



Office Design for Health and Wellbeing - summary of evidence

Summary

91% of employees in western economies work regularly in an office environment (The Stoddart Review, 2016) and, given that people spend a large proportion of their waking hours at work, the office environment can have a considerable impact on an individual's health and wellbeing. New workspaces are being built and redesigned at a rapid rate, and the workplace is the second largest cost to organisations after their wage bill (The Stoddart Review, 2016). Evidence shows that organisations with high levels of employee wellbeing have been found to outperform the stock market by around 2-3% per year (What Works Centre for Wellbeing, 2018, citing London Business School, 2015), and there now appears to be a growing recognition that the financial health of a business correlates with investments in worker wellbeing. Many organisations are therefore now seeing the importance of good workplace design in terms of individual and organisational wellness, and are showing an increasing interest in designing for wellbeing.

There is a large body of relevant literature which focuses on the design of the physical workplace and the organisational impact it can have. This work is found across the diverse fields of environmental psychology, architecture, ergonomics and corporate real estate management. Historically, the main areas of focus have been ambient factors (such as lighting and temperature) and office layout (particularly open-plan vs private offices). More recently, attention has also been given to new ways of working, such as 'agile working' and specific health-promoting features in the workplace, such as staircases and sit-stand desks.

In the main, studies have explored associations with performance/productivity and latterly, other outputs including job satisfaction, perceived control and perceived privacy. Measurement of health and wellbeing outcomes has been limited yet as public interest in personal wellbeing has grown, and the links between performance and wellbeing established, industry experts appear to be balancing the cost implications of office design with an increasing focus on employee experience and individual impact, and industry research has also moved in this direction.

It is also important for us to know about how the space is used, and how the physical office environment interacts with the psychological and social factors such as management, team dynamics and communication. Organisational psychologists have a long-established understanding of the psychosocial

factors at work that influence the health and wellbeing of staff but relatively little is known about how the physical office environment and the psychosocial environment interact to impact health and wellbeing.

Ambient Factors - air quality, temperature, noise, biophilia and lighting

Ambient factors

Ambient environment dimensions or 'Indoor Environmental Quality' (I.E.Q.) factors such as lighting, temperature, air quality and noise have been shown to have a significant impact on employee wellbeing. The most commonly used measures appear to be visual, acoustic and thermal comfort levels, and in some cases, physiological health outcomes are also examined.

Al Horr et al (2016) analysed over 100 research articles from the last 45 years which explore links between I.E.Q. factors in office buildings and occupant wellbeing and comfort. They found significant evidence to suggest that light, temperature, air quality and noise can impact employees' experience of the workplace and comfort levels. In addition, these ambient features when experienced negatively are found to be associated with Sick Building Syndrome (SBS) symptoms i.e. eye/nose/throat irritation, headaches, cognitive disturbances, depression and gastrointestinal distress.

Whilst contextual and individual differences make it difficult to specify specific optimal levels of ambient factors, one way of measuring excellence is via the Green Star certification, which industry specialists use in the USA to confirm a 'gold standard' in I.E.Q. factors. One study (MacNaughton et al, 2017) matched 5 pairs of high performing buildings to compare the cognitive function and health measures of employees in Green Star certified buildings, to those in non-certified buildings. Workers in Green certified buildings scored 26.4% higher on cognitive function tests (which used software to test high order decision making ability) and had 30% fewer Sick Building Syndrome (SBS) symptoms – measured via a daily self-report survey. They also tracked sleep patterns and found that those in the Green certified buildings had significantly better sleep quality.

Longitudinal studies measuring I.E.Q factors and impact on wellbeing are less common. One example, however, is that of Lamb and Kwok (2016) based in Wellington, New Zealand. Data was collected over 8 months, including regular online surveys measuring perceived thermal comfort, lighting comfort and noise annoyance, work performance and individual state factors such as motivation, fatigue, distraction, mood and cognitive function. The study found that these stress factors directly impacted the state variables (motivation, tiredness and distractibility) and significantly reduced self-reported work performance and objectively measured cognitive performance by between 2.4% and 5.8% in most situations, and by up to 14.8% in rare cases. These results indicate that environmental stress can reduce not only the cognitive capacity for work, but the rate of work (i.e. by reducing motivation). In

addition, when increasing the number of individual stress factors an employee experienced, a near linear reduction in self-reported work performance was seen, together with an increase in the proportion of staff using analgesic medication from 8.6% (when no stressors were reported) to 31% (when three stressors were reported). Environmental stressors were also negatively associated with self-reported employee wellbeing (including lower mood and greater frequency of headaches).

