Position Paper

HSE Workplace Health Expert Committee (WHEC)

Sedentary Work and Health

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WHEC Report

WHEC
Workplace Health Expert Comittee

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Foreword

The development of policy in HSE needs to be informed by the best available contemporary scientific evidence. In 2015, HSE formed the Workplace Health Expert Committee (WHEC) to provide independent expert advice to them on:

- New and emerging workplace health issues
- New and emerging evidence relating to existing workplace health issues
- The quality and relevance of the evidence base on workplace health issues

Questions about workplace health issues come to WHEC from many sources, which include HSE, trade unions, employers, interested individuals and members of WHEC. WHEC's responses to these questions are published online as reports to HSE, as position papers following investigation, or as a briefer response where the current evidence is insufficient to warrant further investigation. In cases where the evidence-base is limited WHEC will maintain a watching brief and undertake further investigation if new and sufficient evidence emerges.

In its formal considerations, WHEC aims to provide answers to the questions asked based on the available evidence. This will generally include review of the relevant scientific literature, identifying the sources of evidence relied on in coming to its conclusions, and the quality and limitations of these sources of evidence.

The purpose of WHEC reports is to analyse the relevant evidence to provide HSE with an informed opinion on which to base policy. Where there are gaps in the evidence, which mean that this is not possible, WHEC will identify these and, if appropriate, recommend how the gaps might be filled.

Executive Summary

The relationships between sedentary work and health are complex and the epidemiological research that explores these relationships is subject to significant methodological challenges and, in particular, obtaining valid measures of exposure to sedentary work behaviours, establishing behaviours away from the workplace and considering the potential for reverse causation. The health outcomes found to be of particular interest include all-cause mortality (females), cancer (females) and type 2 diabetes. Further research is needed on all of these to better estimate their significance. Whilst there is little contemporary evidence that occupational sitting is associated with an increase in musculoskeletal symptoms, such problems are reported in young workers/adolescents and should be a focus of attention, especially as this demographic will form the future workforce. As some demographic groups appear to be at greater risk of adverse health outcomes, workplace intervention strategies may seek to prioritise these groups. Attempts to reduce exposure to sedentary work in the workplace have been shown to have small but demonstrable impacts on behaviour but only when the interventions are appropriately designed. The nature of sedentary lifestyles/work and of physical activity needs further research. Currently, while physical activity in leisure time is generally seen to be beneficial for health, some physically active occupations have been associated with poorer health. This needs to be clarified to prevent confusion for both employers and employees.

Introduction

This discussion paper is based on a limited, but contemporary, review of the literature coupled with the views of selected international experts.

The relationship between sedentary work and occupational health is not a new issue and has been the subject of epidemiological research for over 60 years. In the early 1950s, Morris et al. (1953a, 1953b) demonstrated that there was a higher mortality rate and risk of first clinical episodes of coronary heart disease (CHD) and earlier onset of CHD for bus drivers than there was for the conductors. This they linked to the sedentary nature of driving. Similarly, the relationship between sedentary work and back pain has been contested for many years (e.g. Kelsey et al, 1975; Riihimaki, 1991). Much of the research in more recent years has been focused on the wider public health issues relating to a sedentary lifestyle (e.g. obesity) with sedentary work generally seen as a subset of this lifestyle.

Defining sedentary behaviours and sedentary work

Owen et al (2011) classify the four main domains in which adults typically accumulate sedentary time as: transport, leisure, domestic and occupational. Occupational sitting is considered to be that which occurs as part of or relating to work. Commuting to and from work might therefore be seen as occupational sitting. The studies referenced in this report have generally used their own research definition of 'sedentary' when classifying exposure. This variability of exposure makes direct comparison of results across studies problematic. Some have sought physiological definitions. For example, sedentary behaviour has been defined (Sedentary Behaviour Research Network, 2012) as any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture. Metabolic equivalent of task (MET) is the energy expended for an activity - defined as a ratio of the energy expended during quiet sitting (stated as oxygen used per kilogram of body weight per minute, one MET equal to the oxygen cost of sitting quietly, equivalent to 3.5 ml/kg/min.). However, this definition does not seem to have been widely adopted in epidemiological studies, presumably because it would be difficult and resource intensive to apply.

