FYSIEK

Sitting - bad for your health?

Workstation alternatives to reduce sitting time at work

Too much sitting seems bad for your health and puts you at risk for early death. Since a large part of the working population spends the majority of their workday sitting, the workplace has great potential to address the public health problem of too much sitting. Workstation alternatives that allow desk work to be done while standing, walking, biking or stepping reduce the total time spent sitting without substantially affecting work performance. Moreover, these alternatives are acceptable to users. However, it is too early to abandon the traditional desk and chair from the office and recommend the widespread use of alternative workstations. More high quality evidence is needed with regard to the long term effects and generalizability of results to different working populations. Ergonomists could play an important role in developing recommendations for set-up and use of alternative workstations, as well as in improving their feasibility.

Maaike Huysmans, Hidde van der Ploeg, Karin Proper, Erwin Speklé en Allard van der Beek

Too much sitting (at work) and the effects on health

Traditionally, ergonomics primarily focused on protecting workers from metabolic overload, fatigue or biomechanical strain by reducing physical exposures at the workplace (Straker & Mathiassen, 2009). Reducing the exposure was appropriate for jobs that were biomechanically and physiologically too demanding. However, the technological revolution in combination with efforts to improve workers' health and safety have made that, over the last 50 years, drastic changes have occurred in working life. Occupations have moved away from work with high levels of physical activity towards occupations with low physical activity that are more mentally demanding and predominantly require sitting (Church et al., 2011; Straker & Mathiassen, 2009). Working adults spend about one half to two thirds of their working day sitting, mostly in jobs comprising extensive computer use in an office setting (Brown et al., 2003; Jans et al., 2007; Tigbe et al., 2011; Toomingas et al., 2012). Since the eighties of the last century, there is a rising awareness in ergonomics that sedentary jobs with minimal physical workloads may also put the worker at risk for musculoskeletal symptoms, giving rise to initiatives that increase exposure variation in jobs, e.g. by introducing active breaks or job rotation (Straker & Mathiassen, 2009). Not until recently, public health research has suggested that too much sitting in itself may also be detrimental to health, independent of physical inactivity.

A large epidemiological study (N = 222,497) found that prolonged sitting time is a risk factor for all-cause mortality, independent of physical activity, and is responsible for 7% of premature deaths (van der Ploeg et al., 2012). Evidence about the health effects of sitting is not consistent (e.g. Proper et al., 2011; van Uffelen et al., 2010), but several reviews have suggested that sedentary behaviour is a major lifestyle risk factor for the development of obesity, cardiovascular disease, diabetes, depression and cancer (Proper et al., 2011; Thorp et al., 2011; van Uffelen et al., 2010; Wilmot et al., 2012; Zhai et al., 2014). Sedentary behaviour is distinctly different from physical inactivity and is defined as activities that are done sitting or reclining and cost ≤ 1.5 times the basal metabolic rate (Sedentary Behaviour, 2012). Thus, people can have a physically active and sedentary lifestyle at the same time (i.e. they meet the physical activity guidelines[1] (World Health Organization, 2010) but sit for most of the remainder of the day). As interruptions of prolonged sitting are associated with metabolic health benefits (Dunstan et al., 2012; Healy et al., 2008), promising strategies to improve workers' health aim at reducing or interrupting (e.g. light intensive activities, such as standing and walking) by the total amount of time spent sitting (Chau et al., 2010; Dunstan et al., 2012; Ekblom-Bak et al., 2010; Straker & Mathiassen, 2009). Reducing sitting time might also be helpful in preventing other prevalent disorders among office workers, specifically fatigue and pain in the neck, shoulders and arms (Richter et al., 2009).

Given the many hours that office workers are sitting at their job, the workplace is an important arena for interventions aiming at reducing the total sitting time. One way to address the problem is to introduce (active) breaks from seated work, such as standing up, making short walks of just a few minutes, or doing (stretching) exercises. However, the advice to frequently break up your work to stretch your legs may not appeal to all employers or employees, because they may dread that it affects productivity, even though several studies have shown that this is not the case (Dababneh et al., 2001; Galinsky et al., 2000; Van den Heuvel et al., 2003). From the employer's perspective it may be interesting to explore solutions to reduce and break up prolonged sitting at work without interfering with workers' productivity. Since most office tasks, i.e. computer work, non-computer desk work (reading, writing), calling, attending meetings or presentations, are usually done while seated, it is worthwhile to investigate whether these tasks could also be done while standing or moving.