Objective measures of lighting, heating and noise in workplaces have also been used to assess their impact on employees. For example, Mulville et al (2016) took ambient measures of temperature, humidity, carbon dioxide and noise levels, over a 5 week period in their study of a single office block in South East England. They also gathered data on worker satisfaction with air quality, temperature, humidity, lighting and noise; incidence of headaches, eye/skin irritation, sore/dry throat and fatigue. Findings suggested the ambient environment had a significant impact on occupant comfort, health and wellbeing, with high noise levels being of particular importance in satisfaction and comfort ratings. Occupant behaviour within the workplace was also found to be influential - those taking breaks regularly were less likely to be dissatisfied with ambient factors and less likely to suffer headaches. Gender also played a role as females were found to be more sensitive to thermal and acoustic issues. Perceived I.E.Q. was negatively correlated with incidence of headaches.

Air quality:

Al Horr et al (2016) describe the sources of indoor air pollutants as building materials, office equipment and occupants, including the carbon dioxide exhaled by office workers themselves which can be detrimental when left to amass in high concentrations. Other chemicals and micro-organisms can originate from outside a building. The various health implications associated with poor indoor air quality - from respiratory problems to irritants - have been the subject of research for a long time and are well established. However, as research builds understanding of the impacts, so industry's standards develop in terms of what is considered acceptable or desirable (World Green Building Council, 2018). Best practice industry guidelines (e.g. the WELL Building Standards and the Leadership in Energy and Environmental Design or 'LEED') recommend low pollutant building materials and effective management of I.E.Q. through appropriate air handling systems.

Rashid and Zimring's (2008) review also showed that Volatile Organic Compounds (VOCs) generally found in paints, flooring materials and cleaning products, have been found to cause SBS symptoms (i.e. eye/nose/throat irritation, headaches, cognitive disturbances, depression and gastrointestinal distress). For air-conditioned buildings, research appears to demonstrate that the optimum ventilation rate is between 20 and 30 litres/second (l/s), with benefits tailing off thereafter. This is significantly higher than minimum standards required, which are typically between 8-10 l/s (World Green Building Council, 2018). Low ventilation rates (less than 10 l/sec per person) are associated with increased SBS symptoms and poorer health outcomes (Seppanen, Fisk and Mendell, 1999).

Reduced absences may also be a useful indicator of the benefits of good indoor air quality for

organisations. Milton et al (2000) analysed the sick leave data for 3700 employees in 40 different buildings and found that short term sick leave was found to be 35% lower in offices ventilated by an outdoor air supply rate of 24 l/s compared to buildings with rates of 12 l/s.

One option discussed by Al Horr et al (2016) is natural ventilation, and some research shows that occupants of naturally ventilated buildings have fewer SBS symptoms than those in air conditioned offices. However, natural ventilation has also been shown to be detrimental in cities where outdoor air pollution is high. Al Horr et al (2016) note that most of the current studies relating to air quality are missing data on occupant psychological and physiological states and conclude that more research is needed.

Thermal comfort:

Al Horr et al (2016) advise that gender, age, culture and climatic conditions all have an impact on the thermal comfort perceived by the occupant. The location and typology of the building along with outdoor climate and season also influence thermal comfort of occupants. Such factors make the attainment of ideal thermal comfort for occupants, which is a predominant stressor in office buildings (Rashid and Zimring, 2008), a complex exercise.

In various studies conducted in Northern Europe and cited by Rashid and Zimring (2008), room temperatures above 22 °C have had a consistently linear relationship with reported sick building syndrome symptoms, suggesting perhaps that 22 °C may be a good 'ideal' optimal temperature. However, other studies have shown that SBS symptoms also increased when temperatures were deemed both "too warm" and "too cold". In addition, one study showed that whilst participants reported decreases in perceived performance and concentration as temperature increased from 22 to 30 °C, actual performance on tests did not change (Rashid and Zimring, 2008).

In a subsequent experiment, Lan et al (2011) asked subjects to perform tasks typical of office work whilst thermally neutral (at 22°C) and whilst warm (at 30°C). Results showed that when the subjects felt warm, they assessed the air quality to be worse, reported increased intensity of many sick building syndrome symptoms, expressed more negative mood, and were less willing to exert effort. Task performance also decreased when the subjects felt warm. Their heart rate, respiratory ventilation, and end-tidal partial pressure of carbon dioxide increased significantly, and their arterial oxygen saturation decreased. Tear film quality (the quality of the lubricating liquid that coats the outer surface of the eye) was found to be significantly reduced at the higher temperature when they felt warm. These results imply that the negative effects on health and performance that occur when people feel thermally warm at raised temperatures are caused by physiological mechanisms and not by the distraction of subjective discomfort. This implies that the detrimental impact will occur independently of discomfort, i.e. if people have become used to the environment.

