How the ***physical workplace*** influences employees' ***mental health*** at home and at the office

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Abstract

Background and objectives.
Mental illness is the largest disease burden in the western world. Since people spend a considerable amount of their time at the office, physical workplace characteristics may have a significant influence on their mental health. According to the salutogenic approach, mental health consists of both the absence of mental disease as well as the promotion of mental well-being. Until recently, most studies have focussed on how uncomfortable indoor environmental quality (IEQ) causes mental illness, instead of on how comfortable IEQ and the more tacit workplace characteristics (e.g., plants, views outside, wall colours) may improve mental well-being. The unexpected shift to working from home (WFH) due to the COVID-19 pandemic may also have had an influence on the importance of these workplace aspects on mental health. This study therefore aims to gain insights in the potential influence of all these physical workplace characteristics at the office and at home on mental health and well-being to improve future workplaces according to employees' needs.

Methods.
In this research, a mixed-method approach has been used to obtain both quantitative and qualitative data on the relationships between physical workplace characteristics and mental health at the office and at home. This approach consists of the performance of systematic literature reviews, path analyses, and experiments (i.e., a stated choice experiment and a living lab experiment) to provide an overview of existing knowledge as well as to gain new insights on these relationships.

Results.
This research shows that noise is a strong workplace-distraction, and has a negative influence on employees' mental well-being. While at home, working from a dedicated workroom seems to be a solution to noise distraction, at the office a more centralized solution, namely sound masking, can be introduced to reduce noise distraction. Results show that sound masking positively contributes to employees' mental well-being. Furthermore, this research also shows that in previous studies the potential positive effect of the introduction of biophilic design elemtents (e.g., plants, natural views outside and natural wall colours) on mental health remains under-studied. These elements have a positive influence on people's cognitive and psychological responses, which also improves mental well-being.

Originality.
This research uses a holistic approach to study the relationships between physical workplace characteristics at the office and at home on mental health. It introduces ten indicators of mental health, namely **stress**, **mood**, **well-being**, **productivity**, **concentration**, **burnout**, **engagement**, **fatigue**, **sleep quality**, and **depression**. This research adds insights about how mental health at work can be improved by studying the influence of different workplace design strategies.

Noise, acoustics, and privacy
At the office:
- In 28 out of 133 studies noise, acoustics, and privacy is related to productivity.
- In the soundmasking experiment, it is tested whether the introduction of a white noise reduces noise distraction and improves employees' mental health.

At home:
- In 11 out of 27 studies noise, acoustics, and privacy is related to productivity.
- Noise is the strongest distractor in the home-workplace. Distraction is strongly related to stress- and concentration-issues.

Look and feel
At the office:
- In 7 out of 133 studies look and feel is related to productivity.
- Red or warm wall colours are preferred over blue-green and neutral colours and have a positive effect on the perception of stress, and feeling happy and relaxed.

At home:
- In 2 out of 27 studies look and feel is related to productivity.
- Employees with blue/green wall colours are more stressed, but also rate their happiness and satisfaction (i.e. hedonic tone) more positive.

Methods

PRISMA Method:
- To report results of a systematic literature review in a complete and transparent way.
- The use of eligibility criteria during several screening phases to get a final database with relevant papers.
- The use of a data collection sheet to extract relevant paper information (e.g., country, journal, and publication year).

Path analysis:
- A special case of structural equation modelling (SEM).
- To simultaneously determine which direct and indirect relationships between independent and dependent variables are significant.
- All relationships that are insignificant at the 0.05 ($t<1.96$) significance level are deleted from the path model.
- Repeated backward stepwise process until an acceptable model fit is found and all insignificant relationships are removed.

Stated choice experiment:
- Survey-based stated choice experiment to determine choice behavior.
- Different attributes can be controlled while others are varied.
- Mixed-multinomial logit model (MMNL) to determine probability that particular alternative is chosen.