Despite a lack of standardised measures of exposure, Ng and Popkin (2012) estimate that sedentary behaviours have increased by 43% in the USA and 47% in the UK since the 1960s. Shifts in the nature and design of work are used to explain these changes. However, self-reported postural behaviours and the use of job titles as a surrogate for measurement of workplace activities, are recognised as having poor validity and reliability. As a result, most studies are subject to significant potential for exposure measurement and classification errors that may reduce strength of associations. However, recent advances in technology mean that simple, ambulatory recording devices that recognise many different physical behaviours may rapidly change our ability to record exposures in sedentary work. Such studies will inform our knowledge of potential risk and make it easier to establish the benefits of any workplace intervention strategies. Therefore, there is a need for cheap and wearable technology for the assessment of occupational sedentary behaviour (Holtermann et al, 2017) and for well–designed cohort studies to elucidate the relationship between sedentary work and a range of health problems.

What are the established health impacts of sedentary life-styles and how do these compare with the impacts of sedentary work (i.e. occupational exposure) on health?

Systematic reviews have demonstrated increased risk associations between high sedentary life-style behaviour and: all-cause mortality, cardiovascular disease, type 2 diabetes, colon, endometrial, lung and breast cancers and depression. In addition to the total amount of time spent sitting, increase in the duration of uninterrupted bouts of sedentary time are shown to be particularly harmful (Dunstan et al, 2014; Healy et al, 2011).

The evidence relating to health outcomes for sedentary work (i.e. occupational exposure) is, generally, less consistent than for sedentary lifestyle behaviours. The reason for differences may arise from the proportion of the total day that is spent in work, measurement biases in recording sitting exposure and lifestyle factors. Other potential biases, including confounding behaviours away from the workplace, also exist. For example, health-related selection bias may exist for those entering and undertaking sedentary work. If such biases exist, then it becomes difficult to make comparisons with those engaged in less sedentary/more physically active work. Confounding factors for some disorders/diseases (e.g. such as the relationship between social class and cardiovascular disease) are also problematic in much of the epidemiological research in this area.

A systematic review of health outcomes and sedentary work (van Uffelen et al, 2010) found 43 papers that met their quality inclusion criteria (21% cross sectional, 14% case control, 65% prospective with a median study-quality score of 12 points.) They examined the associations between occupational sitting and body mass index (BMI), cancer, cardiovascular disease (CVD) diabetes mellitus (DM) and mortality. Half the cross-sectional studies showed a positive association between occupational sitting and BMI, but the prospective studies failed to confirm a causal relationship. There was some evidence for a positive association between occupational sitting and cancer from case-control studies; however, this was generally not supported by the prospective studies. The majority of prospective studies found that occupational sitting was associated with a higher risk of DM and mortality.

All-cause mortality

A marginal increase in all-cause mortality was reported by Kikuchi et al (2015) among Japanese workers in primary industry, longer duration of occupational sitting was either significantly or marginally associated with higher mortality [HR 1.23, 95% confidence interval (95%CI) 1.00–1.51 among men; HR 1.34, 95% CI 0.97–1.84 among women].

Stamatakis et al (2013) found sitting occupations are linked to increased risk for all-cause and cancer mortality in ***women*** only, but that no such associations exist for cardiovascular mortality in men or women (see Table 1). In women, a standing/walking occupation was associated with lower risk of all-cause (fully adjusted hazard ratio [HR] = 0.68, 95% CI 0.52–0.89) and cancer (HR = 0.60, 95% CI 0.43–0.85) mortality, compared to sitting occupations.

Cancers

van Uffelen et al (2010) found some case-control evidence for a positive association between occupational sitting and cancer; however, this was generally not supported by prospective studies.

Table 1. All-cause mortality and work activity amongst females from Stamatakis et al (2013)

WOMEN

	All-cause Mortality			
Predominant activity at work	**Cases/total n**	**Model 1† HR (95% CI)**	**Model 2† HR (95% CI)**	**Model 3† HR (95% CI)**
Sitting	116/2090	1	1	1
Standing/walking about	149/3124	0.76 (0.59–0.97)	0.73 (0.57–0.94)	0.68 (0.52–0.89)
Trend p‡		0.030 (0.087)‡	0.016 (0.051)‡	0.005 (0.017)‡
	Cancer mortality			
Sitting	77/2090	Referent		
Standing/walking about	83/3124	0.65 (0.47–0.88)	0.60 (0.44–0.82)	0.60 (0.43–0.85)
Trend p		0.007 (0.021)‡	0.002 (0.006)‡	0.004 (0.014)‡
	CVD mortality			
Sitting	11/2090	1	1	1
Standing/walking about	31/3124	1.63 (0.82–3.25)	1.74 (0.86–3.51)	1.53 (0.72–3.24)
Trend p		0.161 (0.322)‡	0.121 (0.247)‡	0.272 (0.478)‡

