness programs

- Comprehensive programming aimed at improving employees' cardiovascular and general health, including tobacco cessation and prevention, regular physical activity, stress management/reduction, early detection/screening, nutrition education and promotion, weight management, disease management, CVD education and changes in the work environment to encourage healthy behaviours and promote occupational safety and health.
- Programming that is integrated into the organisational structure of the workplace through: health education, incorporation into existing employee assistance programs, voluntary worksite screening for risk factor modification.
- Combine health risk appraisals with organisational health promotion checklists prior to programming to identify health needs in the workplace and ensure that employees have an understanding of their own risks and health status.
- Evaluate the effectiveness of the program and, if necessary, tailor the programming and policies to optimise the effects.

2. Environmental modifications

- Design the social and physical environment of the workplace to be more conducive to the recommended behaviours, whilst simultaneously minimising the physical, organisational and occupational risk of the work environment.
- Incorporate occupational health and safety into the programming to ensure that workplaces are free from hazards that jeopardise cardiovascular health and employee safety and wellbeing.

3. Regulations/policy approaches

- Increased opportunity for employers to reach a greater majority of the employee population and produce health benefits should be a key consideration of the regulatory environment.
- Observe all the regulations and address hazards to employee health and safety and provide working conditions that are optimal for cardiovascular health and wellbeing.

4. Vulnerable/special populations

- Accommodate the needs of all employees at a given workplace regardless of gender, age, ethnicity, socioeconomic status, culture, job type or physical or intellectual capacity.
- Design the program to be culturally sensitive and all-inclusive.
- Consider targeted, complementary interventions for more vulnerable employees specifically designed to engage those who are economically challenged, less educated, or underserved.
- Conduct research to determine how to improve participation among employees who have the highest risk behaviours.

In addition, another useful resource document developed by the US National Institute for Occupational Safety and Health (NIOSH) as part of the WorkLife Initiative is intended to provide a guide for employers and employer-employee partnerships in the establishment of effective workplace programs that sustain and improve worker health (Department of Health and Human Services 2008). This framework highlights the need for specific attention to the work environment, including: management support for changes in the workplace context that encourage healthy behaviours; use of onsite personnel for program delivery; physical resources (telephone/email, internal communication channels); and employee participation in tailoring programs to the specific workplace. In particular, the 20 essential elements presented within the NIOSH WorkLife framework for effective workplace programs and policies improving worker health and wellbeing should serve as a reference in which future interventions targeting the reduction in workplace sitting could be built upon (see Table 2 following).

Table 2: Essential elements with the NIOSH WorkLife framework (Department of Health and Human Services, 2008) and their potential application to a workplace sitting reduction intervention

Component	Potential application to workplace sitting reduction intervention
Organisational culture and leadership	
1. Develop a 'human-centred culture'	An effective intervention is more likely to thrive in organisations with policies and programs that promote respect throughout the organisation and encourage active worker participation, input and involvement.
2. Demonstrate leadership	Build relationships with the leaders of the organisation to ensure that the commitment to worker health and safety (e.g. workplace sitting reduction) is acknowledged by the leaders and communicated widely throughout the organisation.
3. Engage mid-level management	Work with the supervisors and managers at all levels to support the promotion of the workplace sitting intervention. Mid-level supervisors/managers are considered to be an essential key to integrating, motivating and communicating with employees.
Program design	
4. Establish clear principles	Clearly articulate the principles of the intervention program (e.g. reducing the health hazards associated with prolonged sitting) in order to focus priorities, guide program design and direct resource allocation.
5. Integrate relevant systems	Conduct an initial inventory and evaluation of the existing programs and policies relevant to health and wellbeing and determine if potential connections could be made (e.g. highlighting the consistency with OHS recommendations). If possible, integrate separately managed programs into a health-focused system and manage them as one.
6. Eliminate recognised occupational hazards	If it can be reasonably assumed that prolonged sitting is an occupational hazard, changes in the work environment could encompass improvements in workstation design and flexibility to allow employees to have the choice to implement changes in their work pattern (i.e. more frequent postural transitions throughout the work day). Also, work task variety (screen and non-screen based) should be available.
7. Be consistent	Alterations in the physical and organisational work environment need to be aligned with the specific health goals of the program. For example, employees may be more likely to reduce their sedentary time if they perceive that the workplace environment is truly supportive of the goal through changes in the workstation design and policies relating to reducing and breaking up sedentary time during the day.
8. Promote employee participation	Employees should be actively engaged in identifying the relevant issues in their workplace and contribute to the workplace sitting intervention program design and implementation. Provide practical examples of ways to reduce and break up sitting time.

