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Sawyer, A., Smith, L., Ucci, M., Jones, R., Marmot, A. and Fisher, A. (2017) Perceived office environments and occupational physical activity in office-based workers. *Occupational Medicine*, 67(4), pp. 260-267.(doi:10.1093/occmed/kqx022)

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Perceived office environments and occupational physical activity in office-based workers

ABSTRACT

Background: Individuals in office-based occupations have low levels of physical activity but there is little research into the socio-ecological correlates of workplace activity.

Aims: To identify factors contributing to office-based workers' perceptions of the office environment and explore cross-sectional relationships between these factors and occupational physical activity and sitting.

Methods: Participants in the Active Buildings study reported perceptions of their office environment using the Movement at Work Survey. A principal component analysis (PCA) was conducted on survey items. A sub-sample wore the ActivPAL^{3TM} accelerometer for 3 or more workdays to measure occupational step count, standing, sitting and sit-to-stand transitions. Linear regression analyses assessed relationships between environmental perceptions and activity.

Results: There were 433 participants, with accelerometer data available for 115 participants across 11 organisations. The PCA revealed four factors: 1) perceived distance to office destinations, 2) perceived office aesthetics and comfort, 3) perceived office social environment, 4) perceived management discouragement of unscheduled breaks. Younger

participants perceived office destinations as being closer to their desk. Younger and female participants perceived more positive office social environments; there were no other socio-demographic differences. Within the sub-sample with accelerometer data, perceived discouragement of breaks by management was related to occupational step count/hour (B=-64.5; 95%CI:-109.7 to -19.2). No other environmental perceptions were related to activity or sitting.

Conclusions: Perceived managerial discouragement of breaks could be related to meaningful decreases in occupational step count. Future research should aim to elucidate the role of the workplace socio-cultural environment in occupational walking, with a focus on the role of management.

Key words: movement, sedentary jobs, social environment, work environment

INTRODUCTION

Low levels of physical activity are associated with non-communicable disease risk factors in high-income countries and can account for up to 3% of total healthcare costs and 10% of wider societal costs (1-4). Introducing more opportunities to perform light and moderate intensity activity (such as walking and standing) and reduce periods of sitting has been suggested as an effective and achievable way to obtain meaningful health benefits at population level (5,6). Understanding the determinants of these behaviours is therefore a public health priority.

Socio-ecological models of physical activity hypothesise that policy, physical and socio-cultural environments and individual characteristics influence activity levels (7). These may operate independently or interactively, probably determined partly by the physical activity domain, i.e. occupational, leisure or transport. Most research to date has focused on outdoor leisure-time or transport activity. In terms of socio-cultural influences an emerging literature explores the influence of neighbourhood environments on walking, suggesting that individuals with stronger social connections, who trust their neighbours and participate in local activities engage in higher levels of physical activity (8-10). A recent review of reviews demonstrated that distance to non-residential destinations and higher environmental quality in terms of physical attractiveness and mixed land-use were also related to higher levels of leisure-time and transport walking (11). However a US study combining telephone surveys and geographical information systems found that environmental perceptions may have different relationships with walking and leisure-time or transport activity than objective characteristics (12). Similar findings have been reported elsewhere (e.g. 13).

Research investigating these factors in relation to occupational physical activity has largely focused on moderate-to-vigorous activity (e.g. stair climbing) (14). However one study suggests that perceptions of the physical office environment may have associations with light occupational physical activity. In an online sample of office-based workers in Australia higher self-reported co-worker visibility and connectivity were associated with fewer self-reported breaks in sitting (15). Current research into workplace socio-cultural environments and physical activity has predominantly examined activity outside work hours. Cross-sectional analysis of data on over 30,000 workers in Finland found that a positive workplace social environment (e.g. sense of belonging to the team and a belief that supervisors are trustworthy and considerate) decreased the odds of performing multiple harmful health behaviours including overall physical inactivity (16). However an intervention in 850 employees in small businesses reported that higher workplace social capital was associated with decreased leisure-time physical activity at 18-month follow-up after intervention (17). The authors suggested that high social capital could endorse both healthy and unhealthy behaviours or reflect longer working hours. Elsewhere recent qualitative research exploring determinants of occupational sitting in office-workers highlighted a potentially important role of the social and cultural office environment in facilitating decreases in sedentary behaviour (18).