Noise:

Both Mulville et al (2016) and Al Horr et al (2016) found that acoustic distraction was a major source of dissatisfaction. Furthermore, there may be a direct relationship between acoustic comfort and employee productivity in commercial buildings (Al Horr et al, 2016). Roper and Juneja (2009) conducted a multi-disciplinary systematic literature review on the topic, examining 59 studies in detail. They found that acoustic distraction correlates with a broad range of detrimental outcomes including cognitive loading; lack of privacy; increased stress; lower motivation; reduced social facilitation and interaction; reduced performance; and reduced satisfaction.

In addition, a review by Rashid and Zimring (2008) found that the type of noise can also determine annoyance and stress effects on employees e.g. unpredictable and novel noises had the greatest negative effect on efficiency, and intelligible speech is more distracting than unintelligible speech. Despite such findings, however, research indicates that acoustic comfort is not considered high priority in building design (Al Horr et al, 2016).

The World Green Building Council report (2018) recognises the particular challenge in open plan offices – to provide background sound levels to smooth unwanted distraction, whilst avoiding excessive noise which may cause stress. The report recommends a background sound level of 45dBA in open offices and 40dBA for private offices, where there is less need for noise to be masked.

Biophilia:

Biophilic design is defined as that which encourages the use of natural elements and processes in the built environment (Gillis & Gaterslaben, 2015). Natural elements include natural light, natural images and materials, sounds and images of water, plants and natural colour palettes. This relatively new concept in building design is based on the wealth of evidence that shows exposure to natural environments and features have positive and restorative effects on human health and wellbeing (World Green Building Council, 2018).

A review of psychological literature which considers the benefits of biophilic design by drawing on Attention Restoration Theory and Stress Recovery Theory (commonly used in environmental psychology) showed that there are considerable positive benefits for certain biophilic design attributes (Gillis & Gaterslaben, 2015). Positive benefits were found for the presence of natural elements in building design, both for direct experiences of light, water and plants, and indirect exposure through natural images or colour palettes. These benefits included improved mood, communication, concentration, pain tolerance, perceived and actual productivity and reduced stress levels. Some evidence also exists, however, to suggest that higher density of plants in offices can, whilst improving mood, lower productivity. Less evidence was cited, however, on the benefits of natural materials (such

as wood, stone, clay and hemp) in our built environment, mainly because very little research exists in this area to date.

In a rare example of multi-disciplinary collaboration, a study conducted by occupational psychology consultancy Robertson Cooper and interior design experts Interface (2015) found comparably positive results. The authors explored the relationship between psychological well-being and work environments by surveying 7,600 people across 16 countries. Well-being was measured by the combination of participants' responses to three scales: happy; inspired; and enthusiastic, utilising Robertson Cooper's stress evaluation tool (ASSET). Measures of sickness absence, productivity and creativity were also included.

Results showed that those who work in environments with natural elements, such as greenery and sunlight, report a 15% higher level of well-being than those who work in environments devoid of nature. Other pertinent findings included:

- greenery in the office, such as plants and green walls, was associated with higher levels of creativity
- an absence of greenery both within the workspace and in the immediate outdoor environment was associated with higher levels of employee stress
- individuals in workspaces with no natural light or greenery reported higher levels of sickness absence
- having no window view was significantly linked to greater levels of stress whereas those with views of trees and water outside were significantly less stressed
- window scenes of nature, such as countryside views, natural landmarks and wildlife, all positively impacted creativity and productivity

Interestingly, office design was also shown as a potential influence on recruitment attraction and retention – one third of all respondents in the global study said that the design of an office would affect their decision to work for a company.

Natural lighting has also been shown to positively impact sleep. A recent US-based study by neuroscientists found that office workers with windows slept an average of 46 minutes more per night. In addition, workers without windows reported poorer scores than their counterparts on sleep quality, sleep disturbances, physical problems and vitality (Boubekri et al, 2014).