Component	Potential application to workplace sitting reduction intervention
9. Tailor programs to the specific workplace	The program needs to account for diversity within the organisation and be designed to meet the needs of both individuals and the organisation. Program flexibility is preferred over a 'one size fits all' approach.
10. Consider incentives and rewards	Incentives and rewards for individual program participation could be used to encourage engagement.
11. Find and use the right tools	The use of relevant, validated measurement instruments that assess both individual and organisational factors is important for the optimal assessment of the program's efficacy.
12. Adjust the program as needed	Ongoing evaluation will assist in detecting unanticipated effects and provide capacity to adjust the program based on the analysis of the experience.
13. Make sure the program lasts	Design the program with a long-term outlook to facilitate sustainability. Sufficient flexibility is necessary to assure responsiveness to changes in workforce and workplace conditions.
14. Ensure confidentiality	Communication to employees needs to be clear on this issue to enhance the likelihood of success.
Program implementation and resources	
15. Be willing to start small and scale up	Initially commence with modest and achievable targets for workplace sitting reductions and the number of breaks in sitting time and then gradually scale this up (for example, through workstation modification) once initial success is achieved.
16. Provide adequate resources	In the early phase of the intervention development, identify and engage appropriately trained and motivated staff. Work closely with the organisation and management to ensure that there is a sufficient allocation of resources, including staff, space and time, to achieve the desired results.
17. Communicate strategically	Ensure that the messages and means of delivery are tailored and targeted to the group or individual and consistently reflect the values and direction of the intervention program. Provide periodic updates to the organisational leadership and employees.
18. Build accountability	Build into the intervention a sense of accountability that reflects leadership commitment to improved programs and outcomes. The goal should be to see this accountability cascade through the organisation starting at the highest levels of leadership.
Program evaluation	
19. Measure and analyse	Develop objectives and a selective menu of relevant measurements, recognising the goals of the intervention and the expected outcomes. For example, sedentary time should be measured objectively via accelerometers, chronic disease risk through biomarkers and other pertinent outcomes, such as productivity, through validated instruments.
20. Learn from experience	Adjust or modify the program based on the results that have been measured and analysed.

7. Appendix: Search terms used in initial literature search

Search terms:

OR		**OR**		**OR**		**OR**
activity	**AND**	computer terminal	**AND**	case study	**AND**	absenteeism
computer time		computer terminals		intervention		compensation
energy expenditure		employee		program		health claim
exercise		employees		programs		presenteeism
exercises		employment		promotion		productivity
health		occupation		RCT		5
healthy		occupational		strategies		
sedentariness		occupations		strategy		
sedentary		operator		trial		
sitting		operators		9		
standing		organi*ation				
stretching		organi*ational		add:		
12		policies		study		
		policy		field		
add:		staff				
rest break* (instead of healthy; go health*)		systems approach				
computer work		teller				
		tellers				
		VDT				
		VDTs				
		video display terminal				
		video display terminals				
		work				
		worker				
		workers				
		workplace				
		workplaces				
		workstation				
		workstations				
		29				

8. Glossary of terms

Workplace	Physical location of the work (i.e. not at home).
Workplace sitting	Time spent in sedentary behaviour (see below) while at the workplace.
Ergonomics	The science of designing the job, equipment and workplace to fit the worker.
Productivity	Measure relating a quantity or quality of output to the inputs required to produce it.
Absenteeism	An employee's time away from work due to illness.
Presenteeism	Decreased on-the-job performance due to the presence of health conditions.
Metabolic equivalent (MET)	Unit used to estimate the amount of oxygen used by the body during physical activity. 1 MET = the energy (oxygen) used by the body at rest.
Sedentary behaviour	The term used to collectively describe all those behaviours that are characterised by a sitting or reclining posture and low energy expenditure (1.0 to 1.5 METs). For example, television viewing and sitting in the workplace are unique sedentary behaviours.
Light intensity physical activity	Typically incidental (not planned) physical activity. MET value of 1.6 to 2.9. Includes standing. Is also termed baseline activity.
Moderate intensity physical activity	MET values 3.0 to 5.0. Includes activities such as brisk walking or climbing several flights of stairs.
Vigorous intensity physical activity	MET values 5.0 to 9.0. Includes activities such as jogging, fast bicycle riding or carrying heavy loads.
Breaks in sedentary time	Interruptions to sedentary time through a change in posture from sitting to standing/ambulation. Can be structured (i.e. after a set time), unstructured (employee driven) and/or task driven (e.g. standing to answer the phone, collecting print material). The break can be an interruption to the work task (rest break) or may just involve a change of posture (e.g. from sitting to standing). Can also be differentiated by the intensity and/or type of activity undertaken during the break (e.g. exercise, stretching, standing).
Microbreaks	Short duration (~30 seconds) breaks in sedentary time.
Australian Physical Activity Recommendation	Participation in at least 30 minutes of moderate-intensity physical activity on most days of the week. Typically interpreted as at least 150 minutes per week, on at least five days.
Self-report measures	Workers' reports on their perceptions of how much time they spend sedentary and physically active (which has the potential to be biased and probably significantly underestimates the time spent sedentary). Typically questions are asked about the previous week, or usual state.

Accelerometers	Small electronic devices that provide objective measures of sedentary and physical activity time; they generally are worn on the hip and allow detailed data on the volume and intensity of most movement to be downloaded to a computer for later analysis (Troiano et al., 2008). Lack of these movements can be used to derive time spent sedentary.
Inclinometers	Small, electronic devices that measure the posture of the body. They can be used to distinguish unambiguously between sitting or reclining, standing and moving (walking or running).

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