Figure 1. Sit-stand workstation of which the whole desk can be moved up and down (source: Ergotron).

In the present paper our aims were to: (1) give an overview of workstations that allow deskwork performed while standing, walking, stepping or biking and thereby replacing the traditional desk and office chair set-up, (2) summarize effects of these alternative workstations on the total time spent sitting and on health, and (3) give insight in the feasibility aspects of introducing these alternative workstations in the workplace. In order to meet these aims, we used the information provided by four recent systematic reviews and by the individual studies that were included in these reviews (Karakolis & Callaghan, 2014; MacEwen et al., 2014; Neuhaus et al., 2014; Tudor-Locke et al., 2014).

Alternative workstations to reduce total time or prolonged sitting at work

Alternative workstations enable office workers to perform their computer work and other desk-based tasks while standing, walking, stepping or pedalling. Different types of alternative workstations are currently commercially available and already implemented at a small scale in companies and distributed as individual or shared workstations.

Sit-stand or standing workstations

Sit-stand workstations vary with respect to the surface that can be heightened; either the whole surface (figure 1) or a small height-adjustable device holding the monitor, keyboard and mouse (figure 2) can be moved up and down. *Standing desks* can either be fixed or height-adjustable (manually or electrically), which allows working in either sitting or standing position.

Over de auteur

Dr. M.A. Huysmans, senior research scientist, Department of Public and Occupational Health and the EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands

m.huysmans@vumc.nl

1 The World Health Organization states that, to be physically active, adults should perform at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or perform at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week (or an equivalent combination of the two in bouts of at least 10 minutes duration).

Figure 2. Sit-stand workstation with a small height-adjustable device that can be fixed on top of an ordinary desk (source: Ergotron).

Figure 3. Treadmill workstation (source: Walkdesk).

Active workstations: treadmill workstations, stepping workstations, cycle ergometers and pedal devices

Treadmill workstations allow desk work while walking. They can either be fixed or height-adjustable (manually or electrically) and allow to be used in combination with a chair (figure 3). *Stepping workstations, cycle ergometers or pedal devices* allow desk work to be done while stepping or pedalling and differ with respect to the body position they are used in: either upright under a sit-stand or standing workstation (figure 4), or from a chair with the pedalling or stepping device fitted under the desk. In the latter position, even though the worker is sitting, positive cardio-metabolic health impact is expected because the large leg muscles are active.

Health effects of alternative workstations

Alternative workstations have indeed shown to reduce sedentary time (Neuhaus et al., 2014; Torbeyns et al., 2014). Meta-analyses quantified that the use of alternative workstations reduces sedentary time on average by 77 minutes per 8 hour workday (Neuhaus et al., 2014). Also, health effects have been observed with improvements on anthropometric measures (hip and waist circumference and body weight), blood markers and psychological well-being (MacEwen et al., 2014; Neuhaus et al., 2014; Torbeyns et al., 2014). Treadmill workstations led to greater improvements in anthropometrics and blood markers as compared to sit-stand workstations (MacEwen et al., 2014). All of the above reviews included a large variety of laboratory and field studies on sit-stand or active workstations with varying intervention durations and intervention content, i.e. merely providing the workers with an alternative workstation or placing alternative workstations as part of comprehensive interventions. This large heterogeneity in studies hampers drawing strong conclusions.