The above findings align with the reviews of Rashid and Zimring (2008) and Al Horr et al (2016) which reported that humans' preference to be near windows and the therapeutic impact of natural light is well established in the literature. However, some research shows less compelling results and provide a cautionary note. Mulville et al (2016) did not find any significant relationship between proximity to

windows and perceived comfort nor between proximity to windows and the perceived impact of the workplace on productivity. In addition, Hee et al (2015) note that the provision of natural light and views should be carefully balanced with the potentially detrimental impacts of high levels of glazing on overheating and glare.

Lighting:

Whilst evidence broadly suggests that daylighting should be optimised wherever possible, both for user and energy benefits (World Green Building Council, 2018) artificial lighting will likely also be needed within most offices. Poor visibility, glare, flicker and lack of control of the visual environment can all affect task performance, and visual discomfort can lead to eyestrain and headaches. Typical recommendations for task lighting levels in offices are 300-500 lux, and LED lighting is now deemed to offer a good, energy efficient alternative by industry experts (World Green Building Council, 2018).

Control over ambient factors:

A number of studies have established the importance of occupant control in relation to I.E.Q factors and worker wellbeing. In their literature review, Al Horr et al (2016) found various studies that showed having control (e.g. over air quality or thermal features) can improve levels of satisfaction and comfort, and Mulville et al (2016) also demonstrated that access to control was a key influencer in how people experience the ambient features of their workplace environment. Rashid and Zimring (2008) also noted that annoyance is greater in workers when noise comes from machines used by others. Furthermore, in her study of 248 office workers in mid West USA, Kupritz and Haworth Inc. (date unknown) found that having control over lighting directly linked to stress reduction. However, in a lab experiment on lighting conditions and work performance, whilst participants in the choice and preference group unsurprisingly reported more perceived control than those in no-choice conditions, they performed more slowly and poorly on creativity tasks (Veitch and Gifford, 1996). Interestingly, we could not find any studies linking control over other aspects of the physical environment such as desk spacing, layout, placing of equipment etc.

Office layout, activity based working and agile working

Open plan offices:

Much of the literature concerned with office layout and employee wellbeing focuses on the open plan office which has dominated workplace design strategies since the late 1980s (de Croon et al, 2005). Today in the UK, over 8m employees are currently working in open-plan offices (Tidd et al, 2016).

The open-plan (O.P.) office was originally heralded as a cost-effective architecture for workplaces, which also increased communication and collaboration between teams, interactions that were deemed critical due to the rise of knowledge workers (Vischer, 2008). Some research has supported these positive notions. Shared O.P. offices have been associated with greater employee satisfaction, enabling closer

working relationships and increased ease of knowledge sharing; and higher productivity (Chigot, 2003; Meijer et al, 2009; McElroy and Morrow, 2010; Cole et al, 2012).

However, most research in the field finds major negative impacts that O.P. offices can have. Key sources of dissatisfaction have been found to be noise and lack of privacy (de Croon et al, 2005; Danielsson and Bodin, 2009) and the benefits of enhanced 'ease of interaction' have been found to be smaller than the penalties of increased noise level and decreased privacy (Kim and de Dear, 2013). Furthermore, some studies have discovered that the notion of increased positive interaction in O.P. offices is not always apparent i.e. co-worker friendships/cooperation may not improve, and perceptions of supervisory support can decrease (Kaarlela-Tuomala et al, 2009; Morrison and Macky, 2017).

In a recent study using state-of-the-art technology, Bernstein and Turban (2018) set out to investigate the effect of open plan architecture on employees' face to face (F2F), email and instant messenger interactions. The volume of F2F communications decreased significantly in both cases, with an associated increase in electronic interaction. Open architecture appeared to trigger a response of social withdrawal from colleagues, decreasing volume of F2F interactions and increasing move to email and IM comms. Explanations offered include loss of privacy, loss of sense of group identity/belonging and distraction/overstimulation. The authors concluded that caution should be exercised in designing open plan on the assumption it will increase F2F communication and thereby productivity and creativity (as many have previously claimed).

In addition, when comparing employees based in large O.P. offices to those in individual (or 'cell') offices, lower levels of job satisfaction and subjective wellbeing (Otterbring et al, 2018); higher levels of sickness absence (Pejtersen et al, 2011); higher levels of fatigue (Fried, 1990), more frequent headaches (Hedge, 1984); higher levels of self-reported stress (Bodin Danielsson and Bodin, 2010) and lower levels of control (Danielsson and Bodin, 2008) have been found.

