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IN-DEPTH REVIEW

A review of occupational physical activity and sedentary behaviour correlates

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Background	Physical activity reduces the risk of morbidity and high sedentary time may be associated with negative health outcomes. The workplace offers an arena to promote physical activity and reduce sedentary time, but existing workplace-based interventions have typically yielded small effects.
Aims	To collate the literature on correlates of occupational physical activity and sedentary behaviour and to inform future novel approaches to workplace-based intervention or policy.
Methods	Systematic literature searches were conducted in December 2014 using multiple databases. Identified papers were screened against an inclusion criterion. Papers were deemed eligible for this review if they included occupational physical activity and sedentary behaviour as an outcome, were quantitative observational studies and included an adult working population. Identified correlates of occupational physical activity and sedentary behaviour were organized into levels of the socioecological model.
Results	Forty studies met the inclusion criterion. A higher number of studies included only occupational physical activity, not sedentary time, as an outcome and were carried out in the USA and Australia. The review identified that white-collar workers are at greater risk of low occupational physical activity and high sedentary time. The majority of correlates found to be associated with occupational physical activity and sedentary time were intrapersonal and non-modifiable.
Conclusions	Intervention efforts to increase occupational physical activity and reduce sedentary time may be most effective when targeted at white-collar workers. Research is needed to identify additional modifiable correlates of occupational physical activity and sedentary behaviour, in white-collar workers.
Key words	Occupation; physical activity; review; sedentary behaviour; socioecological correlates.

Introduction

Regular participation in physical activity aids in the reduction of non-communicable disease risk factors [1]. Sedentary time has been found to be associated with negative health issues such as metabolic syndrome, heart disease and mental ill health, independently of physical activity levels [2–6]. However, physical activity has been shown to attenuate these associations. For example, sedentary behaviours have been consistently associated with risk of cardiovascular disease in population cohort studies, although associations tend to be most marked in participants reporting low levels of moderate-to-vigorous intensity physical activity (MVPA) [7]. In light of this research, recommendations for physical activity levels have been developed. In adults, a total of 30 min of moderate intensity physical activity on at least 5 days a week has been recommended for good health [8]. However, worldwide ~31% of adults do not meet recommended physical activity guidelines and interventions to increase physical activity and reduce sedentary time are needed [9].

The workplace offers both a captive audience and an arena to promote physical activity and reduce sedentary time. To date, there have been two reviews on workplace-based interventions to increase physical activity [10,11]. The majority of the interventions identified in the reviews have been based on bolstering workers'

motivation or capability for translating motivation into action or offering greater physical activity opportunities to those motivated to be more active. These interventions have typically yielded small effects [10–12]. Workplace-based interventions have also been carried out to reduce overall sitting time (one domain of sedentary behaviour). A recent systematic review identified six workplace-based interventions targeting sitting time of which none showed a significant effect [13]. These interventions targeted participants at the individual level only. More recently, reductions in sitting time have been demonstrated by introducing interventions such as sit-stand workstations and point of choice prompting computer software [14,15].

Studies identified in these reviews have predominantly used intra-individual models or theories of behaviour change (e.g. Transtheoretical Model of behaviour change) to inform physical activity and sedentary interventions [10,11,13]. These models propose that physical activity is primarily influenced by the individual's attitudes and beliefs and therefore have limited scope to embrace physical, social and political environmental factors that are also likely to be important. Socioecological models, in contrast, acknowledge that an understanding of intrapersonal (e.g. psychological, demographic, unique to an individual), interpersonal (e.g. social climate, significant others, information sharing), physical environmental (e.g. built environment, furniture) and political (e.g. incentivization, coercion, job description) level factors are likely to be required to achieve the greatest changes in behaviour. The varying factors of socioecological models consist of correlates of behaviour. Therefore, to achieve the greatest changes in behaviour, these correlates need to be identified and understood.

The majority of workplace-based interventions have targeted overall physical activity and sitting time, but not occupational activity specifically [10,11,13]. The workplace may be specifically conducive to occupational sitting time and inhibit occupational physical activity levels [2,16]. At work, people may be restricted to predominantly sedentary activities, especially if they have sedentary occupations (e.g. call centre or office workers). A recent study of office-based workers residing in England demonstrated high levels of sitting and low levels of physical activity during the working day [17]. Designing interventions that specifically target occupational physical activity and sedentary behaviour may offer additional opportunity for behaviour change [18]. In support, two recent interventions targeted occupational sitting time and both produced large effects [14,18].