†Model 1: adjusted for age; Model 2; also adjusted for waist circumference, self-reported general health, psychological health, frequency of alcohol intake, cigarette smoking, MET-hours/week of non-occupational physical activity, prevalent cardiovascular disease at baseline (angina/stroke/ischaemic heart disease), prevalent cancer at baseline; Model 3: also adjusted for occupational social class (I/II, IIINM, IIIM, IV/V) and age finished educations (15 years of age or less; 16; 17–18; 19 and over).
‡p-values in brackets correspond to the trend in the cox models when the main activity at work variable is entered in its original form with 3-categories (sitting/standing/walking about).
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Mental health

The relationship remains unclear (Proper et al, 2012; Rebar et al, 2014). Proper et al (2012) reported a cross-sectional analysis of 1064 respondents (47% men, mean age 59 years) from the Doetinchem Cohort Study 2008-2009.

Sedentary behaviour was self-reported and mental health was assessed by the Mental Health Inventory (MHI-5). Neither sitting time during transport nor at work was associated with mental health. However, they found that in the working population, sitting during leisure time, and particularly TV viewing, was associated with poorer mental health. Rebar et al (2014) examined, in a cross-sectional online survey of 1,104 Australian adults, whether overall sitting time and time spent sitting in different contexts was associated with depression, anxiety, or stress symptoms. Sitting time (time spent sitting on typical work- and non-work days while engaged in leisure activities, working, using a computer, watching television, and in transport) and symptom severity of depression, anxiety, and stress were self-reported. Overall sitting time was significantly associated with more severe depression and anxiety but not stress symptoms. Time spent sitting while at a computer was associated with more severe depression and anxiety symptoms, and time spent sitting while in transport was associated with more severe anxiety and stress symptoms. The design of the study and self-reporting may have led to measurement biases. Prospective studies are needed with appropriate exposure classification to elucidate the relationship and its direction because of the strong potential for reverse causation (e.g. depression leading to increased sedentary behaviour.)

Musculoskeletal symptoms, including back pain

For general symptoms, the relationship with sedentary work is unclear (Bakker et al, 2009; Waersted et al, 2010) although for some demographic groups and some postural demands the risks differ. It is also probable that the simple measurement of "sitting time" affords too limited an exposure to enable an estimate of risk to be ascertained with very much precision. Changes in posture, physical characteristics of the work station/environment and opportunities to take rest pauses (work organisation) are all likely to be important aspects of sedentary work demands. Roffey et al (2010) reviewed the evidence regarding occupational sitting and low back pain (LBP) but failed to identify high-quality studies to support any of the commonly-used criteria to establish causality. Based on these results, it is considered "unlikely" that occupational sitting is ***independently*** causative of LBP in the populations of workers studied. However, it is considered 'possible/uncertain' that it is a co-factor in the development or aggravation of such disorders (Note: the use of the terms 'unlikely' and 'possible/uncertain' are as defined in a Confidence and Uncertainty WHEC paper).

The ***young*** may be at risk because of the intense use of new technologies. For example, Hakala et al (2012) conclude that musculoskeletal symptoms causing moderate/severe pain and inconvenience to everyday life are common among adolescent computer users. Daily computer-use of 2 hours or more increased the risk for pain at most anatomic sites.

Type 2 diabetes

A positive association has been reported (Hu et al, 2003; Probert et al, 2008). Hu et al (2003) highlighted an association with television watching and other sedentary behaviours in relation to risk of obesity and type 2 diabetes mellitus in women. This was a large, prospective study of 68,497 women who, at baseline, were free from diagnosed diabetes mellitus, cardiovascular disease, or cancer. Each 2-hour/day increment in sitting at work was associated with a 5% (95% CI, 0%-10%) increase in obesity and a 7% (95% CI, 0%-16%) increase in diabetes. Interestingly, standing or walking around at home (2 h/d) was associated with a 9% (95% CI, 6%-12%) reduction in obesity and a 12% (95% CI, 7%-16%) reduction in diabetes. Each 1 hour per day of brisk walking was associated with a 24% (95% CI, 19%-29%) reduction in obesity and a 34% (95% CI, 27%-41%) reduction in diabetes. This finding appears to offer important opportunities to intervene on these risk factors through appropriately informed work organisation. Probert et al (2008) analysed data from the Canadian Community Health Survey and found that occupational physical activity (OPA) was found to be associated with reduced odds of self-reported diabetes, independent of leisure time physical activity status with an OR=0.72 (CI 0.58-0.9) for 'Active' v 'Sedentary. A weak dose-response relationship was also observed across the three self-reported categories of occupational physical activity, namely sedentary/moderate/or active.