Industry commentators, however, are careful to point out that O.P. offices should not be 'demonised' as much as the research above suggests. The Leesman Index Group reports that nine out of ten of their highest performing workplaces are open-plan in style (Leesman Report, 2017). Also, the research surrounding office concepts does have inconsistencies. In their systematic literature review on office concepts and their impact on health and performance, de Croon et al (2005) found inconsistent evidence in terms of cognitive workload, communication, interpersonal relationships and autonomy. They did, however, find consistent and strong evidence for the claim that O.P. office layouts reduce privacy and job satisfaction.

More recently, Richardson et al (2017) have conducted a review of literature comparing private and shared workspaces. 15 relevant studies were identified addressing health effects of shared or open-

plan offices compared with individual offices. Outcomes included sickness absence; health and wellbeing (including psychosocial measures of demands/supervision/peer support); job satisfaction and concentration. As with previous research, the results showed that, compared with individual offices, shared or open-plan office space is not beneficial to employees' health, with consistent findings of negative impact on staff health, wellbeing and productivity.

Despite its recent publication, however, this paper did not appear to consider Activity Based Workplaces as a separate concept (see below for definition). Rather, it solely compared individual offices vs open plan (which is no longer a 'one-size fits all' option). In addition, a number of the studies cited had examined academic settings rather than commercial office premises.

Activity Based Working

In more recent times, and presumably in response to the challenges experienced and documented regarding open-plan designs, Activity Based Working (ABW) is becoming increasingly popular. ABW is defined as "a style of working that allows employees to perform activities in an environment tailored to the task at hand and is supposed to support work activities optimally" (Engelen et al, 2018, p1). A workspace that supports ABW typically provides quiet areas, team desks, sit-stand desks, break out /collaboration space, meeting and phone rooms. In addition, organisations often do not allocate staff a personal workstation, and the workstation : employee ratio of 0.7 - 0.8 is commonly used. This can provide obvious cost savings and reflects the tech-enabled general move towards working flexibly in different locations / at different times that we see increasingly today.

In their systematic literature review of 17 studies and a total sample of over 36,000 participants, Engelen et al (2018) found that ABW has positive merits in the areas of social interaction, communication, control of time and space, and satisfaction with the workspace. Negative associations were found for concentration and privacy, which is interesting given that these are the very issues that ABW is intended to resolve vs traditional Open Plan designs.

Engelen et al further discovered that evidence pertaining to physical and mental health (which eight of the studies measured) was ambiguous and inconclusive. Some evidence suggested that occupants rate their general health more positively in ABW environments and that an increase was also seen in physical movement at work in these environments. However, there is no clarity on whether these findings translate into actual improvements in health. Overall, the authors conclude that ABW appears to be a promising concept in terms of work performance and perceptions of the workplace environment. Importantly, they also recommend that because ABW is associated with greater control over where and when work is performed, it is vital that it is coupled with a supportive management culture and a well-planned transitional period to ensure workers actually embrace and use the environment as intended.

A recent Leesman Research (2017) report echoed the assertion that management and behaviour change is critical to the success of ABW. Their global study of over 35,000 workers in 280 different organisations found that ABW environments can deliver significant performance improvements for those employees who modify behaviours to their new surroundings. However, the research also found poor adoption of appropriate behaviour in activity based workplaces is a significant problem. 71% of the 11,000 ABW employees said they anchored themselves to a single desk each day, thus limiting the potential benefits ABW can provide. This study therefore raises more questions as to why so few employees are embracing the opportunities that ABW presents.

A longitudinal 8 month study by Gerdenitsch et al (2018) may shed some light. They explored changes in workers' perceived need-supply (or Person-Environment) fit, distraction, interaction across teams, and workspace satisfaction during an office relocation from cellular office layout to ABW style. Across time, results showed a linear increase of perceived need-supply fit, a decrease in distraction, and a significant interaction effect where workspace satisfaction and interaction across teams increased more strongly for participants reporting a better perceived need-supply fit. This evidence indicates that ABW will be more beneficial to those workers who can use the new facilities to create/enhance their need-supply fit.

The practice of agile working or 'hot-desking' however, is not without possible downsides. A study by Lawrence et al (2013) found that personalisation of one's deskspace was found to buffer the impact of low levels of privacy on emotional exhaustion. As a result, the authors suggest that if organisations adopt non-territorial workspace designs, allowing for some kind of temporary personalisation of the workspace (such as installing personal screensavers or uploading digital photos) might be prudent.