In recent years, the number of studies exploring socioecological correlates of occupational physical activity and sedentary behaviour has grown. However, to date, this literature has not been collated. This paper reviews existing observational literature on the correlates of occupational physical activity and sitting behaviour, in adult working populations, and uses the socioecological model as a framework to organize and understand findings.

Methods

In December 2014, a literature search was performed using the following electronic databases: Embase, Ovid MEDLINE, PsycINFO and Health and Psychosocial Instruments. Only peer-reviewed journal articles were considered. Manuscripts published in any country and written in English were eligible. No restrictions on date of publication were set. Search terms used referred to workplace or occupation (exposure) and physical activity or sedentary behaviour (outcome), see Table 1 for syntax. Ethical approval was not required to carry out a review of this literature.

Papers were deemed eligible for the study if they included objectively or subjectively measured occupational physical activity or sedentary behaviour as an outcome, were quantitative observational studies (cross-sectional and longitudinal) and included an adult working population. Papers were excluded if they examined physical activity or sedentary behaviour only as a covariate, used an interventional design (occupational physical activity and sedentary interventions have been reviewed recently [10,11,13] and are therefore not included in this review) or examined only physical fitness as an outcome.

Titles and abstracts of all identified papers from the electronic searches were initially screened independently by three reviewers who assessed suitability of the study according to the inclusion and exclusion criteria. Retained full-text articles were then screened for suitability by all reviewers. At all stages of screening, inconsistencies between the reviewers were resolved by discussion.

Three reviewers extracted the following data from each identified manuscript: author, year of publication, title, journal, study sample characteristics (e.g. country and age), sample size, study design, workplace/job type, exposure and exposure measure, outcome and outcome measure and key findings. They assessed the quality of each study using the Critical Appraisal Skills Programme (CASP; www.casp-uk.net), used in a recent review on physical activity and transitioning to retirement [19]. The checklist asks 14 and 12 questions for longitudinal and cross-sectional studies, respectively, and evaluates the overall validity of a study. A score out of 14 or 12 was given for each study with a higher score representing a higher quality of study. Studies were scored based on reviewers' opinions on whether a study met a criterion; inconsistencies between reviewers' opinions were resolved by discussion.

Results

The database search yielded 6197 citations. When duplicates were removed and studies were limited to English and human samples, 3110 citations were

retained. On completion of title and abstract screening and full-text review to assess each study's compliance with the inclusion and exclusion criteria, 39 papers were retained. Citations of these papers were then screened. An additional 10 eligible papers were identified and 1 was retained after full-text review. The flow of citations through the systematic review process is shown in Figure 1.

Table S1 (available as Supplementary data at *Occupational Medicine* Online) contains a summary of the characteristics of the studies reviewed. A total of 40 studies were included in the present review, 30 were on occupational physical activity, 10 were on occupational sedentary behaviour and one included both physical activity and sedentary behaviours. Of these studies, three were longitudinal, all of which had occupational physical activity as an outcome, and 37 were cross-sectional. A higher number of studies were carried out in the USA and Australia (USA = 8 and Australia = 11) than any other individual country (note: one study investigated correlates in multiple countries). The majority of studies included both men and women (n = 37) and had no restriction by occupational type (n = 30).

Occupational physical activity was measured using numerous subjective measures (e.g. Kaiser Physical Activity Survey, National Health Interview Survey (www.cdc.gov), Tecumseh Occupational Physical Activity Questionnaire and the International Physical Activity Questionnaire) and two objective (i.e. pedometer and accelerometer; see Table S1, available as Supplementary data at *Occupational Medicine* Online) [20–22]. A range of outcomes were used to categorize physical activity (e.g. time spent in MVPA and step counts). The majority of items used to measure occupational sedentary behaviour were subjective (e.g. the Self-report Active Australian Questionnaire and the Quebec Health and Social Survey) and one was objective (accelerometers; see Table S1, available as Supplementary data at *Occupational Medicine* Online) [23,24]. Outcomes derived from the tools varied and included occupational sitting time, working posture and accelerometer counts. Because the outcome measures for both physical activity and sedentary behaviour were heterogeneous, a meta-analysis was considered inappropriate.