Obesity

A large, prospective study (Hu et al., 2003 see above) found a positive association between sedentary work and body mass index (BMI). However, other prospective studies found no associations between sedentary work and BMI (van Uffelen et al., 2010). More recently, Eriksen et al (2015) found a positive association between change in occupational sitting time and BMI from 2005 to 2010 in women. Further prospective studies with better defined exposures are required as this is a major source of interest in public, as well as occupational, health.

Venous Thromboembolism

Whilst prolonged seated immobility during long-distance flights is related to an increased risk of venous thromboembolism (VTE), little is known on the risk related to sedentary work. Johannesen et al (2017) examined the risk of VTE according to sitting posture at work. A total of 88 077 participants from the Copenhagen City Heart Study and the Copenhagen General Population Study were included in the study cohort, all without previous thromboembolic events and aged below 65 years. Activity level at work was obtained at baseline through self-administered questionnaires. VTEs were identified through national patient registries with complete coverage. They found that sedentary work defined by a wide-range group of occupations, is not a risk factor for VTE as multivariable adjusted analyses showed no difference in risk of VTE between sedentary and walking work [hazard ratio (HR) 0.95 (95% confidence interval (CI), 0.80–1.14). Occupations with particularly high exposure to immobilised sitting positions were not addressed.

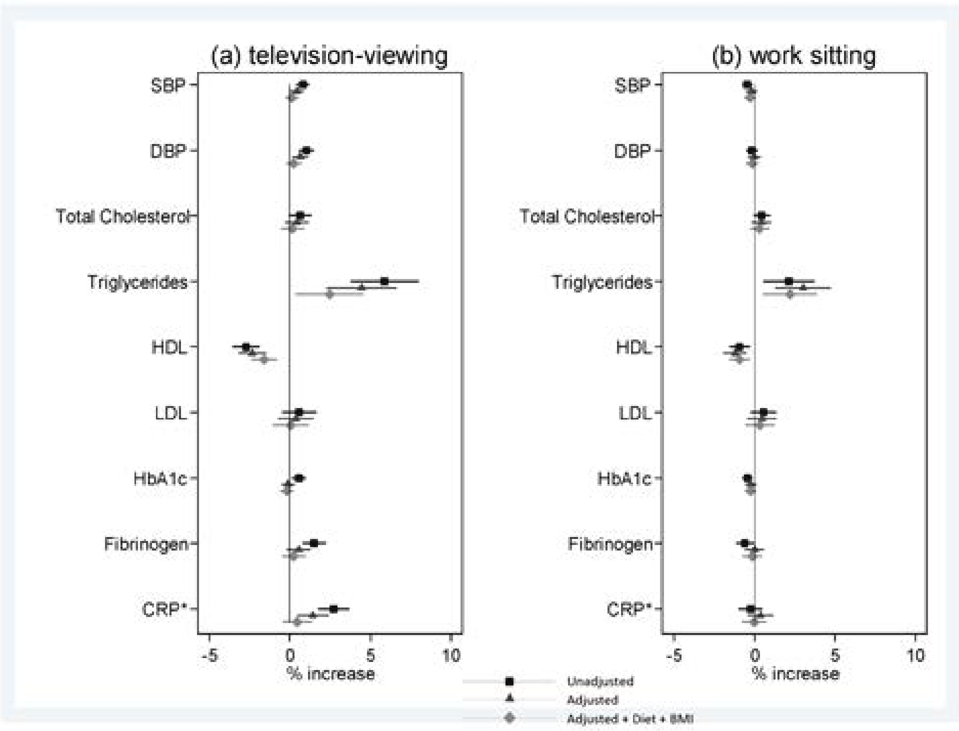

Figure 1 from Pinto Pereira et al (2012) Mean % change (95% CI) in biomarker level, for men, per category increase in television-viewing (a) and sitting at work (b).

Table 2. Estimated parameters for the categorical high/low measure of overall sitting time (Beta-estimates (ß), p-values, 95% confidence intervals (CI), and Type III p-values) from Saidj et al (2013).

