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Background

Recent years have witnessed the increasing use of open-plan office layouts (i.e. employees located in the same room) instead of more traditional cellular or individual office structures [1]. Open-plan office environments can maximise the number of individuals located in a space and are cheaper to build and operate as they have the potential to be more energy efficient [1]. Proponents of open-plan offices highlight their social benefits and potential to increase employee communication and collaboration, removing physical barriers to team working. Despite this, the higher occupant density of open-plan workspaces is associated with increased noise which may hinder concentration, and studies show employee dissatisfaction with such layouts [2, 3]. Furthermore, some researchers have linked open-plan layouts to sick building syndrome (a range of physical health-related symptoms associated with working in buildings) [4, 5]. The potential impact of the office layout on employee health and wellbeing remains largely underexplored within the field of public health. Nevertheless, with individuals spending so much time at their place of work, optimising employee wellbeing in these settings is vital [6].

It is important that the impacts of office layout on employee health, broader work-related outcomes (e.g. job satisfaction and productivity) and sustainability are understood. Employee satisfaction with their work environment will also support their return to office spaces post-COVID-19 pandemic – a period which saw a drastic change in work practices, with enforced home working [7]. Inadequate home workspaces negatively affected employee mental health and wellbeing [8], further highlighting the importance of the working environment for employees.

This rapid review of existing reviews sought to identify the evidence base for the impacts of office layout on productivity, health, and sustainability. This knowledge can inform the future development or re-development of office spaces, is important for understanding how employee health and wellbeing can be improved and is of relevance as employees return to office spaces post COVID-19-restrictions.

Methods

To identify relevant reviews, systematic searches were conducted using a combination of search terms for **office layout, health and sustainability** (see Box 1) across six databases: APA PsycInfo; Art, Design & Architecture Collection; Coronavirus Research Database; Publicly Available Content Database; SciTech Premium Collection; and Social Science Premium Collection. Searches were limited to English language, peer-reviewed studies that used a review methodology, published from 1st January 2000 to 3rd December 2021 inclusive. Bibliographic screening of included studies was conducted to identify additional studies of relevance.

Box 1: Review search terms

Health and productivity: health, wellbeing, comfort, satisfaction, illness, performance, productiv*, efficien*, time management, absen*, work outcome

Sustainability: environment quality, sustainabl* design, sustainabl* technology, green design, sustainab*, green technology, environmentally friendly, eco-friendly, energy efficien*, climate, carbon footprint

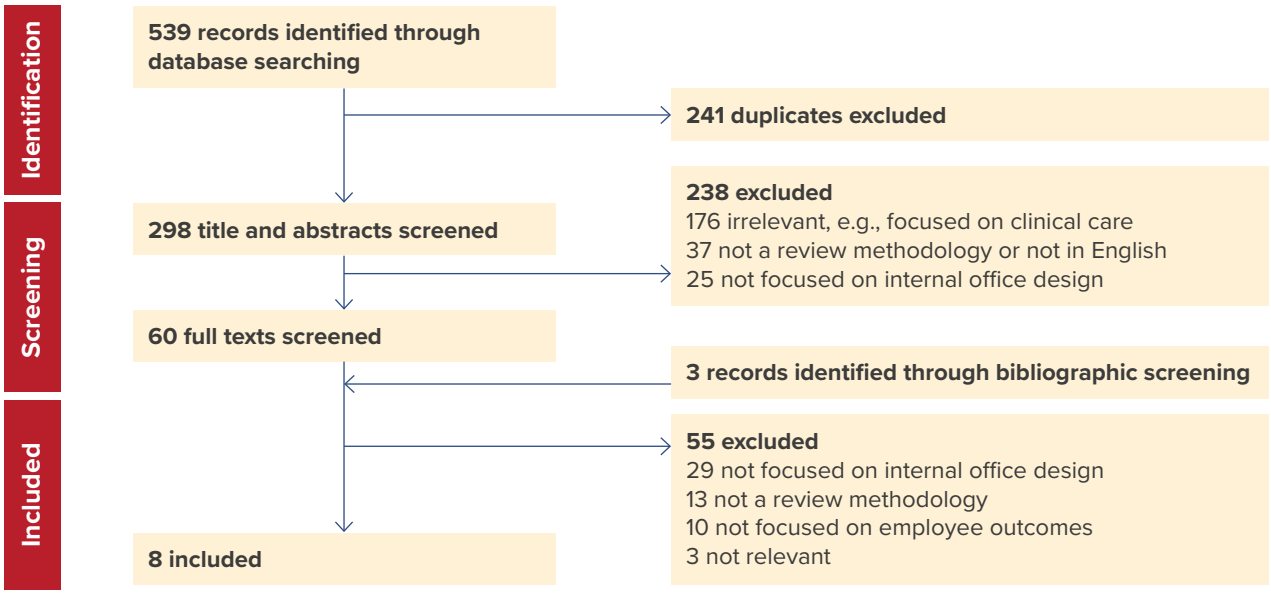
Layout: office environment, office setting, office design, office layout, office space, office type, office building*, shared office, shared workplace, office concepts