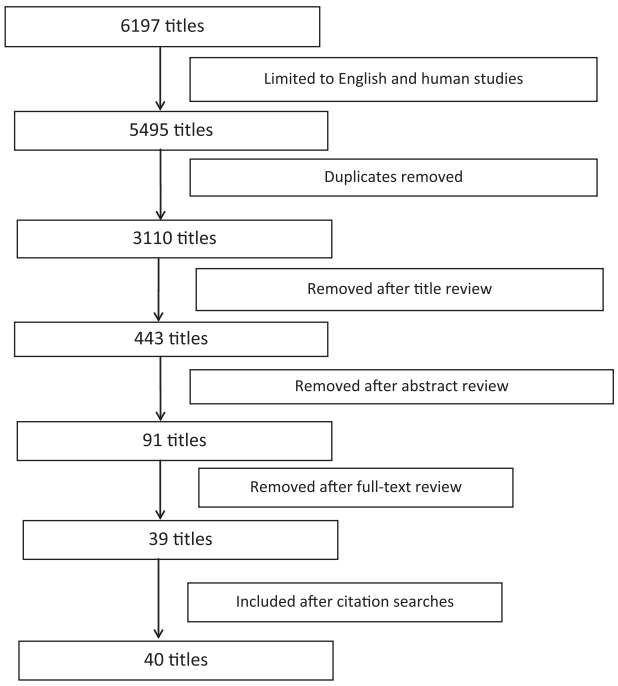

Figure 1. Flow of citations through the systematic review process.

The quality assessment of studies is presented in Table 2. The majority of studies were scored highly on the CASP criteria; cross-sectional studies (CASP scale 0–12) had a range of 6–12 and a median of 10.15. Three longitudinal studies (CASP scale 0–14) had a range of 13–14 and a median of 14 (Table 2).

Correlates that produced null associations with physical activity and sedentary behaviour are not the focus of this review, although reported in Tables 3 and 4. These correlates are least likely to inform physical activity and sedentary behaviour change. Therefore, the following results and discussion will focus on those correlates that were identified to have positive or negative associations with occupational physical activity or sedentary behaviour.

Of the intrapersonal correlates studied, belonging to a minority ethnic group, being male, having a high level of household activity, having a low language acculturation, being a smoker, having a high self-efficacy, having a low SES, using an active mode of travel and having a blue-collar occupation were positively associated with occupational physical activity [26–28, 30–39, 42, 46, 47, 64, 67]. Having a high level of education, leisure time reading, and working in a call centre were negatively associated with occupational physical activity [32, 35, 40, 42–44, 62, 67]. Of the two interpersonal correlates studied, positive social factors (for example, where one's colleagues were physically active or the manager believes physical activity is important) and not being married were positively associated [31, 35]. Among the physical environmental correlates, having more green space in the neighbourhood and having positive perceptions of the workplace environment were positively associated with occupational physical activity [31, 40, 45–47]. High community level urbanization was negatively associated [41]. No papers investigated political correlates of occupational physical activity (Table 3).

Table 1. Syntax

Concept	Search term
Working environment	Office or workplace or worksite or occupation or worker or employee
Behaviour	Physical activity or exercise or step or sedentary or sitting or stair

Table 2: CASP study quality scoring

Author and year published	Score
Physical activity	
Cross-sectional (scale 0 to 12)	
Bauman (2011)	12
Belanger (2011)	6
Bennie (2010)	11
Clemes (2014)	9
Dahl-petersen (2011)	9
Ding (2011)	12
Esquirol (2009)	9
Florindo (2009)	12
Im (2012)	8
Ju (2011)	10
Khaing Nang E (2010)	9
Ma (2011)	10
Marquez (2010)	9
Meseguer (2011)	9
Mytton (2012)	11
Oppert (2006)	10
Oppert (2006)	12
Popham (2007)	12
Prodaniuk (2004)	9
Ramey (2014)	9
Schofield (2005)	12
Steele (2003)	9
Sternfeld (1999)	11
Thorp (2012)	11
Umukoro (2013)	11
Vaughan (2008)	11
Wolin (2006)	10
Longitudinal (scale 0 to 14)	
Cornelio (2008)	14
Monda (2007)	13
Plotnikoff (2010)	13
Sedentary	
Cross-sectional	
De Cocker (2014)	9
Duncan (2010)	11
Jans (2007)	10
Miller (2004)	10
Mummery (2005)	12
Thorp (2012)	11
Tissot (2005)	9
Toomingas (2012)	10
Vandelanotte (2013)	10
Bennie (2011)	11

Of the intrapersonal correlates studied, being in full-time employment, working in a call centre, having a high level of leisure time sitting, having a high body weight, being older, having a high level of education and a high income were positively associated with occupational sedentary behaviour. Having a blue-collar occupation and being a smoker were negatively associated [23, 24, 44, 48–52]. Among the political correlates identified, repetitive work, handling heavy loads at work and forceful exertion at work were negatively associated with occupational sedentary behaviour, whereas a low job strain (the perception of little control over one's work while facing high job demands) was positively associated [24]. No papers identified in the present review investigated interpersonal or physical environmental correlates of occupational sedentary behaviour (Table 4).