CARDIO-METABOLIC RISK FACTORS	CATEGORICAL OVERALL SITTING TIME				
	Low Leisure/Low Occupational	High Leisure/Low Occupational	Low Leisure/High Occupational	High Leisure/High Occupational	Type III p-value
	Reference				
Waist circumference (cm), mean (SD)	*0*	*ß:1.0275*	*ß: 1.0065*	*ß: 1.0520*	***p<.0001***
		p<.0001	*p:.3113*	***p<.0001***	
		CI: 1.0139–1.0413	*CI: 0.9939–1.0194*	*CI: 1.0342–1.0701*	
Body mass index, BMI (kg/m^2), mean (SD)	*0*	*ß: 1.0296*	*ß: 1.0021*	*ß: 1.0629*	***p<.0001***
		p:.0010	*p:.8001*	***p<.0001***	
		CI: 1.0119–1.0476	*CI: 0.9857–1.0187*	*CI: 1.0395–1.0868*	
Body fat (%), mean (SD)	*0*	*ß: 1.4853*	*ß: 0.1784*	*ß: 2.8558*	***p<.0001***
		p<.0001	*p:.6049*	***p<.0001***	
		CI: 0.7709–2.1997	*CI: −0.4977–0.8545*	*CI: 1.9388–3.7728*	
Total cholesterol (mmol/l), mean (SD)	*0*	*ß: 0.0333*	*ß:−0.0207*	*ß: 0.1410*	*p:.1269*
		p:.5268	*p:.6774*	***p:.0361***	
		CI: −0.0698–0.1365	*CI: −0.1182–0.0768*	*CI: 0.009–0.2728*	
HDL cholesterol (mmol/l), mean (SD)	*0*	*ß: 0.9612*	*ß: 0.9776*	*ß: 0.9266*	***p<.0001***
		p:.0028	*p:.0675*	***p<.0001***	
		CI:0.9366–0.9864	*CI:0.9541–1.0016*	*CI: 0.8961–0.9581*	
LDL cholesterol (mmol/l), mean (SD)	*0*	*ß: 0.0466*	*ß: −0.0140*	*ß: 0.1893*	***p:.0074***
		p:.3159	*p:.7462*	***p:.0015***	
		CI: −0.0443–0.1371	*CI: −0.0985–0.0706*	*CI: 0.0723–0.3062*	
Triglycerides (mmol/l), mean (SD)	*0*	*ß: 1.0904*	*ß: 1.0486*	*ß: 1.1989*	***p<.0001***
		p:.0011	*p:.0562*	***p<.0001***	
		CI: 1.0352–1.1486	*CI: 0.9987–1.1009*	*CI: 1.1211–1.2821*	
Insulin (pmol/l), mean (SD)	*0*	*ß: 1.1267*	*ß: 1.1027*	*ß: 1.2930*	***p<.0001***
		p:.0004	***p:.0020***	***p<.0001***	
		CI: 1.0544–1.2038	*CI:1.0364–1.1733*	*CI:1.1871–1.4084*	
Hemoglobin A1c, HbA1c (%), mean (SD)	*0*	*ß: 0.9997*	*ß: 0.9991*	*ß: 0.9953*	*p:.7397*
		p:.9209	*p:.7812*	*p:.2849*	
		CI: 0.9931–1.0062	*CI:0.9929–1.0053*	*CI:0.9869–1.0039*	
Plasma glucose (mmol/l), mean (SD)	*0*	*ß: 0.9971*	*ß: 1.0020*	*ß: 1.0086*	*p:.5256*
		p:.6144	*p:.7024*	*p:.2446*	
		CI: 0.9859–1.0084	*CI: 0.9916–1.0126*	*CI: 0.9941–1.0234*	

Table footnotes:
All estimates are rounded to four decimals.
Models included the covariates sex, age, education, smoking, alcohol consumption, diet and moderate to vigorous physical activity (MVPA).
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Cholesterol and triglyceride levels

Positive associations have been reported (Pinto Pereira et al, 2012; Saidj et al, 2013). Pinto Pereira et al (2012) found that associations with cardiovascular disease and diabetes biomarkers in mid-adulthood differed for television-viewing and work sitting, suggesting that the role of sedentary behaviour varies by domain or that the two indicators reflect differing associations with other disease-related influences.

A few, weak associations for work sitting were found, in men only: e.g. values for HDL-cholesterol were 1.2% (0.5%, 1.9%) and 0.9% (0.3%, 1.5%) higher. Odds for metabolic syndrome were elevated by 82% and 33% respectively for men watching television or work sitting for ≥3 vs. 0–1 h/d (see also Figure 1.)

Saidj et al (2013) have reported a cross-sectional study of 2,544 working adults in a Danish population. Sitting behaviour was self-reported whilst cardio-metabolic risk factors (waist circumference, body mass index, body fat percentage, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, insulin, haemoglobin A1c and plasma glucose) were measured. Occupational sitting time was significantly and detrimentally associated with

HDL cholesterol, triglycerides, and insulin levels (see table 2). It should be noted that these were fewer and weaker associations than those found with leisure-time sitting.

Would attempting to reduce exposure to sedentary postures in the workplace make a difference?