Articles were included for full-text review if they were defined as having a review study design/ methodology (e.g. literature, systematic) and explored the impact of office layout on employee health, work-related outcomes (e.g. productivity), or sustainability. Studies with non-office occupants or settings (e.g. healthcare environments) and those that focused on physical interventions in the workplace (e.g. exercise desks) or building design were excluded. After the removal of duplicates, searches retrieved 298 studies (see Figure 1). Two reviewers (NG, KF) independently reviewed title and abstracts then full-texts to determine eligibility, with discrepancies resolved by a third reviewer (KH). Eight reviews were included in the final sample.

The Overview Quality Assessment Questionnaire (a validated tool for assessing the methodological quality of systematic reviews) was used to assess the methodological quality of included studies [9]. Quality assessment was carried out by two reviewers (NG, KF) independently, with discrepancies resolved by discussion. Assessment ratings are shown in Table 1.

Data were extracted from included studies on review aim, methodology and analysis, study results (including the number of papers included), and key findings. All data extraction was checked for accuracy by another member of the team and findings were narratively summarised. Evidence within each review for the impact of open-plan layouts (compared to individual offices where possible) across available outcomes were rated as positive (e.g. improved the outcome), negative or mixed.

Figure 1: PRISMA flow diagram of study identification, inclusion and exclusion



Results

Table 1 outlines the key characteristics of the eight included reviews. The majority of studies used a systematic review method and focused on the health and work-related impacts of office layouts. No studies explicitly examined sustainability in relation to the office layout. Evidence for associations between open-plan workspaces and outcomes identified in the reviews is summarised in Table 2.