Longitudinal living lab experiment:
- To observe significant difference between preliminary and close-out survey (same questions and respondents).
- To observe significant difference between test floor (with sound masking) and control floor (without sound masking).
- Short survey: signal contingent experience sampling method (ESM) to randomly prompt employees during the work day.
- The performance of descriptive statistics, bivariate and regression analysis.

Objectives

The objective of this research is to identify the relationships between personal characteristics, workplace design characteristics, satisfaction with physical workplace characteristics and mental health, at the office and at home. After the holistic identification of these relationships, the main salutogenic research gaps (i.e., preventing noise distraction and introducing restorative aspects such as plants and views outside) are explored in-depth to identify their detailed effects on mental health.

Light and daylight
At the office:
- In 28 out of 133 studies light and daylight is related to sleep quality.
- A high window-to-wall ratio (60%) has a positive effect on the perception of productivity and concentration.

At home:
- In 8 out of 27 studies light and daylight is related to productivity.
- Employees who are satisfied with daylight are less stressed.
- Employees who are satisfied with artificial light feel happier and more satisfied (i.e., hedonic tone).

Indoor air quality and ventilation
At the office:
- In 29 out of 133 studies indoor air quality and ventilation is related to productivity.

At home:
- In 8 out of 27 studies indoor air quality and ventilation is related to productivity.

Thermal comfort and temperature
At the office:
- In 31 out of 133 studies thermal comfort and temperature is related to productivity.

At home:
- In 10 out of 27 studies thermal comfort and temperature is related to productivity.

Layout and design
At the office:
- In 24 out of 133 studies layout and design is related to productivity.
- A low occupancy rate (25%) is preferred and has a positive effect on mental health responses.

At home:
- In 4 out of 27 studies layout and design is related to productivity.
- Employees with a dedicated workroom at home feel less distracted from their work. Distraction is strongly related to stress- and concentration-issues.

Biophilia and greenery
At the office:
- In 12 out of 133 studies biophilia and greenery is related to productivity.
- Plants have the highest relative importance for all perceived mental health responses.
- Horizontal, potted plants have a positive effect on all perceived mental health responses.
- Natural views have a positive effect on almost all perceived mental health responses.

At home:
- In 3 out of 27 studies biophilia and greenery is related to productivity, mood, and depressive symptoms.
- Employees who are satisfied with their view outside rate their concentration level higher.
- Employees who are satisfied with the greenery rate their well-being higher.

Results

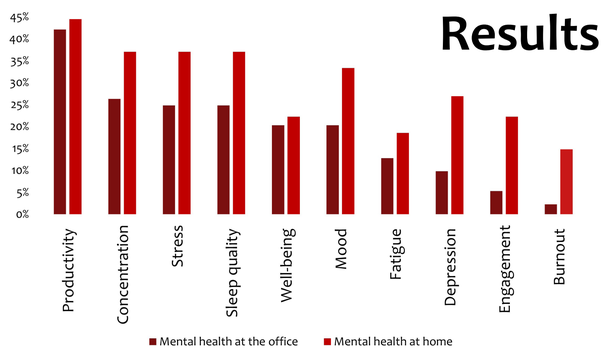

Figure 1: Percentage of studies at home and at the office studying mental health indicators

Figure 1 indicates that productivity is most frequently studied in relation to physical home-and office-workplace characteristics. Less studies focussed on burnout, engagement, and depression, although emotion-focussed indicators did receive some more attention (e.g., mood and stress) for the home-work environment.