Office fit-out, equipment and design features

Increasing physical activity (PA) in the workplace is a good way to support health and wellbeing because high levels of sedentary behaviour (prolonged sitting) have been consistently associated with increased mortality and conditions such as diabetes, cardiovascular disease and some cancers (Jancey et al, 2016; Hallman et al, 2018). In particular, office workers have been shown to be a highly sedentary population (Munir et al, 2018). The accumulation of small bouts of PA, which can fit into daily life, has been suggested as a useful strategy and stair climbing is one of the activities that can be easily integrated into everyday life and contribute to the accumulation of PA throughout the day (Bellicha et al, 2015).

Stair use

Simply designing buildings with stairs however, may not be enough to inspire an increase in physical activity, as people will generally not change their habits without the necessary information and motivation to do so (Michie et al, 2011). Much research has therefore focussed on assessing how organisations can best use interventions to 'nudge' their employees into using the stairs more frequently. In a systematic literature review covering 50 intervention studies, across work and public settings, Bellicha et al (2015) found that an increase in stair climbing was found during the intervention period in 64% of the worksites and 76% of the public setting studies. Different types of intervention

were seen to be more effective for the different settings. For worksites, combining motivational and directional signs in worksites increased stair climbing to a larger extent. In public places, increase in stair use is sustained over time more effectively when interventions include two phases.

The authors conclude that there is evidence that stair-use interventions are effective to increase stair climbing in public settings, but there is less evidence of such effect for worksites. They recommend that consideration of the best design of intervention is of particular importance for worksites because worksites offer individuals more opportunities to climb the stairs throughout the day than public settings and could allow a large number of people reaching the recommended level of physical activity by accumulating short bouts of stair climbing. It is proposed that future research should focus on examining the best sequencing of interventions, the best way to ensure maintenance of the long term effects post-intervention, and the potential importance of environmental interventions e.g. stair well enhancements.

Sit-stand desks

Other equipment such as sit-stand desks (SSDs - which allow the user to vary their position between sitting and standing throughout the day) can also serve to reduce sitting time and improve health in the office environment. Chambers, Robertson and Baker (2019) conducted a scoping review (53 journal articles) to investigate the effects of SSDs. The results showed that SSDs can change behaviours effectively (i.e. time spent sitting vs standing), although more limited impacts on health outcomes (e.g. alleviating discomfort, improving posture, improving mood and satisfaction) were seen. The authors noted that few studies referred to the important role of training in using SSDs, and that compliance and health benefits over longer time periods are largely unknown. Further study is therefore needed to examine long-term effects, and to determine the “clinically appropriate dosage” (i.e. optimal length of bouts of standing vs sitting).

In a broader study incorporating a meta-analysis, Chu et al (2016) examined the evidence for the overall effectiveness of workplace interventions for the reduction of workplace sitting among white-collar working adults. Twenty-six controlled intervention studies published between 2003 and 2015 met the selection criteria, with a total sample size of 4,568. Only studies with a parallel control (or treatment-comparison group) were included. Sedentary behaviour was measured by self-report questionnaires and/or activity diaries) or objective measures (e.g. accelerometry).

Interventions types were classified as a) educational / behavioural (e.g. motivational interviewing, goal setting, use of prompts/cues, social comparison), b) environmental (e.g. sit-stand workstation; stationary cycle ergometer and treadmill desk) or c) multi-component (e.g. combination of sit-stand workstations with behavioural interventions)

The results showed consistent evidence that workplace sitting can be reduced by interventions conducted in worksite settings, particularly by employing multi-component interventions. The pooled intervention effect showed a significant workplace sitting reduction of 39.6 min/8-h workday favouring the intervention group. Multi-component interventions reported the greatest workplace sitting reduction (88.8 min/8-h workday) followed by environmental (72.8 min/8-h workday) and educational/behavioural strategies (15.5 min/8-h workday).

The authors concluded that organisational implementation of such strategies could therefore have considerable beneficial population health effects. However, they also note that considering the potential high costs of strategies involving environmental provisions, economic evaluations should be conducted in future. In addition, subsequent studies could investigate the long-term effectiveness and the comparative effectiveness of different promising intervention strategies.

Furniture forms / layouts

Beyond the research on workplace features and equipment and how they can maximise movement at work, there is little research to show whether furniture design and other provisions can impact wellbeing. There are some, however, that look at how people respond emotionally to shapes of furniture and layouts. Curvilinear forms and settings of furniture, for example, have been shown to elicit significantly stronger 'pleasure' and 'non-arousal' ratings in experiment participants than rectilinear forms (Dazkir and Read, 2012).