Health and wellbeing

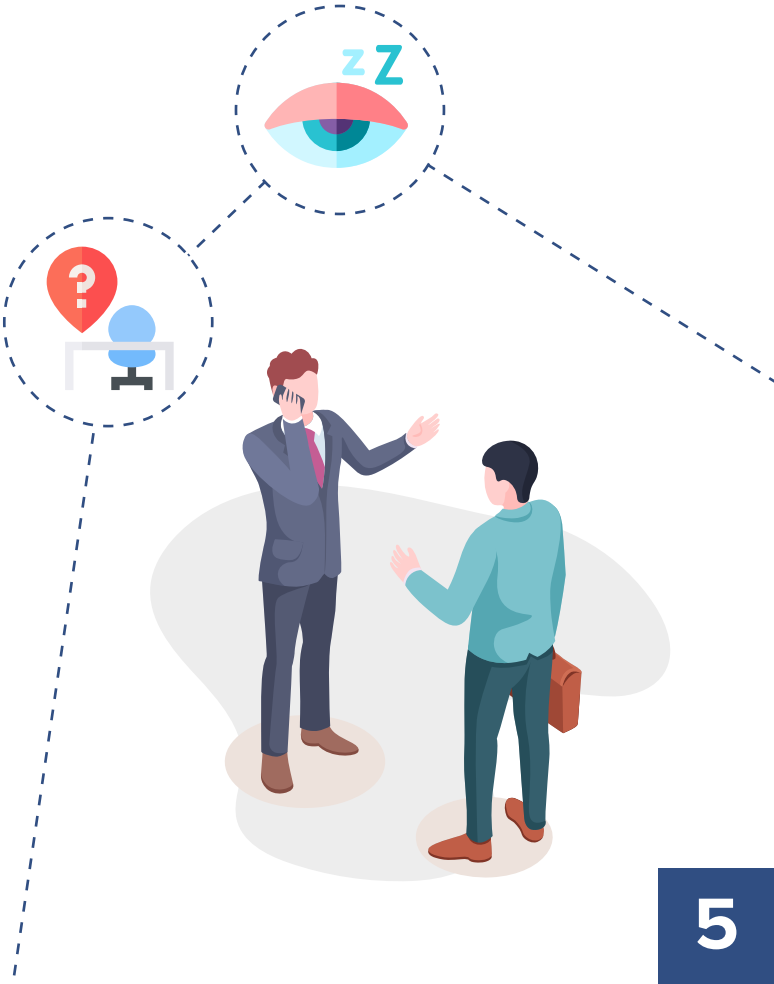
Review findings overwhelmingly associated open-plan office layouts with deleterious effects on physical health for individuals using these spaces, with the exception of a 2005 review which found inconsistent evidence on workplace openness on health (measured as crowding stress; [10]). Other reviews identified negative effects for measures of general health [11–13] and a range of specific physical health outcomes including: fatigue [12, 14–16]; stress [11–16]; headaches [12, 16]; and ear, nose and throat [12, 15], respiratory [12], musculoskeletal, central nervous system and mucus membrane symptoms [11, 15]. Open-plan layouts were also consistently associated with negative mental wellbeing impacts, including on psychological mental health, sleep, tiredness and mental exhaustion [12–14, 16]. Equally, strong relationships were identified for sickness absence [12, 16], with studies consistently finding higher rates of sickness absence in open-plan layouts compared to other office types [13].

Work-related outcomes

Open-plan office environments were associated with low employee job satisfaction, motivation and productivity [10–15]. Findings for employee performance in some studies were mixed [10]. James et al. [12] found that open-plan layouts (compared to single or cellular offices) were associated with lower satisfaction (both with the work environment and job), distraction and privacy across all studies that measured these outcomes. Consistent associations with reduced privacy were shown across all but one of the included reviews (see Table 2). The increased noise levels in open-plan environments were associated with poor acoustic privacy, increased distraction and lowered concentration. A close distance between workstations (as predominantly found in open-plan office layouts) was also found to intensify cognitive workload [10]. However, across studies there was inconsistent evidence for the impact of distance between workstations on job satisfaction and crowding stress.

Interpersonal relationships

Overall, a number of studies identified general employee dissatisfaction with open-plan layouts [11], which may be linked to negative impacts on recruitment and retention, or high staff turnover as identified by Oommen et al. [15]. There was limited evidence across reviews that open-plan layouts improve relationships. Open-plan offices can offer close proximity of co-workers, yet across studies there were mixed findings of the impact of close co-worker proximity [12]. One review identified a significant decline in relationships and friendship opportunities with open-plan layouts, concluding that any benefits of co-worker interaction are outweighed by the increased noise and distraction, and decreased privacy and confidentiality that open-plan spaces create [13]. Yet, findings on the impact of office layout on employee interactions were inconsistent. In their review, Sugiyama et al. [17] identified that employees in open-plan settings had overall shorter sitting time and more frequent face-to-face interaction compared to staff in closed offices. However, the duration of communication was found to be longer in closed offices, with the reduced duration of face-to-face interactions in open-plan spaces thought to be due to the lack of privacy that open-plan offices offer and employee concerns for noise distraction.



Recommendations for employers

Positive benefits of open-plan office layouts included increased cleanliness, opportunities to meet others, informal conversations, and flexibility in time and location of work [13]. Nevertheless, in quasi-experimental studies which recorded attitudes towards the transition from cellular to open-plan offices, employees reported increased distraction, lower self-rated performance and increased social withdrawal; leading to the use of coping strategies, such as increased virtual communication (i.e. email and online messaging) [11]. Furthermore, long-term studies show that individuals do not get used to these negative effects [16]. Summarising these effects, recommendations across reviews are for employers to avoid open-plan layouts, as in comparison to open-plan, small shared rooms can support social wellbeing [16].