Chau et al (2010) reviewed the literature regarding workplace studies to reduce sedentary work. They found few, high quality studies and no evidence of significant, effective interventions. Parry et al (2013) took a participatory approach to change sedentary behaviour at work. They used an RCT experimental design and demonstrated a significant reduction in sedentary time on work days (21.6%, $p = 0.006$) and during work hours (21.7%, $p = 0.014$) and a significant increase in number of breaks/sedentary hour on work days (0.64, $p = 0.005$ and during work hours (0.72, $p = 0.015$); there was a concurrent significant increase in light activity during work hours (1.5%, $p = 0.012$) and moderate/vigorous activity on work days (0.6%, $p = 0.012$). A small study by Pronk et al (2012) considered the benefits of a sit stand device for a range of workers with sedentary jobs. They reported a reduction in sitting of 66 minutes per day (representing a reduction of 224%) along with reduced upper back and neck pain and improved mood states (see Grove and Prapavessis, 1992). The study results are of interest and should be the subject of further research where problems such as random allocation to the intervention groups and improved exposure assessment might be overcome.

More recently, Coenen et al (2017) studied 14 work teams within one organisation that were randomised (by worksite) to a multicomponent program with individual-, organisational-, and environmental-level (sit-stand workstations) change strategies; or, to a control condition (no intervention). There were significant reductions in sitting and increased standing at work ($p < 0.05$). However, effects varied significantly by the presence of pre-existing low-back (but not other) symptoms, with greater benefit being seen in those without symptoms. Effects on sitting time and sitting bout duration were weaker in those with low-back symptoms compared to those without by 34.6 [95% CI (0.9; 68.3)] min/8-h workday and 5.1 [95% CI (0.2; 9.9)] min, respectively. Comparable effects were seen for standing. Hallman et al (2016) have reported that, in a prospective study of blue collar workers, more sitting time at work was associated with a significantly ($p= 0.027$) faster decline in neck-shoulder pain across 12 months (adjusted for demographic, occupational and lifestyle factors, and baseline pain) intensity over 12 months.

Whilst not a health issue, it is important to recognise that there is some (mixed) evidence exists to suggest that sedentary time may adversely impact work productivity (Brown et al, 2013; Guertler et al 2015.) This may help incentivise employers to further explore the additional benefits that might accrue from addressing the challenges of sedentary work.

Would increasing occupational physical activity help?

Physical activity (PA) is well documented to generally improve health. However, this documentation is restricted to leisure time physical activity (LTPA), for example sports, recreation and transportation (Holtermann et al, 2012) albeit that over exertion injuries can occur in many contexts. Some studies suggest that occupational physical activity (OPA) does not improve health (Li et al 2013)] and may be detrimental. These contrasting health effects of LTPA and OPA constitute the so-called physical activity health paradox (Holtermann et al, 2012) and warrant further research. Earlier research (Paffenbarger et al, 1977) suggests that work requiring high energy output may reduce risks for fatal heart attacks. The relationship between health, physically demanding and sedentary work is therefore complex. Some researchers (e.g. Baker et al, 2018) have considered, in a laboratory study, the potential for health (and performance) risks associated with prolonged standing. They found that two-hour, prolonged standing led to increased discomfort (in all body areas studied) and that reaction time and mental state deteriorated, while creative problem-solving improved. Further studies are required, and the authors suggest caution in replacing sitting with standing in office work.

Concluding Comments

- The relationship between sedentary work and sedentary lifestyle is complex. The relationships between each of these and health outcomes is not consistent. In some instances, this appears contradictory.
- Methodological challenges in studying this issue are not helped by the difficulty that exists in obtaining valid measures of 'exposure' to sedentary work.
- Health outcomes of particular interest include all-cause mortality (females), cancer (females) and type 2 diabetes.
- Musculoskeletal problems in young workers/adolescents should be a focus of attention, especially as this demographic will form the next workforce. Perhaps surprisingly there is little contemporary evidence that occupational sitting for the general working population is associated with an increase in musculoskeletal symptoms. This appears inconsistent with earlier research into, for example, the biomechanics of back pain.
- As some demographic groups appear to be at greater risk of adverse health outcomes, workplace intervention strategies may seek to prioritise these groups.
- Attempts to reduce exposure to sedentary work in the workplace have been shown to have small but demonstrable impacts on behaviour but only when the interventions are appropriately designed and conform with the principles of ergonomics and human factors.
- Opportunities for reducing prolonged periods of sitting through better work organisation should be further studied.
- Prolonged sedentary work may affect work performance, so should be of interest to employers. Potential benefits of different forms of work organisation (perhaps aimed at specific, segmented groups of the workforce) coupled with postural variety should be researched further. For example, Buckley et al (2014) demonstrated that standing after lunch causes blood glucose levels to subside more quickly, perhaps suggestive of a beneficial mechanism in those with poor glucose control.
- There is a possible paradox, at a simplistic level, that physical activity in leisure time is, generally, health beneficial but that some physically active occupations may result in poorer health. This needs to be clarified to prevent confusion amongst employers and employees.