Further research establishing socio-ecological influences on occupational physical activity is necessary (19). It is recommended that individuals perform at least 10,000 steps a day (roughly equivalent in energy expenditure to 30 minutes of moderate-vigorous physical activity) and reduce extended periods of sedentary behaviour (20). Recent estimates using the Active Buildings sample of office-based workers in South East England suggest average daily step counts close to the 10,000 step target, although there was a high proportion of sedentary

behaviour in the sample and it is notable that most steps occurred outside typical working hours while two peaks in sedentary behaviour occurred during office hours (21). Findings suggest that sedentary portions of the workday may provide opportunities for intervention. In view of growing numbers of office-based workers (22) this population represents a large group in need of physical activity interventions. However current interventions tend to target individual-level characteristics, often lead to increases in only small sections of the target population and have effects that do not always last beyond the measurement period (23). Moreover a recent systematic review highlighted a lack of research exploring potentially modifiable socio-cultural and physical environmental correlates of office-based activity (24). Research addressing this gap in the evidence base is warranted by the prospect of informing the development of interventions with more sustainable impact.

This study aimed to identify factors contributing to workers' perceptions of the physical and socio-cultural workplace environment, and to explore relationships between environmental perceptions and occupational physical activity in a sample of office-based workers in South East England.

METHODS

Participants were adults in office-based occupations who participated in the Active Buildings study, a cross-sectional study of the relationship between the spatial configuration of workplaces and occupational physical activity (www.activebuildings.co.uk) (25). Further recruitment and protocol details are reported elsewhere (21, 25). In brief, participants were predominantly workers in (sub)urban areas of South East England, from a mix of 2 public, 8 higher education, 2 non-profit and 2 private organisations, including university departments, government bodies and corporate offices. Participants from 14 organisations were invited to

complete the Movement at Work survey. Participants from 11 organisations (4 located in the same building and 7 being departments within a larger organisation) were then invited to participate in an objective-monitoring study sub-sample if the organisation agreed and the participant reported no movement-impairing illness. Data were collected between March 2013 and March 2014. Ethical approval for the study was granted by University College London Non-NHS Research Ethics Committee (4400/001). All participants provided informed written consent.

The Movement at Work Survey (accessible at www.activebuildings.co.uk) was developed to assess socio-cultural and physical environmental factors previously investigated as predictors of outdoor physical activity and included items adapted from previous surveys (9,11). Working group discussions with experts in the built environment, facilities management and physical activity were drawn upon for item development. Items included statements about the quality and layout of the physical environment (e.g. *"My workplace design is aesthetically pleasing"*, *"My work desk is close to the coffee/tea point*), and the quality of the socio-cultural workplace environment (e.g. *"I am discouraged from leaving my desk for unscheduled breaks by the management"*). Responses were recorded using a 5-point Likert scale (reverse-coded: 1='strongly disagree'; 5='strongly agree'). Test-retest reliability of items was assessed in a separate sample of 27 participants who completed the survey at two points 7 or more days apart.

Occupational physical activity was conceptualised as physical activity and sitting performed during the workday (including breaks). Sitting and light physical activity variables were assessed, acknowledging that these would be the most frequent types of physical activity in the office environment (5).

Participants in the objective-monitoring sub-sample had sitting time, standing time, sit-to-stand transitions and step counts measured with the ActivPAL^{3TM} accelerometer (http://www.paltechnologies.com/). The ActivPAL^{TM3} has previously been used in studies of office-based workers and is a validated tool for measuring the outcomes of interest (26). Accelerometers were fitted by trained researchers to the middle front of the participant's right thigh. Participants were supplied with waterproof dressings and asked to wear the monitor continuously (including during bathing and sleeping) and not deviate from their usual behaviour. Participants wore accelerometers for five consecutive days (encompassing 3 or more workdays), with data captured from the day after administration.

