Occupational Medicine 2016;**66:**408–411
Advance Access publication 14 January 2016 doi:10.1093/occmed/kqv213

Do active design buildings change health behaviour and workplace perceptions?

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Background	Occupying new, active design office buildings designed for health promotion and connectivity provides an opportunity to evaluate indoor environment effects on healthy behaviour, sedentariness and workplace perceptions.
Aims	To determine if moving to a health-promoting building changed workplace physical activity, sedentary behaviour, workplace perceptions and productivity.
Methods	Participants from four locations at the University of Sydney, Australia, relocated into a new active design building. After consent, participants completed an online questionnaire 2 months before moving and 2 months after. Questions related to health behaviours (physical activity and sitting time), musculoskeletal issues, perceptions of the office environment, productivity and engagement.
Results	There were 34 participants (60% aged 25–45, 78% female, 84% employed full-time); 21 participants provided complete data. Results showed that after the move participants spent less work time sitting (83–70%; $P < 0.01$) and more time standing (9–21%; $P < 0.01$), while walking time remained unchanged. Participants reported less low back pain ($P < 0.01$). Sixty per cent of participants in the new workplace were in an open-plan office, compared to 16% before moving. Participants perceived the new work environment as more stimulating, better lit and ventilated, but noisier and providing less storage. No difference was reported in daily physical activity, number of stairs climbed or productivity.
Conclusions	Moving to an active design building appeared to have physical health-promoting effects on workers, but workers' perceptions about the new work environment varied. These results will inform future studies in other new buildings.
Key words	Active design; indoor environment; sedentary behaviour; survey; workplace health.

Introduction

Many adults spend most of their waking hours at work. Over recent decades, this has shifted from physically active performance-based work to sedentary knowledge-based work, with occupational activity contributing less to their overall physical activity. This is reflected in one-third of the adult population worldwide not achieving minimum levels of physical activity for health and well-being [1]. Sedentary behaviour (sitting) is a related health issue that compounds the public health risk of low physical activity and is independently associated with adverse health [2].

The workplace is one logical setting for interventions. Strategies to increase physical activity at work include stair use promotions, provision of exercise facilities and pedometer walking programmes. Fewer interventions have included interior building design. Sit-stand desks and activity-based workplaces are easier and less costly to implement than major building redesign interventions.

Active design is a new concept that includes levels of environmental design, workplace culture and policy. It addresses features of the built environment that can support daily physical activity. When new office and research buildings are designed, they often include central staircases, light and attractive walkways, communal areas and

toilets adjacent to central areas that can increase incidental physical activity. These features of active design are seldom evaluated for their health-promoting effects. Construction of state-of-the-art office buildings provides an opportunity to evaluate how the indoor environment can change physical activity and sedentary behaviour.

The aim of this study was to determine if moving to a health-promoting building changed workplace physical activity, sedentary behaviour, perceptions and productivity among university staff moving into a new building.

Methods

The study included participants moving from four different locations into one new building at the University of Sydney, Australia. Subjects were invited to participate by their managers and provided consent. Ethics approval was obtained from the University of Sydney Research Ethics Committee (2013/637).

In this natural experiment, we collected data through an online survey comprising 37 questions. Participants reported their physical activity [3]; time spent sitting, standing, walking or doing heavy physical labour at work [4]; musculoskeletal issues [5]; stair use and hours of sleep. Additionally, participants were asked about their perceptions of the office environment [6], productivity and engagement [7], as well as connectivity [8].

Participants completed the survey 2 months before the move and those with baseline data were approached 2 months post-move to complete the follow-up survey. Paired *t*-tests compared baseline and follow-up results. $\rho < 0.05$ with Bonferroni correction for multiple comparisons was considered significant. Data on building characteristics were collected using lux and decibel meters and a trundle wheel to measure distances. Manual observations of stairs and types of office fit-outs were made.

Results

There were 34 adult participants (25 female; 27 full-time); half were academic staff/researchers. Twenty-one (66%) participants provided baseline and follow-up

Table 1. Means, standard deviations (SDs) and change statistics of workability, indoor environment quality, musculoskeletal issues, physical activity and sedentary behaviour at baseline and post-test