References

Baker, R Coenen, P Howie, E Lee, J Williamson A & Straker L (2018) Br. J. Sports Med. 52(3):176 – 183. A detailed description of the short-term musculoskeletal and cognitive effects of prolonged standing for office computer work, Ergonomics, 61,7, 877-890.

Bakker, E.W., Verhagen, A.P., van Trijffel, E., Lucas, C., Koes, B.W., (2009). Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies. Spine 34, E281eE293.

Brown, H. E., Ryde, G. C., Gilson, N. D., Burton, N. W., & Brown, W. J. (2013). Objectively measured sedentary behavior and physical activity in office employees: relationships with presenteeism. J. Occup Environ Med, 55(8), 945-953.

Buckley, J.P., Mellor, D.D., Morris, M. and Joseph, F., (2014). Standing-based office work shows encouraging signs of attenuating post-prandial glycaemic excursion. Occup Environ Med, 71, 109-11).

Chau JY, der Ploeg HPv, van Uffelen JGZ, Wong J, Riphagen I, et al. (2010) Are workplace interventions to reduce sitting effective? A systematic review. Prev Med 51: 352–356.

Chau, J.Y., van der Ploeg, H.P., Merom, D., Chey, T., Bauman, A.E., (2012). Cross-sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. Prev. Med. 54, 195e200.

Coenen P, Gilson G, Healy GN, Dunstan DW, Straker LM (2017) A qualitative review of existing national and international occupational safety and health policies relating to occupational sedentary behaviour. Appl Ergon 60:320–333.

Coenen, P., et al., (2018). Associations of occupational standing with musculoskeletal symptoms: a systematic review with meta-analysis. Br. J. Sports Med. 52(3):176-183

Coenen, P., Healy, G.N., Winkler, E.A.H. et al. (2017) Pre-existing low-back symptoms impact adversely on sitting time reduction in office workers Int Arch Occup Environ Health 90: 609.

Dunstan, D., et al., (2014). Action Area 5: Prolonged Sitting, In Blueprint for an Active Australia. 2nd edition Melbourne National Heart Foundation of Australia, Melbourne, Australia.

Eriksen D, Rosthøj S, Burr H, Holtermann A. (2015) Sedentary work--associations between five-year changes in occupational sitting time and body mass index. Prev Med. 73:1-5.

Grove J, and Prapavessis H. (1992) Preliminary evidence for the reliability and validity of an abbreviated Profile of Mood States. Int J Sport Psychol. 23(2):93-109.

Guertler D, Vandelanotte C, Short C, Alley S, Schoeppe S, Duncan MJ. (2015) The association between physical activity, sitting time, sleep duration, and sleep quality as correlates of presenteeism.J Occup Environ Med. 57(3):321- 328.

Hakala P et al. (2012) Musculoskeletal symptoms and computer use among Finnish adolescents - pain intensity and inconvenience to everyday life: a cross-sectional study. BMC Musculoskeletal Disorders13:41.

Hallman DM, Gupta N, Heiden M, Mathiassen SE, Korshøj M, Jørgensen MB and Holtermann A. (2016) Is prolonged sitting at work associated with the time course of neck-shoulder pain? A prospective study in Danish blue-collar workers. BMJ Open. Nov 10;6(11).

Healy, G.N., Matthews, C.E., Dunstan, D.W., Winkler, E.A., Owen, N., (2011). Sedentary time and cardio-metabolic biomarkers in US adults: NHANES 2003-06. Eur. Heart J. 32, 590e597.

Holtermann, A., Hansen, J., Burr, H., Sogaard, K., & Sjogaard, G. (2012). The health paradox of occupational and leisure-time physical activity. British Journal of Sports Medicine, 46, 291-295.

Holtermann, A Schellewald, V, Mathiassen, S et al (2017) A practical guidance for assessments of sedentary behaviour at work Applied Ergonomics, 63, 41-52.

Hu, F.B., Li, T.Y., Colditz, G.A., Willett, W.C., Manson, J.E., (2003). Television watching and other sedentary behaviours in relation to risk of obesity and type 2 diabetes mellitus in women. JAMA 289, 1785e1791.

Johannesen CDL, Flachs EM, Ebbehøj NE, et al (2017) Sedentary work and risk of venous thromboembolism Occup Environ Med ;74: A51-A52.

Kelsey, J (1975) An epidemiological study of the relationship between occupations and herniated lumbar intervertebral discs. Int. J Epidemiology 4. 197-205.