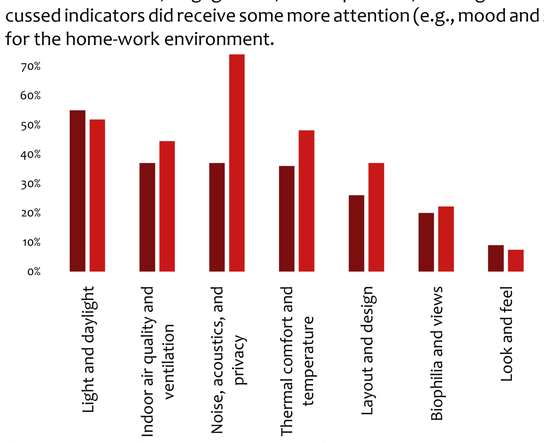

Figure 2: Percentage of studies at home and at the office studying physical workplace characteristics

Figure 2 indicates that previous studies mainly focussed on IEQ aspects, such as light and daylight, indoor air quality and ventilation, and noise, acoustics, and privacy. Especially at home, noise has frequently been studied. Less studies focussed on the salutogenic workplace characteristics, such as biophilia and views and look and feel, both at the office and at home.

Noise, acoustics and privacy

Both at home and at the office, noise, acoustics, and privacy have a significant influence on employees' mental health.

At home:
Noise is the strongest workplace-distraction, meaning that uncomfortable home-workspace noise could substantially distract employees from their job. Distraction significantly increases the experience of stress, and reduces concentration and productivity. It also influences employees' hedonic tone, reducing their happiness and satisfaction. Noise is especially distracting for employees without a dedicated workroom at home. Those employees usually have more than two children, who were not allowed to attend school or daycare during the COVID-19 pandemic. Now that employees are allowed to return to the office, more flexible work-regulations could support employees to work from their preferred work location, which might reduce the experience of distraction.

At the office:
Irrelevant sounds with temporal spectral variability, such as intelligible speech conversations, distract employees from their job at the office. Sound masking technology, which emits a stable background noise to mask distracting speech, is introduced in an open-plan office environment. This study is not yet finished, but it is hypothesized that after the introduction of sound masking, employees feel less distracted by noise and rate their mental well-being more positively. Further analyses should provide further insights in the contribution of sound masking to employees' mental health.

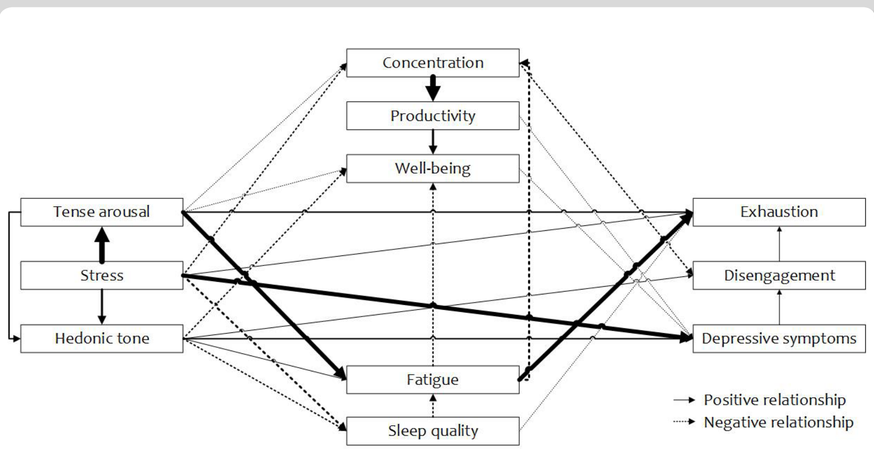

Figure 3: Network of mental health indicators

Salutogenic workplace characteristics

Both at home and at the office, the influence of salutogenic workplace characteristics, such as plants and greenery, and look and feel (incl. wall colours) on mental health have less frequently been studied.

At home:
Satisfaction with daylight, views outside, artificial light, privacy, and greenery are most strongly related to mental health, and are highly interconnected, suggesting a complex mechanism with multiple input variables. On the other hand, satisfaction with temperature, sound, ventilation, and air quality at home are less strongly related to mental health. This is an important contribution to existing knowledge, because office-research usually shows that IEQ variables are considered highly important for employees' mental health. At home, this seems not to be the case.