Participants kept an activity diary during the objective measurement period to record working days, arrival/departure time at/from the office and monitor removal. Work days spent outside the office were not included. Daily work times were calculated from arrival times rounded up to the nearest hour (e.g. 09:30 to 10:00) and departure times rounded down to the nearest hour (e.g. 17:30 to 17:00) to ensure commuting time was excluded. This was considered acceptable as analyses used hourly averages rather than sum values. Where arrival and departure times were not reported, work times were calculated as an average of other work times recorded by the participant, or failing that, an average of work times within the participant's organisation.

ActivPAL^{TM3} data were downloaded using ActivPAL^{TM3} software and stored using Microsoft Excel 2010. Data were summarised in 15-second intervals which were examined in 1-hour intervals. Visual inspection of the data revealed no unusual episodes for exclusion. Days when the ActivPAL^{TM3} was not worn continuously were removed from analysis. Average hourly sitting, standing, sit-to-stand transitions and step counts were calculated across all work hours for participants with 3 or more workdays of data. Data were considered to be

normally distributed and values lying more than two standard deviations (SD) from the mean were removed from analyses as outliers.

Participants self-reported their age, sex, smoking ('don't smoke', 'smoke outside building', 'smoke beyond building premises'), occupation (Standard Occupational Classification (SOC) code) and organisation. Trained researchers collected body weight (kilograms) and height (metres) to calculate body mass index (BMI). Principal component analysis (PCA) using orthogonal Varimax rotation was performed on questionnaire items to identify factors relating to participants' environmental perceptions. The PCA used data from all participants who completed the Movement at Work survey to increase reliability. Identified factors were condensed into three-level variables with the lowest category representing more negative responses and the highest category representing more positive responses. Test-retest reliability was assessed by agreement across two time-points using a two-way, random effects, single measure intraclass correlation coefficient (ICC).

Descriptive statistics were used to characterise the PCA sample and the objective-monitoring sub-sample. Chi-squared analyses, t-tests and one-way ANOVAs tested socio-demographic differences in environmental perceptions and between the PCA sample and objective-monitoring sub-sample. Simple linear regression analyses assessed the relationship between environmental perceptions and activity outcomes. Multiple linear regression models including age, sex, BMI, SOC code and organisation, controlled for potential covariates or confounding effects of organisations (9). Analyses were performed in SPSS v20. A significance level of $p<0.05$ was applied.

RESULTS

Relevant survey data were available for 433 participants. Prior to performing a PCA three items were removed from the scale as they were highly correlated with a retained item and were likely to be measuring a single construct (e.g. distance to a multi-functional device, retained item: *"My work desk is close to the printer"*; removed items: *"My work desk is close to the scanner/photocopier/fax"*). Sampling was adequate for a PCA to obtain reliable and distinct factors (KMO=0.7) and the correlation between items was sufficiently large but not so large that items measured only one construct (Bartlett's test of sphericity $X^2(78)=1221$, $p<0.001$). A PCA revealed four constructs with an eigenvalue >1 which in combination explained 57% of the variance. Factor loadings of variables after rotation are displayed in **Table 1**. Only 1 item loaded onto two factors; this item loaded more highly onto factor 2 so was retained on this factor. The factors were 1) perceived distance to office destinations, 2) perceived aesthetics and comfort of the physical office environment, 3) perceived office social environment and 4) perceived discouragement of unscheduled breaks by management. The sum of factor scores demonstrated good test-retest reliability (ICC=0.622).

Younger participants were more likely to perceive office destinations as being close to their desk ($F(2,441)=9.93$, $p<0.001$) and a positive workplace social environment ($\chi^2(2)=29.4$, $p<0.001$). Female participants were more likely to perceive a positive workplace social environment ($\chi^2(2)=7.4$, $p<0.05$). There were no other demographic differences in factor scores (**Table 2**). Of the 131 participants with ActivPAL^{TM3} data, 115 provided complete survey information and comprised the objective monitoring sub-sample. There were no socio-demographic differences between the objective-monitoring sample and PCA sample. Participants were aged on average 39.6 (SD±10.5) and had a mean BMI of 25.8 (SD±4.5), corresponding to national data for this age group (27). Just over half were women (54%; **Table 3**). Overall, during each working hour, participants had a mean step count of 433

(SD±186), sat for an average of 0.7 hours (SD±0.14), stood for an average of 0.22 hours (SD±0.13) and performed an average of 3.25 (SD±1.21) sit-to-stand transitions.