A number of strategies identified across the literature may lessen the associated negative effects with open-plan layouts. For example, the use of sound absorbing materials (e.g. textile floor covering), insulating partitions and low-level background noise may help to mask speech and limit negative impacts on privacy [14, 17] and other functional and aesthetic attributes which provide visual stimuli may help to improve wellbeing [15]. Features such as biophilic design (which enhances occupant connectivity to the natural environment e.g. greenery), optimal lighting, temperature control and interventions to reduce sedentary time (e.g. standing desks) have been found to positively influence workplace productivity, satisfaction and minimise negative health outcomes [6].

Furthermore, designs that incorporate shared areas for interaction and private work zones to enable concentration for independent work are shown to be advantageous. Recommendations across studies highlight the need for employers to seek input from employees in any proposed office re-design [10, 15] as control over the work environment can increase job satisfaction, reduce stress and enhance productivity [12].

Limitations

There are a number of limitations to this study, which should be considered when interpreting its results. Although the included reviews placed no geographical restrictions on their searches, they were limited to English language and the majority of studies they included were conducted in the USA [10, 12], or Western Europe [17], impacting generalisability and transferability to other office settings. The included evidence was limited to review methodologies, which focused on the impact of office layouts, therefore, studies examining the impact of building structure/design (e.g. green buildings) or facilities (e.g. standing desks) were excluded. Evidence for the impact of such structures/interventions on occupier health and wellbeing is therefore not included here. This may account for the absence of studies focusing on sustainability in this review – those identified as relating to sustainability generally focused on building design and technological enhancements (e.g. energy saving appliances). Additionally, while limiting included studies to reviews enabled a rapid synthesis of available evidence, relevant individual studies that have not been included in previous reviews may have been missed. Across studies, there was heterogeneity in study outcomes, samples and methodologies. Generally, studies included in the reviews used self-reported outcomes and findings may be affected by the subjective measurement of comfort, which is highly variable between individuals. Furthermore, the terminology used to define different office layouts varies and this may affect comparisons between open-plan office layouts and other office layouts. As highlighted by a number of included reviews [14, 16], future research should explore methodologies to quantifiably measure the impact of indoor environmental qualities. Finally, a number of included studies were categorised as low-quality, with no formal methods described and limited information on the studies included in the review, which limited our analysis to a narrative summary [11, 14, 15].