At the office:
In a virtual open-plan office that represents a real office, salutogenic design aspects are perceived to be important to retain expected psychological and cognitive responses that could eventually influence health. Each of the design attributes predicts perceptions of at least one psychological or cognitive response. Figure 4 shows the utility values for each attribute per response. Plants have the highest relative importance for all the expected responses. The absence of plants has a perceived negative effect on all responses, while horizontal plants have a positive effect. Furthermore, employees expect to prefer an office with windows with sufficient daylight and a view outside, the use of warm wall colours, the absence of screens between workstations, and a low occupancy rate for positive psychological and cognitive responses. These insights are highly valuable because they show which salutogenic workplace aspects attract employees to return to the office after the COVID-19 pandemic.

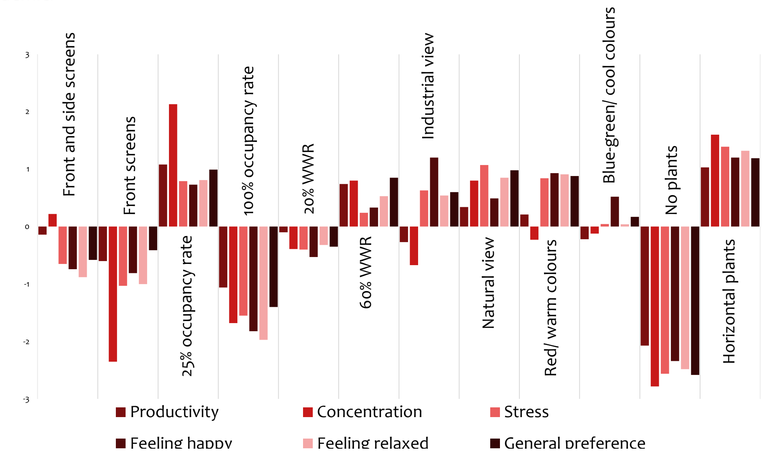

Figure 4: Utility values for each attribute per psychological and cognitive response

Conclusions

Mental illness is the largest disease burden in the western world and can therefore no longer be ignored. However, instead of the sole focus on mental illness, this research aimed to focus both on the recovery of mental illness and the promotion of mental health. Ten indicators of mental health were identified and proven to be related to physical workplace design at home or in the office, namely well-being, stress, depression, engagement, burnout, concentration, fatigue, mood, sleep quality and productivity.

The path model (Figure 3) shows that all ten mental health indicators are related to at least one other mental health indicator. The indicators form a complex network of relationships, which shows that a temporary mental illness resulting from poor workplace design, such as stress or a negative mood, can, in the long term, develop into severe mental health issues, such as exhaustion or depression. The model also shows that productivity is related to well-being. This finding corresponds to the definition of WHO, indicating that mental health is a state of well-being in which people can work productively and fruitfully. It confirms the self-determination theory, that employees have a need for efficacy.

This research also shows that, both at the office and at home, noise is a strong workplace distractor. Although the noise source at home (e.g., family members, pets, or neighbours) may be different from the source at the office (e.g., telephone conversations between colleagues, coffee or copy machines), noise distraction has a negative influence on employees' mental health in both locations. Workplace managers should aim for the protection of employees from noise distraction. Especially after the COVID-19 pandemic, employees may be stimulated to return to the office, because some employees may not have a dedicated workroom with a large desk at home. In addition, at the office, noise-reducing strategies, such as sound masking, are shown to improve the office-comfort, and possibly also employees' mental health. These office-strategies are available to all employees.

Another important contribution of this research is that the understudied biophilic design elements are shown to have a significant influence on employees' health, both at the office and at home. Such design elements have a positive influence on people's cognitive and psychological responses, which could eventually stimulate their health. Although this research did not investigate the number and type of plants or considered all possible wall colours, it does provide first insights in the important contributions of such small, low-cost workplace interventions.

In conclusion, this research has shown that the physical workplace has a significant influence on employees' mental health. Because people now divide their time between the home and the office, both should not just be a physical place to work, but should be a place where you, as an employee, feel healthy and well. This can be stimulated through the promotion of sufficient physical resources that improve mental health significantly.