Perceiving that management discouraged workers from leaving their desk for unscheduled breaks (39% 'disagree'; 41% 'neutral'; 19% 'agree') was related to lower hourly step count ($F(1,113)=7.96$, $p<0.01$; **Table 4**). Participants who agreed that management discouraged breaks took on average 64 fewer steps/hour than those who did not feel that management discouraged breaks. No other environmental perceptions were associated with step count (**Table 4**) and there were no significant associations between environmental perceptions and sitting, standing or sit-to-stand transitions (**Table 4**). Models adjusting for sex, age, BMI, smoking, SOC code and organisation obtained the same results but reduced the sample size owing to missing data so unadjusted regression models are presented.

DISCUSSION

This study identified four factors measuring participants' perceptions of the office environment which we called 1) perceived distance to destinations, 2) perceived aesthetics and comfort of physical office environment, 3) perceived social office environment and 4) perceived discouragement of unscheduled breaks by management. Participants who felt management discouraged unscheduled breaks walked less during the working day than those who did not; no other environmental perceptions were associated with occupational step count. None of the perception factors were related to occupational sitting, standing or sit-to-stand transitions. To our knowledge this is the first attempt to examine how workers' perceptions of the office environment relate to objectively-measured occupational physical activity.

The use of objectively-measured physical activity is an important strength of the study, especially as it is typically difficult to recall unstructured, lighter intensity activity (5). This is particularly consequential within office environments where individuals are likely to visit destinations repeatedly over the course of a day, accruing steps over many similar, short-distance trips rather than more memorable long-distance trips. Having a study sample drawn from different organisations constituted a further strength, although additional research should test the generalisability of results.

It is possible that certain aspects of the workplace social environment (e.g. social cohesion), previously found to be important for health, were overlooked (16). Existing questionnaires were not used in the interest of investigating social and physical environmental perceptions simultaneously and limiting the burden on participants completing an already lengthy questionnaire (16). Further research should overcome this limitation by exploring more comprehensively the wider socio-cultural correlates of occupational physical activity.
Compensatory physical activity was not considered as it was deemed outside the scope of this study; it is possible that participants accumulating higher occupational step counts had lower step counts in non-work time. This constitutes a limitation of the study, although it is noted elsewhere that individuals with active occupations do not tend to compensate for this energy expenditure with reduced activity in non-work time (28).

Perceived discouragement of unscheduled breaks by management had a large effect on step count. Participants who felt management discouraged breaks accrued on average 64 fewer steps per hour. Over a typical 8-hour workday this could equate to 512 steps, equivalent to over 5% of the recommended daily step count (20). Due to the cross-sectional nature of analyses it is not possible to infer the direction of the relationship between discouragement of

unscheduled breaks by management and workers' step counts. However because of the hierarchical structure of organisations it seems logical that discouragement of unscheduled breaks by management would influence workers' movement rather than the converse. It is noteworthy that this effect was obtained with only one item measuring managers' perceived attitudes towards breaks. Further research collecting information on this construct may reveal a larger effect on step count.

It is not clear from our results *where* workers with higher step counts accumulated extra steps. However the fact that there was no difference in sit-to-stand transitions in relation to perceptions of the office environment suggested that participants were taking longer, rather than more frequent, breaks from sitting. Preliminary analyses using radiofrequency identification (RFID) indoor location tracking information from the Active Buildings study suggested that a large number of steps during the workday were taken when participants were outside the office, possibly attending meetings or taking breaks (29). Moreover analyses presented elsewhere demonstrate increased participant step counts between 12pm and 2pm, indicating that additional steps were taken during typical lunch hours (21). Physical activity outcomes for this novel, exploratory study did not differentiate between activity accumulated inside and outside the office and the role of lunchtime activities was not explored as data were unavailable. Further research should aim for more precise measurement of activity and explore how and where office workers accumulate additional steps, to aid interpretation of results and develop effective intervention strategies.