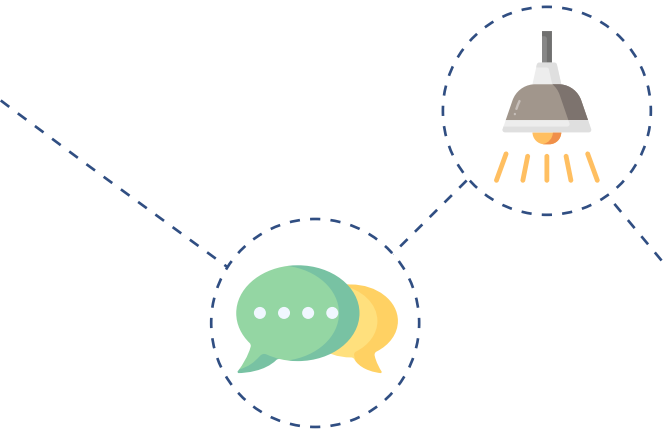


Table 1: Included studies

Ref	Focus	Review method	Review aim	Dates covered	Inclusion/exclusion criteria	Analysis type	Papers in review (n)	Characteristics of included review	Summary of review-level findings	Q
[12]	Health / work-related	Systematic Review	To explore the positive and negative effects of single occupant 'cellular' offices vs. OP design on health, satisfaction, productivity, social interactions and retention	Until 2018	English language, quantitative peer-reviewed studies using cross-sectional or longitudinal design	Qualitative synthesis	31	n=26 cross-sectional, n=5 longitudinal. 16 Europe; 10 North America; 4 Australia; 1 Asia. Sample sizes 31 - 43,021	Compared with individual offices, shared or OP office space is not beneficial to health, with consistent findings of deleterious effects on staff health, wellbeing or productivity	6
[14]	Work-related	Literature Review	To explore the impact of indoor environment quality on office occupant productivity	1920 - 2015	Journal articles, conference articles and books	Not specified	300+ resources	Not specified	OP layouts can have negative impacts on fatigue, motivation, performance, and privacy	5
[17]	Health	Systematic Review	To summarise evidence of modifiable office spatial design features on workplace sitting and face-to-face interaction	Until 2019	English language, quantitative studies examining office spatial design attributes (excluding non-spatial design e.g. workplace physical activity)	Not specified	20	n=9 workplace sitting; n=10 workplace interactions; n=1 both outcomes. n=17 cross-sectional, n=3 quasi-experimental. 10 USA; 5 Europe; 5 Australia. Sample sizes 26 - 5531	Findings are inconsistent, with employees in OP (vs closed offices) having overall shorter sitting time and more frequent face-to-face interaction	7
[11]	Health / work-related	Literature Review	To critically explore and map the research landscape on OP office space to aid facilities management decision making	2007 - 2020	Excluded commercially produced/funded publications	Not specified	42	Not specified	Research highlights employee dissatisfaction with OP design and links to reduced privacy and worse health	3
[10]	Health / work-related	Systematic Review	To explore the effect of office location, layout and use on employees' short-term physiological and psychological reactions (e.g., stress, job satisfaction) and long-term physiological and psychological reactions (e.g., decreased performance)	Until 2003	Original studies examining the office location, layout or use as independent variables among office workers. Low quality studies excluded	Narrative analysis and synthesis	49	n=3 office location; n=7 office layout, n=31 office use. 29 USA; 9 Netherlands; 2 UK; 1 Germany; 4 Australia; 1 Sweden; 1 Canada; 1 Finland; 1 India	Strong evidence that working in open workspaces reduces privacy and job satisfaction. Inconsistent evidence on impacts on performance and health.	7
[16]	Health	Systematic Review	To explore the relationship between interior office space and physical, psychological and social wellbeing	1993 - 2019	English language, peer-reviewed empirical studies and systematic reviews relating to administrative office buildings. Direct measurement of health. Job satisfaction, motivation and productivity excluded	Content analysis and narrative synthesis	50	n=15 cross-sectional, n=13 controlled field study; others longitudinal, controlled lab studies, systematic reviews. Majority European	Working in OP workspaces tends to have a negative relationship with wellbeing if there are no other enclosed workspaces to use	7
[13]	Health	Systematic Review	To explore if individual offices (vs. shared workspaces) affect the health and wellbeing of workers	2000 - 2017	English language, peer-reviewed empirical studies considering single vs. shared workspaces	Qualitative synthesis	15	n=7 cross-sectional, n=5 longitudinal, n=3 surveys. Locations undefined. Sample sizes 60 - 42,764	Consistent findings for negative effects of OP spaces on health, wellbeing, stress, job satisfaction, and productivity	7
[15]	Health / work-related	Literature Review	To provide health service managers evidence on the impact of OP work environments on employees	Not specified	English language, high-quality publications	Not specified	Not specified	Not specified	OP environments linked to loss of privacy, low work productivity, low job satisfaction and health issues	5

Ref=Reference. OP=Open-plan. Q=The overall scientific quality of the review (1=extensive flaws, 3=major flaws, 5=minor flaws, 7=minimal flaws).