	Baseline, mean (SD)	Post-test, mean (SD)	*t*
Workability			
Motivating	**5.4 (2.2)**	**6.6 (1.5)**	**2.06***
Looking forward to going to work	6.2 (2.1)	6.1 (1.5)	−0.19
How often do you work at home (days/week)?	1.3 (0.6)	1.4 (0.7)	0.47
Do you prefer to work at home?	3.0 (1.3)	3.1 (1.1)	0.28
Focus at work	7.0 (1.5)	6.7 (1.9)	−0.56
Efficiency at work	6.8 (1.5)	6.2 (1.9)	−1.28
Quality of work	7.7 (1.2)	7.4 (1.1)	−1.00
Amount of work	7.6 (1.4)	7.0 (1.8)	−1.54
Indoor environment quality			
Noise level satisfaction	**3.9 (1.1)**	**3.2 (1.0)**	**−2.19***
Air quality satisfaction	**3.0 (1.2)**	**3.8 (0.7)**	**2.59****
Light satisfaction	**3.5 (1.4)**	**4.2 (0.9)**	**1.78***
Space satisfaction	**4.3 (0.9)**	**3.6 (1.2)**	**−2.44****
Temperature satisfaction	2.9 (1.3)	2.8 (1.3)	−0.29
Musculoskeletal issues			
Pain in neck and/or shoulders	2.5 (1.1)	2.2 (1.0)	−1.18
Pain in hands and/or arms	1.8 (1.0)	1.6 (0.7)	−0.82
Pain in lower back	**2.5 (1.0)**	**1.7 (1.1)**	**−2.53****
Pain in legs and joints	2.0 (1.0)	1.7 (1.0)	−1.2
Do you feel mentally tired when leaving for work?	**4.1 (1.6)**	**3.4 (1.5)**	**−1.76***
Sleep per night (h)	3.6 (0.60)	3.6 (0.5)	−0.53
Physical activity and sedentary behaviour			
Sitting at work (%)	**83 (12)**	**67 (22)**	**−2.8****
Standing at work (%)	**9 (8)**	**21 (19)**	**2.9****
Walking at work (%)	11 (7)	10 (8)	−0.18
Heavy labour at work (%)	0	0	
How many days 30 min MVPA in past week?	4.9 (0.4)	4.6 (0.5)	−0.5
How many flights of stairs (per day)?	2.2 (0.3)	1.8 (0.2)	−1.31

Significant results in bold. MVPA, moderate-to-vigorous physical activity.
*$P < 0.05$, **$P < 0.01$.

Table 2. Characteristics of old and new buildings

	Old	New
Build year	1933–70	2014
Light level: brightest/darkest location (lux)	[0.7–11]/[0.28–0.64]	13.3/0.75
Noise level office/open-plan (dB)	43/49	30/46
Average floor space (m^2/person)	8–16	9.6
Sit-stand desks (%)	0	7.50
Route to kitchen longest/shortest (m)	[24–34]/[1–12]	42/8
Route to bathroom longest/shortest (m)	[24–30]/[9–28]	89/40
Stairs	Closed, well-lit, artificial light, no external views	Open, well-lit, natural light, external views

data. Of the 13 participants who did not provide post-move data, 5 did not move and 2 left the university. The remaining six varied in their characteristics, with no clear bias in dropouts observed.

Participants reported less sitting at work after the move (Table 1) (83–67%, $P < 0.01$), with sitting largely replaced by standing (9–21%, $P < 0.01$). No corresponding change in walking was seen. Participants reported less low back pain ($P < 0.01$). The new open-plan work environment was perceived as more stimulating with better air quality, but the noise level was less satisfying and it provided less space. No difference was reported in productivity, daily total physical activity or stairs climbed.

Table 2 summarizes characteristics of the old and new buildings, which differed in many aspects of indoor environmental quality and design.

Discussion

This study found that workers who moved to a new active design building reported sitting less by 1.2 h/day, an effect consistent with the literature [9]. One could hypothesize that sit-stand desks contributed to increased standing, although relatively few height-adjustable desks were introduced in the new building in this period. It is possible that more frequent movement around the office took place but was not recorded as 'walking' by the participants. The new building provided more opportunities for incidental activity, given the stairs are accessible and distances to kitchens and bathrooms longer than in any of the old buildings. This would need to be studied further using objective measures.

The participants reported less lower back pain after the move that could be related to less sitting or possibly to better ergonomically designed office furniture in the new building. Participants' perceptions of the office environment changed, with participants reporting more light and air quality, but less noise and storage satisfaction. Objective measures revealed a higher light intensity in the new building than in the old buildings, whereas the noise levels were similar. However, the noise level was higher in the open-plan than in the shared offices and this could explain the decreased noise satisfaction. This is in line with previous research [10] that found dissatisfaction with noise and privacy in open-plan offices.

The new work environment was perceived as more stimulating but no significant changes were seen on the self-rated quality or quantity of work. Employers opt for open-plan offices as an economic measure, with the hypothetical argument that they are conducive to communication and collaboration and hence productivity and creativity. Some studies have found that 'increased interaction' facilitated by open-plan office configuration was outweighed by increased noise levels and decreased privacy [10]. Importantly, however, in this study we found no significant negative effects on self-reported productivity measures.

Limitations of the study include the use of self-report measures. Ideally, objective physical activity and sedentary behaviour measures could have been used but these were not deemed feasible by the management team. Nonetheless, the self-report measures used in this study have demonstrated substantial repeatability and validity [3,4]. Other limitations include the small pilot study sample and low generalizability. Hence, larger studies with more active design buildings and other workforces are needed. The main strength of this study was its natural experiment nature, where participants were their own control.

This small novel pilot study on active design suggests some physical health benefits of moving to a new active design building, but the perceptions of the various aspects of the workplace varied. Further research to track employees' patterns of movement within active design is under development.

Key points

- Active design buildings are becoming more common but these designs are seldom evaluated for health-promoting effects.
- Active design can have an effect on healthy behaviour, with sitting time reduced and standing time increased.
- The move to an active design building was accompanied by less reported low back pain and higher ratings of work-related motivation.

Conflicts of interest

None declared.

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