The fact that no other perceptions of the subjects' work environment were related to daily step count could be because effect sizes were small. Step counts were higher in participants who perceived office destinations to be closer and fewer sit-to-stand transitions where performed

in participants reporting higher ratings of the office social environment but these findings were not significant. Both findings merit further investigation in larger samples distributed across more organisations. However it appears that within this sample perceived management attitudes towards movement around the office was a potentially important correlate of occupational physical activity. The role of social control or rules concerning movement is mentioned in other literature supporting the presence of a relationship between autonomy and increased sit-to-stand transitions (30) and increased visibility and decreased self-reported occupational physical activity, which was attributed to an increased potential for surveillance by colleagues (15).

Understanding the implications of the reported relationship between perceived managerial discouragement of unscheduled breaks and participants' occupational step counts is constrained by several factors. Firstly it is not possible to know whether workers' perceptions reflected their response to explicit or perceived management policies around movement. It could be that, as in the outdoor environment, perceptions of and objective measurements of the environment have different relationships with walking (13). Secondly multilevel modelling was not deemed feasible for data from only 11 organisations; the results presented here assess variance in perceived discouragement of unscheduled breaks among participants from the same organisation. Variance in perceptions could arise because participant responses related to immediate line management rather than senior management (which were not differentiated). Alternatively participants could have perceived discouragement differently, with an interaction between individual and environmental factors. Future research investigating these distinctions will help identify effective intervention strategies.

In conclusion, office-based workers who perceived managerial discouragement of unscheduled breaks had lower levels of occupational physical activity, taking significantly fewer steps during the working day. The health benefits of short periods of daily walking suggests that further research into this novel finding could highlight ways in which management can increase walking at work and thereby promote workforce health (6).

Key points

- Individuals in office-based occupations have low levels of physical activity. More research is needed to elucidate the role of the physical and socio-cultural workplace environment in influencing workplace physical activity.
- Office-based workers who held the perception that management discouraged unscheduled breaks had significantly lower step counts during the working day than colleagues without this perception.
- This new evidence provides a strong rationale for further research into socio-cultural correlates of workplace activity in order to inform the development of more effective interventions to increase physical activity in office-based workers.

Acknowledgments: The authors would like to thank the participants and organisations participating in the Active Buildings study and the experts who have contributed their ideas in Advisory Group meetings.

Funding: This work was supported by the National Institute for Health Research's School for Public Health Research (NIHR SPHR). The views expressed are those of the authors and not necessarily of the NHS, NIHR or Department of Health.

Conflicts of interest: The authors declare that they have no conflicts of interest.

Financial disclosure: The authors have no relevant financial disclosures.

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85 **Table 1:** Factors from the Movement at Work Survey revealed by principal component analyses (n=433).

	Rotated Factor Loadings			
Item	**Factor 1** Distance to destinations	**Factor 2** Aesthetics and comfort	**Factor 3** Social environment	**Factor 4** Management discouragement
Desk close to coffee point	.899			
Desk close to toilets	.802			
Desk close to kitchen	.799			
Desk close to printer	.652			
Workplace comfortable		.755		
Workplace feels creative		.742		
Office design aesthetically pleasing		.737		
Workplace has sufficient privacy		.658		
Workplace is safe from crime		.444		(-.406)
Would use workplace gym			.657	
Nice to have more office plants			.637	
Often socialise with colleagues			.597	
Management discourage unscheduled breaks				.800
Eigenvalues	2.537	2.478	1.234	1.154
% of variance	20	19	9	9

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Table 2: Participant demographics and distribution across standard occupational classification (SOC) code for PCA sample.