Table 2: Findings across studies for the impacts of open-plan layouts on health, wellbeing and work-related outcomes – whether they improved, worsened or had mixed impact

	Health and wellbeing				Work-related outcomes				Interpersonal relationships	
Ref	**Physical health/ wellbeing**	**Stress**	**Mental wellbeing**	**Absence**	**Job satisfaction**	**Productivity / presenteeism**	**Performance**	**Concentration**	**Privacy**	**Social wellbeing / relationships**
[12]	↓ Overall health ↓ Respiratory illness ↓ Fatigue ↓ Pain ↓ Headaches ↓ ENT issues	↓ Stress	↓ Psychological/ mental health ↓ Sleep ↓ Tiredness	↓ Sickness absence	↓ Satisfaction	↓ Perceived productivity	↓ Independence ↓ Personal and work tasks	–	↓ Privacy	↔ Communication ↔ Social interaction ↔ Inter-personal relationships ↑ Co-worker visibility
[14]	↓ Fatigue	↓ Stress	↓ Anxiety	–	↓ Satisfaction	↓ Perceived productivity ↓ Presenteeism	↓ Performance ↓ Motivation	↓ Distraction ↓ Disturbances	↓ Privacy	↑ Interaction ↑ Access to colleagues
[17]	↔ Sitting time	–	–	–	–	–	–	–	–	↔ Face-to face-interaction ↔ Integration ↔ Connectivity
[11]	↓ General health ↓ Central nervous system symptoms	↓ Stress	↓ General wellbeing	–	↓ Satisfaction (job and workplace environment)	↓ Productivity	↓ Internal motivation ↓ Performance	↓ Concentration ↓ Distraction	↓ Privacy	↔ Interactions
[10]	↔ Health	↔ Crowding stress	↔ Autonomy	–	↓ Satisfaction	↓ Cognitive workload	↔ Performance	–	↓ Privacy	↔ Communication ↓ Interpersonal relations
[16]	↓ Skin/eye/nose/ throat irritation ↓ Headache/ nausea/ dizziness ↓ Visual comfort ↓ Tiredness/ fatigue/alertness	↓ Perceived stress	↓ Psychological wellbeing	↓ Sickness absence	–	–	–	↓ Noise annoyance/ disturbances	↓ Privacy/crowding	↓ Interpersonal relations
[13]	↓ Perceived health ↓ Physical health	↓ Stress	↓ Emotional and cognitive irritation ↓ Mental work ability	↓ Sickness absence	↓ Demands ↓ Satisfaction ↑ Variety of work locations	–	↓ Performance	↓ Concentration ↓ Distraction	↓ Privacy	↑ Interaction ↓ Friendship ↓ Supportive supervision
[15]	↓ Musculoskeletal problems ↓ Viral transmission ↓ Fatigue ↓ Blood pressure ↓ ENT issues ↓ Physical exhaustion	↓Stress	↓ Mental exhaustion	↓ High staff turnover	↓ Satisfaction	↓ Productivity	↓ Performance	↓ Concentration ↓ Disturbances	↓ Privacy	–

Ref = Reference. ↓ = negative impact; ↔ = mixed evidence for impact; ↑ = positive impact; – = not explored; ENT = ear, nose and throat. There was heterogeneity in outcomes across studies (see limitations).

Discussion

The findings of this rapid review indicate that the collaborative and communicative benefits often advocated for open-plan offices may be anecdotal and not backed up by research evidence. Findings here showed little evidence for open-plan layouts improving working relationships. Instead, overwhelming evidence points to the harmful effects that working in open-plan office environments may have on individuals and their productivity. Noise may likely be the mediating factor for some of the negative outcomes examined, and other factors, such as effective ventilation and light and the use of sit-stand desks may be important to improve office employee health and wellbeing [12, 14]. However, findings highlight that employers should consider the research evidence for open-plan layouts before moving from individual offices to such environments.

The negative health impacts identified here are especially important given the current context of office use and the rearrangement of office use as COVID-19-related restrictions on home working are removed [17]. With studies highlighting that open-plan office layouts increase respiratory illness [12] and viral transmission [15], further research should explore the impact of open-plan layouts on the health of employees particularly in light of COVID-19. Further research should also explore the sustainability of open-plan office layouts as we identified no evidence for this in this review. Employers and organisations should weigh the financial benefits of open-plan workspaces against the negative impacts for employees, including increased sickness absence, reduced productivity and job satisfaction, which present threats to staff recruitment and retention [10].

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