Kikuchi H, Inoue S, Odagiri Y, Inoue M, Sawada N, Tsugane S; (2015) Occupational sitting time and risk of all-cause mortality among Japanese workers. Japan Public Health Centre (JPHC) study group. Scand. J. Work Environ. Health. 41(6):519- 528.

Li J, Loerbroks A, Angerer P. (2013) Physical activity and risk of cardiovascular disease: what does the new epidemiological evidence show? Current Opinion in Cardiology; 28:575-583.

Morris, J. N., Heady, J. A., Raffle, P. A. B., Roberts, C. G., & Parks, J. W. (1953a). Coronary heart-disease and physical activity of work. The Lancet, 2, 1053–1057.

Morris, J. N., Heady, J. A., Raffle, P. A. B., Roberts, C. G., & Parks, J. W. (1953b). Coronary heart-disease and physical activity of work. The Lancet, 2, 1111–1120.

Morris, J. N., Kagan, A., Pattison, D. C., Gardner, M. J., & Raffles, P. A. B. (1966). Incidence and prediction of ischaemic heart-disease in London busmen. The Lancet, 2, 553–559.

Ng SW, Popkin BM. (2012) Time use and physical activity: a shift away from movement across the globe. Obes. Rev. 13(8), 659-680.

Owen, N., Sugiyama, T., Eakin, E. E., Gardiner, P. A., Tremblay, M. S., & Sallis, J. F. (2011). Adults' sedentary behavior determinants and interventions. Am J Prev Med, 41(2), 189-196.

Paffenbarger, R Hale, W Brand, R Hyde R (1977) Work-energy level, personal characteristics, and fatal heart attack: a birth-cohort effect, American Journal of Epidemiology, 105, 200–213.

Parry S, Straker L, Gilson ND, Smith AJ. (2013) Participatory workplace interventions can reduce sedentary time for office workers--a randomised controlled trial. PLoS One. 2013 Nov 12;8(11):e78957

Pinto Pereira, S.M., Ki, M., Power, C., (2012). Sedentary behaviour and biomarkers for cardiovascular disease and diabetes in midlife: the role of television-viewing and sitting at work. Plos One 7, e31132.

Probert, A. W., Tremblay, M. S., & Gorber, S. C. (2008). Desk potatoes: the importance of occupational physical activity on health. Canadian Journal of Public Health, 99(4), 311-318.

Proper, K.I., Picavet, H.S., Bemelmans, W.J., Verschuren, W.M., Wendel-Vos, G.C., (2012). Sitting behaviours and mental health among workers and non-workers: the role of weight status. J. Obes. 2012, 607908.

Pronk NP, Katz AS, Lowry M, Payfer JR. (2011) Reducing Occupational Sitting Time and Improving Worker Health: The Take-a-Stand Project. Prev Chronic Dis 2012;9:110323.

Rebar, A.L., Vandelanotte, C., van Uffelen, J., Short, C., Duncan, M.J. (2014). Associations of overall sitting time and sitting time in different contexts with depression, anxiety, and stress symptoms. Ment. Health Phys. Act. 7, 105e110.

Riihimaki, H (1991) Low back pain, its origin and risk indicators. Scan Jnl Work Environ and Health, 17, 81-90

Roffey D, Wai E, Bishop P, Kwon, B, Dagenais S, (2010) Causal assessment of occupational sitting and low back pain: results of a systematic review, Spine 10, 252-261.

Saidj, M., Jorgensen, T., Jacobsen, R.K., Linneberg, A., Aadahl, M. (2013). Separate and joint associations of occupational and leisure-time sitting with cardio-metabolic risk factors in working adults: a cross-sectional study. Plos One 8, e70213.

Stamatakis E, Chau JY, Pedisic Z, Bauman A, Macniven R, et al. (2013) Are Sitting Occupations Associated with Increased All-Cause, Cancer, and Cardiovascular Disease Mortality Risk? A Pooled Analysis of Seven British Population Cohorts. PLoS ONE 8(9): e73753.

Straker, L., Coenen, P., Dunstan, D., Gilson, N., Healy, G. (2016), Sedentary Work – Evidence on an Emergent Work Health and Safety Issue – Final Report, Canberra: Safe Work Australia

van Uffelen, J.G., et al., (2010). Occupational sitting and health risks: a systematic review. Am J Orev Med 39, 379 - 388

Waersted, M., Hanvold, T.N., Veiersted, K.B., 2010. Computer work and musculoskeletal disorders of the neck and upper extremity: a systematic review. BMC Musculoskelet. Disord. 11, 79.

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