Musculoskeletal benefits have been reported as well with the use of sit-stand workstations, such as reduced musculoskeletal discomfort (Husemann et al., 2009), less low back pain, shoulder tension, and wrist and elbow pain (Pronk et al., 2012). A study in overweight workers found a reduction in fatigue and musculoskeletal discomfort in the lower back when replacing 4 hours of occupational sitting with 4 hours of standing over a workday (Thorp et al., 2014). Yet, too much standing may have its own detrimental health effects, such as pain in the back, legs, knees and feet and varicose veins in the legs (Chester et al., 2002; Health Council of the Netherlands, 2011; Neuhaus et al., 2014). In addition, laboratory studies found that standing was perceived less comfortable and more fatiguing than sitting (Beers et al., 2008) and led to higher levels of leg discomfort (Straker et al., 2009) in protocols of relatively short duration (maximum 20 minutes). The study of Ebara et al. (2008), on the other hand, concluded that alternating 10 minutes of sitting with 5 minutes of standing over a protocol of 150 minutes led to more musculoskeletal discomfort in the

Figure 4. Cycle ergometer (source: Deskbike).

right forearm, wrist and hand as compared to continuous sitting.

The use of a treadmill desk led to minor increases of wrist and/or leg discomfort in a laboratory study with a 6 minutes protocol of standardized computer tasks (Straker et al., 2009). In a field study among 25 nurses, getting access to treadmill workstations reduced pain in workers with low back pain as compared to the usual seated situation (Thompson et al., 2008). Effects on fatigue in the study of Thompson et al. (2008) were less clear: some participants indicated more fatigue at the end of the day, whereas others reported less fatigue.

Alternative workstations have the potential to reduce and break up prolonged sitting, which in turn may result in health benefits; however, negative (musculoskeletal) side effects may occur and should be prevented.

Feasibility of alternative workstations

Acceptability, reasons for use, facilitators and barriers

In total, 18 out of 19 studies with acceptability measures reported predominantly positive feedback and workers most often preferred the alternative workstation to a traditional sitting workstation (Neuhaus et al., 2014). More specifically, sit-stand and standing workstations were found to be easy to use, enjoyable, and comfortable (Alkhajah et al., 2012; Pronk et al., 2012). Factors that contributed to successful implementation of the sit-stand workstations included: providing instructions (Wilks et al., 2006), intrinsic motivation, and a supportive work environment (Chau et al., 2014; Grunseit et al., 2013; Neuheus et al., 2014). Therefore, among others, for successful implementation and utilization of sit-stand workstations it seems essential to properly educate and motivate workers (Wilks et al., 2006). However, barriers to use sit-stand workstations have also been identified, such as working in an open plan office (Chau et al., 2014), the need to change footwear to comfortably use the sit-stand desk (Alkhajah et al., 2012), and practical aspects regarding the desk set-up, such as the desk hitting obstacles in moving up, insufficient storage space at standing height or manual operations of the height-adjustable desk taking too much time (Grunseit et al., 2013). From an employer's perspective, costs may also work as a barrier for widespread implementation of alternative workstations (Karakolis &Callaghan, 2014). Prices for alternative workstations range widely, from around one hundred Euros for a small pedalling device that can be placed under the desk to a few thousand Euros for more fancy treadmill workstations or cycle ergometers. Other barriers mentioned in the literature were related to the ergonomic design of the specific type of sit-stand workstation used in that particular study, i.e. the type that is placed on the desk (figure 2), such as instability of the workstation when typing, an uncomfortable monitor distance, height restrictions for taller users, the loss of desk space for those who like to spread out their work materials, unsufficient support for the hands and wrists and insufficient room to move the mouse (Alkhajah et al., 2012; Chau et al., 2014).

As for treadmill workstations, only a few studies reported on feasibility aspects. Several positive aspects have been mentioned in the literature, including the ability to break up the day, the potential to increase creativity when walking on a treadmill (Straker et al., 2009), and workers' believe that treadmill workstations are not too noisy (Thompson et al., 2008). A negative aspect was that the head movement while walking relative to the computer monitor could have a dizzying effect (Straker et al., 2009). A pedalling device that can be used under the desk was found easy to use (Maeda et al., 2014) and could be seen as an improvement over the treadmill desk in terms of balance and less upper body movement when compared to regular walking (Straker et al., 2009). Negative aspects for the pedalling device were minor leg or gluteal discomfort related to the seat (Straker et al., 2009) and hitting the knees against the underside of a conventional desk (Carr et al., 2013; Maeda et al., 2014). Both of these concerns, however, seem to be design issues that can be ergonomically solved.