In addition, different spatial workspace layouts and colour palettes have been shown to influence users' emotions in a variety of ways. In a study of over 300 workers who were shown images of different workspaces, a presence of activity zones vs homogenous desk layouts impacted feelings of energy and engagement; colour palettes influenced calmness, belonging and engagement; soft seating inspired a sense of belonging, and variety in space impacted feelings of autonomy (Haworth Inc, 2017). Partition height has also been shown to be a factor in employee satisfaction levels, concerning privacy and distraction in particular (Yildirim et al, 2007)

Office relocation and refurbishment

In order to allow impact comparisons of different types of physical workspace environments, research is often conducted in the context of an office relocation and/or a change in workspace design. Humans have a natural tendency to rootedness and a resistance to physical moves (Inalhan, 2009) so any relocation, which will generally be an enforced change for an employee over which they have limited control, may present both cognitive and emotional challenges. As such, it is important to also consider factors relating to relocation and change processes when investigating employee health and wellbeing outcomes associated with the physical office design. Indeed, one recent study of over 800 workers found that, contrary to previous studies, there was no significant difference between office accommodation types in terms of worker emotional wellbeing or cognitive irritation ratings, once the

level of change experienced was controlled (Lutke-Lanfer et al, 2017).

Industry experts suggest that the social and emotional consequences of physical office environment change are, in general, neglected (Kampf-Dern and Konkol, 2017) and there appears to be little empirical research that focuses specifically on office relocation and employee health outcomes. There are, however, some studies which consider the employee experience of relocation and workspace change, which can be impacted at a number of different levels, defined by Rothe et al (2013):

- New geographical location
- New work space design
- New expectations of working 'etiquettes'
- The process of change and how it is managed by the organisation

Theories of place attachment ("one's emotional and affective ties to a place" Finch, 2011) are relevant here. Displacement breaks this emotional connection and the subsequent disorientation and nostalgia may undermine one's sense of belonging and mental health in general (Fullilove, 1996). Most research considers place attachment relating to home environments, rather than workplaces. Inalhan (2009) however, examined place attachment in an 18 month qualitative study conducted during an office relocation. The author found that even if a new office space promises better comfort and functionality, employees can experience grief and loss leaving a workplace, and need to establish new connections with a new building which will help them to transition. He also highlights that current change management practices may be inadequate as they tend not to acknowledge place attachments, and often result in negative employee behaviours.

Negative experiences of relocation may lead to longer term impacts such as decrease in employee morale, lower job satisfaction, poorer attitudes towards the organization and increased turnover (Christersson and Rothe, 2012).

The importance of good change management processes is discussed by a number of studies, especially in Corporate Real Estate journals (e.g. Christersson and Rothe, 2012; Rothe et al, 2013). Sound communication in particular is vital in terms of informing and educating employees about a relocation to gain trust and commitment. There is also evidence to suggest that good communication (particularly about reason for and impact of change) is associated with higher levels of satisfaction with the new workspace (Bull and Brown, 2012).

Participation and involvement, for example via focus groups, has also been shown to be important and resistance to change related to work space moves can be minimised by ensuring participation to increase the perceived level of control for the employee (LaFramboise et al, 2003; Van Diermen and Beltman, 2016). In addition, levels of trust and feedback to staff about the impact their participation

has had on the change plans were found to help minimise the impact of change. Perceived procedural fairness was also found to play a critical role in the relationship between an organisation's justification for relocation and employees' intent to remain (Daly and Geyer, 1994).

Further research is needed to explore the role that relocation and/or refurbishment have in the context of employee wellbeing. In particular, Rothe, Sarasoja and Heywood (2013) suggest investigation of the impact that individual differences, such as personality type and job role, have on the employee's experiences, perceptions of and reactions to relocation.

Quick view recommendations for office design for health and wellbeing

Office design for health and wellbeing is of interest to specialists working across a diverse range of professions and roles. A number of recommendations can be made from drawing on the evidence, and they are summarised here:

Collaborative multi-stakeholder approach

The research presented in this review highlights a largely siloed approach to design, with design specialists, Human Resources, Corporate Real Estate and Facilities Management all pursuing similar but unconnected strategies. Organisations need to be clear on who is taking responsibility for the interaction between the physical workplace and the employee workforce health. Historically, the building environment will have been managed by Corporate Real Estate / Facilities Management experts and worker wellbeing decisions would sit with Human Resources and/or Occupational Health. However, given the evidence, it appears that a joint accountability needs to be explicit and disciplines should work collaboratively to maximise knowledge, understanding and impact.

Ambient features/I.E.Q.