Discussion

The majority of occupational physical activity correlates identified in this review were intrapersonal. For example, Belonging to a minority ethnic group, being from a lower socio-economic status (SES) group (indexed by income, education or employment type) and being male were associated with higher levels of occupational physical activity. The present review also identified correlates that were positively (e.g. being in full-time employment, working in a call centre and being an older age) or negatively (e.g. having a blue-collar occupation and smoking) associated with occupational sedentary behaviour.

This is the first systematic review of literature on occupational physical activity and sedentary correlates. The broad variety of search databases utilized, as well as extensive reference searches, reduced the risk of selection bias. However, there is a potential influence of publication bias, with negative and null findings remaining in the 'file drawer'. The score produced by the CASP is difficult to interpret because it cannot be compared to a common metric and it is unknown if the scale operates on a linear basis. Thus, the tool can only be used to gauge the quality of papers against one another.

The majority of occupational physical activity correlates identified in this review were intrapersonal. However, these are likely to be confounded. Data from 2011 showed that 1 in 3 full-time UK male workers was in production industries (a 'blue-collar' occupation) compared with 1 in 10 full-time female workers [53]. In 2000, 19% of white American males were in production industries compared with 28% of Black African males [54]. Interestingly, the present review also identified that having a blue-collar occupation was also associated with higher occupational physical activity. For example, Bennie *et al.* [31] found that 73% of blue-collar workers reported being physically active at or around the workplace, compared with 62% of white-collar workers and 60% of professional workers, in a sample of 1107 Australian adults. It may be that associations found between the intrapersonal correlates and occupational physical activity are confounded by occupation type. However, it should be noted that in a recent review white-collar workers reported higher levels of leisure time physical activity than blue-collar workers [55].

The discussed intrapersonal correlates identify groups who are at risk of low levels of occupational physical activity. While these correlates cannot be feasibly modified

Table 3. Correlates of occupational physical activity

Exposure	*n*	Positive association	Null association	Negative association
Physical activity				
Intrapersonal factors				
Minority ethnic group	3	[26,32]		[25]
High level of household activity	1	[35]		
High level of education	6			[32,35,40*,42,43,67]
Smoking	2	[32,35]		
High self-efficacy	3	[46,47]		[35]
Being male	10	[27,28,30–34,42]	[37,61]	
High leisure time physical activity	2		[61]	[59]
Blue-collar workers (versus other)	5	[31,37–39,67]		
Call centre workers (versus indoor occupations)	1			[44]
Shift workers	2	[60]	[29]	
Low SES	3	[27,42,64]		
Health/self-perceived health/ BMI	4	[35]	[42,35]	[32,33]
Low language acculturation	1	[36]		
High leisure time reading	1			[62]
Leisure time screen time	1		[62]	
Active travel	1	[37]		
Sport and exercise	1		[37]	
Total screen time	1		[37]	
Older age	5	[27,42]		[32,33,63]
Interpersonal factors				
Positive social factors	1	[31]		
Relationship status (not married)	1	[35]		
Physical environment				
More green space/predominantly rural	2	[40*,45]		
High level urbanization	1			[41]
Non-farming season (farming specific)	1			[39]
Positive workplace perceptions/perceived workplace environment	3	[31,46,47]		

*For two or more countries studied; BMI, body mass index.

(e.g. sex, ethnicity, SES and non-blue-collar occupation) to increase levels of occupational physical activity, it is informative for researchers to know that these groups may require targeted intervention. Two modifiable interpersonal and physical environmental correlates were identified in this review, including level of social support (e.g. employees who perceive their managers to support physical activity at work were more likely to be active at work) and perceptions of the workplace environment. Encouraging managers to support physical activity (e.g. leading walking groups during lunch breaks) or manipulating the workplace environment to generate positive perceptions (e.g. creating an aesthetically pleasing working environment) may be effective strategies to increase occupational physical activity levels, particularly in non-blue-collar workers (e.g. desk-based workers).