Workers seem to highly accept alternative workstations, especially sit-stand workstations. Perceived barriers for the use of alternative workstations, especially those involving ergonomic design aspects, can be addressed to further enhance perceived feasibility and effectiveness.

Task performance

Sit-stand and standing desks do not seem to impair task performance when compared to the traditional seated condition as indicated in four recent reviews (Karakolis & Callaghan, 2014; MacEwen et al., 2014; Neuhaus et al., 2014; Tudor-Locke et al., 2014). Active workstations that allow working while walking, stepping or pedalling could result in a slight decline in performance, especially in mouse tasks and to a lesser extent in typing tasks (Neuhaus et al., 2014; Tudor-Locke et al., 2014). However, anecdotic reports of improved task performance with alternative workstations also exist, such as improved self-rated performance and interaction with co-workers when using treadmill workstations (Ben-Ner et al., 2014; Hedge & Ray, 2004).

Sit-stand workstations do not seem to decrease task performance, while walking, stepping or pedalling workstations seem to have a small negative effect on performance, mainly on mouse tasks.

Concluding remarks

Alternative workstations have the potential to reduce and break up prolonged sitting without evidently compromising productivity. Although workers seem to accept alternative workstations, currently, it is too early to abandon the traditional desk and chair from the office and recommend the widespread use of alternative workstations. Most of the studies referred to in this paper concerned small-scale (pilot) studies among selective user populations (mostly university employees or workers of a health department), often lacking a control group, and with limited duration of the intervention (mostly several weeks up to several months in field studies, or sometimes as short as 6 min in laboratory studies). In addition, it should be realized that this paper concerns an anecdotal description of the literature. We therefore recommend a systematic review that especially focusses on the feasibility aspects of alternative workstations.

We need to establish the long-term effects and prerequisites for the successful implementation of alternative workstations and test these in large-scale randomized controlled trials in diverse office populations. Providing workers with an alternative workstation is not enough to guarantee its use and workers should at least be informed about the health benefits and receive instructions about a proper set-up and optimal use (Wilks et al., 2006). Additional intervention components could support the behavioural change process, preferably using evidence-based techniques such as goal-setting, use of feedback or use of prompts, e.g. software reminders to stand up. These components should be developed and selected in collaboration with end-users and tailored to their needs, e.g. the way that workers prefer to alternate sitting with standing, such as following a task-based or a time-based routine (Chau et al., 2014). It should be borne in mind that for optimal worker's health advices on reduced prolonged sitting (1) should not be limited to working time, but should include commuting and leisure time as well, and (2) should be combined with the advice to meet the guidelines for physical activity (Ekblom-Bak et al., 2010). Ergonomists could play a major role in (1) developing such a comprehensive intervention on alternative workstations, (2) determining the optimal design and set-up of alternative workstations, and (3) recommending on how to alternate sitting with standing or moving for optimal metabolic health and minimal musculoskeletal risks.

To conclude, alternative workstations seem to be a promising strategy to reduce the total time and prolonged time spent sitting of workers. However, research is still needed to confirm health and performance effects and to promote a successful implementation strategy.

Samenvatting

Te veel zitten lijkt de kans op gezondheidsklachten en het risico op vroegtijdig overlijden te verhogen. Aangezien veel werknemers een groot deel van de werkdag zitten, ligt het voor de hand om het probleem van te veel zitten op het werk aan te pakken. Uit onderzoek blijkt dat werkplekalternatieven, waarmee bureauwerk staand, lopend, fietsend of steppend kan worden uitgevoerd, de totale zittijd verminderen zonder dat de productiviteit noemenswaardig wordt beïnvloed. Bovendien zijn gebruikers overwegend positief over het gebruik. Het is echter te vroeg om kantoormedewerkers massaal over te laten stappen op alternatieve werkplekken. Eerst moet worden vastgesteld of de resultaten op de lange termijn standhouden en ook gelden voor diverse kantoorpopulaties. Daarnaast is er behoefte aan voorwaarden voor succesvolle implementatie en aanbevelingen over het instellen en het gebruik van alternatieve werkplekken. Hierin is een belangrijke rol weggelegd voor ergonomen.

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