- Manage air quality and temperature with reference to particular industry standards e.g. WELL Building standards. Much research suggests that the optimum ventilation rate is between 20 and 30 litres/second (l/s), and a maximum indoor temperature of 22 degrees Celsius may be a useful guideline for Northern European countries.
- Wherever possible, give employees some level of control over the ambient settings in their workspace
- Make natural light from a window or other similar access available, although potential issues relating to overheating and glare should not be overlooked. When artificial lighting is necessary, typical recommendations for task lighting levels in offices are 300-500 lux, avoiding flicker.
- Provide indoor plants, water, natural images and natural colour palettes where possible.
- Encourage and model taking regular breaks from work.
- Closely monitor noise levels and consider the need for privacy and quiet space as a priority. A background sound level of 45dBA in open offices and 40dBA for private offices is recommended.

- Consider performing a cost analysis on the impact that distractions have on office workers and think about introducing adaptable workspaces to meet dual needs of collaboration and concentration.

Office layouts

- Pay attention to the potentially negative effect of workplace openness by providing visual and acoustic protection.
- Consider whether collaboration is really as critical as many perceive it to be. Don't set up organisations for collaboration to the detriment of quiet space.
- Consider building in active design features to promote movement and Activity Based Working (ABW) for choice and control.
- Ensure there are sufficient technical infrastructures and clear etiquettes in place, plus clarity in space legibility (i.e. what each space should be used for)
- If introducing ABW, ensure a well-planned transitional period to enable employees to embrace and use the environment as intended and devise interventions to ensure sustainable behaviour change.
- As ABW is associated with greater control over where and when work is performed, it is vital that it is coupled with a supportive culture based on trust and an outcome-focused management style.
- If an agile environment is in use, allow some aspect of personalisation and system to allow co-workers to easily locate each other
- If a non-agile environment is in place, locate co-workers close together, in department zones or territories
- Avoid locating work stations near foot traffic

Features and equipment

- Nudge employees to use stairs more by combining motivational and directional signs in the workplace.
- Encourage more standing at work via multi-component interventions i.e. a combination of environmental and behavioural interventions
- Conduct an economic evaluation to assess whether the potentially high costs of strategies involving environmental provisions are worthwhile.
- Provide curvilinear furniture design, soft furnishings, activity zones, variety and choice in workplace.

Relocation/change process

- Employ sound change management practices including information, participation, and the recognition of loss.
- Break down the impact of change into new location, new workspace, new etiquettes and the change process – each facet should be considered and managed separately
- Communicate in a transparent and consistent fashion, particularly about the reason for and the

likely impact of changes.

- Encourage staff participation and involvement, and ensure staff get feedback on how their involvement has impacted the plans.
- Ensure perceived procedural fairness amongst employees.

On a final note it is important that organisations recognise that the physical office environment makes up only part of the picture of influencing staff health and wellbeing. There is a wealth of research to show that job design, peer support, line management style, organizational leadership and lifestyle are also critical factors in the promotion and maintenance of employee wellbeing. As such, we recommend a strategic approach that considers a range of perspectives simultaneously – both in research terms considering how the various factors interact, and in terms of strategic planning for organisations seeking to improve their workforce health.

Conclusions and recommendations for future research

The review of the current literature base has indicated that inter-disciplinary research is limited, particularly in terms of establishing longer term health and socioemotional outcomes (De Croon et al, 2005). There is also no single unifying theoretical approach and a lack of standardisation in the measurement of outcomes. Health assessments are often based on self-reported perceptions and constructs sometimes measured without reference to established scales or well-validated reliable instruments (McCoy and Evans, 2005). In addition, study designs seen are overwhelmingly cross-sectional, thus causality cannot be established, and they often utilise small samples.

There are three clear academic priorities for future exploration. Cross-discipline collaboration and better joined-up thinking between architects, ergonomists, corporate real estate experts and psychologists is needed (Davis, Clegg and Leach, 2011). Robust, longitudinal, interdisciplinary research will be critical in developing better understanding of the factors that impact the relationship between physical workspace and worker wellbeing. Various scholars make these recommendations on their areas of expertise detailed above (e.g. Gillis and Gatersleben, 2015; Engelen et al, 2018). Such integration would ensure expertise and knowledge is shared; research draws more rounded, clearer conclusions, resulting in better practical recommendations for organisations.

Clarity of constructs, robustness of methodology and outcome measurements could also be agreed more broadly across disciplines, and ultimately a unifying theoretical approach could be developed (Veitch, 2018). A paper by Appel-Meulenbroek et al (2017) gives a comprehensive summary of the gaps in the research and recommendations on how disciplines could collaborate to address them.

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