	Total PCA Sample	**Distance to destinations**			**Aesthetics and comfort**			**Social environment**			**Management discouragement**		
		Negative	Neutral	Positive	Negative	Neutral	Positive	Negative	Neutral	Positive	Negative	Neutral	Positive
Sex n (%)													
Male	194 (45)	63 (32)	83 (42)	47.6 (26)	70 (35)	80 (40)	51 (25)	89 (45)*	62 (32)*	45 (23)*	90 (45)	79 (39)	32 (16)
Female	235 (54)	89 (34)	113 (44)	58 (22)	89 (34)	103 (40)	69 (26)	82 (34)*	82 (34)*	79 (33)*	95 (36)	113 (43)	53 (20)
Age Mean (SD)	40.0 (10.7)	43.0 (11.2)***	38.9 (10.4)***	37.5 (9.8)***	40.9 (10.7)	39.4 (10.4)	39.6 (11.3)	42.0 (10.0)***	40.9 (11.5)***	35.6 (9.6)***	50.0 (10.3)	39.5 (11.2)	37.9 (10.4)
BMI Mean (SD)	25.7 (4.3)	26.5 (5.3)	25.4 (3.9)	25.6 (4.3)	26.5 (4.2)	25.0 (4.2)	26.2 (5.0)	24.9 (3.8)	26.9 (4.7)	25.2 (4.3)	25.4 (3.5)	25.4 (3.9)	27.7 (6.7)
SOC n (%)													
Management	115 (28)	40 (33)	54 (51)	26 (29)	39 (32)	47 (39)	36 (30)	52 (45)	33 (28)	31 (27)	60 (49)	45 (37)	17 (14)
Professional	212 (52)	75 (33)	89 (39)	63 (28)	82 (36)	89 (39)	57 (25)	85 (39)	72 (33)	61 (28)	95 (42)	98 (43)	35 (15)
Administrative	79 (20)	29 (34)	41 (48)	15 (18)	29 (34)	37 (43)	20 (23)	29 (36)	27 (34)	24 (30)	25 (29)	42 (49)	19 (22)

Total n=433, sex n=429, age n=422, BMI n=111, SOC code n=406. BMI, body mass index; SOC, standard occupational classification; SD, standard deviation. * $p<0.05$; ***$p<0.001$.

Table 3: Participant demographics and distribution across standard occupational classification (SOC) code for sub-sample of participants monitored with accelerometers (n=115).

	n (%)	Mean (SD)
Sex		
Male	52 (46)	-
Female	61 (54)	-
Age (years)[a]	-	39.6 (10.5)
BMI[a]	-	25.8 (4.5)
SOC code		
Managerial	27 (26)	-
Professional	58 (56)	-
Administrative	19 (18)	-

[a] Mean (SD). BMI, body mass index; SOC, standard occupational classification; SD, standard deviation.

Table 4: Associations between environmental perception factors and objectively-measured average hourly occupational step count, sitting, standing and sit-to-stand transitions.

	B (95% CI)	β	p
Hourly step count			
Distance to destinations	42.1 (-1.69 to 86.0)	0.177	NS
Aesthetics and comfort	-22.7 (-66.8 to 21.5)	-0.096	NS
Management discouragement of breaks	-64.5 (-109.7 to -19.2)	-0.258	0.01**
Social environment	23.4 (-19.0 to 65.8)	0.107	NS
Hourly sitting			
Distance to destinations	0.01 (-0.03 to 0.04)	0.037	NS
Aesthetics and comfort	0.01 (-0.02 to 0.05)	0.059	NS
Management discouragement of breaks	0.02 (-0.01 to 0.06)	0.120	NS
Social environment	0.01 (-0.03 to 0.04)	0.032	NS
Hourly standing			
Distance to destinations	-0.02 (-0.05 to 0.02)	-0.093	NS
Aesthetics and comfort	0.00 (-0.03 to 0.03)	0.009	NS
Management discouragement of breaks	-0.02 (-0.05 to 0.02)	-0.101	NS
Social environment	-0.00 (-0.03 to 0.03)	-.016	NS
Hourly sit-to-stand transitions			
Distance to destinations	-0.08 (-0.37 to 0.21)	-0.051	NS
Aesthetics and comfort	0.15 (-0.14 to 0.44)	0.099	NS
Management discouragement of breaks	-0.17 (-0.47 to 0.14)	-0.100	NS
Social environment	-0.27 (-0.54 to 0.01)	-0.186	NS

Step count and sitting: n=114 for distance, aesthetics and comfort and management discouragement, n=105 for social environment; standing: n=113 for distance, aesthetics and comfort and management discouragement; n=105 for social environment; sit-to-stand transitions: n=115 for distance, aesthetics and comfort and management discouragement, n=106 for social environment. CI, confidence interval. **p<0.01.