Inconsistent findings exist in the literature, for example, eight studies found that being male was associated with higher levels of occupational physical activity, while two studies found no significant association. All studies scored similar on the CASP scale. Therefore, these different findings may be explained by the social and political contexts of the different countries studied or the different outcome measures used (objectively measured occupational step counts versus self-report occupational physical activity levels). Moreover, these differences may reflect differences in statistical power between the studies.

The majority of identified sedentary behaviour correlates were intrapersonal and no correlates that can be feasibly modified to reduce occupational sedentary time were found. Nonetheless, understanding these correlates is still important. Working in a blue-collar occupation was found to be consistently and negatively associated with occupational sedentary behaviour. It is likely that blue-collar workers accumulate lower levels of occupational sedentary time, owing to the nature of the work. A production line worker is likely to adopt a standing posture to carry out tasks at work (e.g. assembling car parts as they come down the production line), whereas a non-blue-collar worker is likely to remain seated (e.g. cold calling or working at a computer). Interestingly, working in a call centre has been found to be associated with higher levels of sedentary behaviour than other indoor occupations [44]. It is therefore possible that differences in sedentary behaviour between job roles within

Table 4. Correlates of occupational sedentary behaviour

Exposure	*n*	Positive association	Null association	Negative association
Sedentary				
Intrapersonal factors				
Full-time employment (versus part time or casual)	4	[24,48–50]		
Blue collar (versus professional and white)	6			[23,48–52]
Call centre workers (versus indoor occupations)	1	[44]		
High leisure time sitting	1	[48]		
Leisure time activity	2	[24]	[51]	
High body weight	3	[24,50,51]		
High overall step count	1			[52]
Being male	4	[50,51]		[65,66]
Older age	3	[24,51]		[50]
Higher education	2	[24,50]		
Higher income	2	[24,50]		
Smoking	1			[24]
Political				
Repetitive work	1			[24]
Handling of heavy loads at work	1			[24]
Forceful exertion at work	1			[24]
Psychological job demands	1		[24]	
Low job strain	1	[24]		

similar settings arise from other levels of influence (e.g. political). Workplace policies might exist that discourage call centre workers from leaving their desk during unscheduled breaks which can interrupt periods of prolonged sitting, while these policies may not exist for desk-based professionals. However, this hypothesis has not been tested.

Although no modifiable occupational sedentary behaviour correlates were identified in this review, one possible solution to decrease sitting time in white-collar workers is to adopt a similar working posture to those in blue-collar occupations (i.e. standing). This has been attempted in workplace-based interventions using 'standing hot desks' [14,56]. In a study of Australian office workers ($n = 11$), Grunseit *et al.* found that the introduction of standing hot desks into the workplace resulted in a mean 2 h per day decrease in sitting time ($P = 0.014$) between baseline and follow-up [56]. Further research is needed to provide a precise estimate of the effect of standing hot desks in other populations.

The findings from this review suggest that those at the greatest risk of low levels of occupational physical activity and high occupational sedentary time are white-collar workers and interventions may be better targeted towards these populations. However, further research to identify modifiable socioecological correlates is needed. It is plausible to assume that distances required to reach office building destinations (e.g. printers, refreshment points, toilets, meeting rooms and stairs/elevator) could influence daily step counts and breaks in sitting time. If a printer is located a long distance from a worker's desk, the worker may compensate for this distance and 'bulk' print documents once or twice a day possibly accumulating a high number of steps but few breaks in sitting time. Conversely, if the printer is located close to the worker's desk, the worker may print regularly and accumulate a high number of daily breaks in sitting time but few steps. There may be an optimal distance where the worker accumulates both a high number of daily steps and a high number of breaks in sitting time but to date this hypothesis has not been tested. The authors of this manuscript are currently investigating how the layout of UK office buildings influences the physical activity and sitting behaviour of their occupants [57]. Moreover, recent research has suggested that the broader office environment can beneficially impact on standing time in office workers [58]. Out of the 40 papers identified in the current review, just 10 papers researched occupational sedentary behaviour. This is an understudied research area in comparison to correlates of occupational physical activity and one that requires attention.

Key points

- The present review aimed to collate the literature on correlates of occupational physical activity and sedentary behaviour.
- Intervention efforts to increase occupational physical activity and reduce sedentary time may be most effective when targeted at white-collar workers.
- Research is needed to identify additional modifiable correlates of occupational physical activity and sedentary behaviour, in white-collar workers.

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Conflicts of interest

None declared.

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