

# Relationships between mental health and indoor environmental quality (IEQ) in the home workplace

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## 1 Introduction

The influence of the indoor environmental quality (IEQ; air quality, thermal comfort, lighting, and noise) on humans is evident and often associated with health outcomes [1]. While physical and social health in relation to the workplace are commonly studied, mental health in the context of the (physical) workplace still remains underexposed [2, 3]. It is difficult to quantify mental health due to its subjective nature. Previous studies demonstrated significant effects between IEQ conditions and their perception [3], but only limited in relation to potential mental health consequences. Both objective and subjective IEQ should be reviewed, as they are not always aligned.

Since the outbreak of the Covid-19 infection, the workplace at home has suddenly become more relevant as well. However, research on teleworking so far has neglected IEQ conditions at home. Research in the context of mental health while working from home does not yet exist. Therefore, this paper aims to identify relationships between IEQ conditions and workplace mental health while working at home.

## 2 Materials and Methods

Based on the examination of scientific literature a network of relevant variables was constructed, which functioned as a conceptual model. Variable groups distinguished are personal characteristics; objective IEQ conditions; workplace at home; subjective IEQ conditions; and workplace mental health. This conceptual model has been the basis for the subsequent analyses. First, in order to explore any significant relationships between pairs of variables bivariate analysis was conducted. Secondly, the significant pairs were used as input for a path model. The path model enables to analyze the interaction with the network of variables simultaneously.

To collect data, 36 Dutch consultants participated in this study in April 2020. The research set-up benefited from the governmental stay-at-home orders to prevent the spread of covid-19, requiring people to work full-time from home. Environmental satisfaction as well as mental health concepts were captured by repeated surveys in a five-business day measuring period. At the end of the week a reflective extensive survey covered variables not being subject to changes during the day. Moreover, the actual IEQ conditions were measured continuously by wireless sensors on participants' desks.

The four main IEQ parameters included in this study are illuminance, sound pressure level, temperature, and CO<sub>2</sub>-concentration as a proxy for general air-quality. In most research solely one IEQ construct is tested against one other variable and all others are assumed to be constant [4]. By using a holistic approach including all four IEQ parameters, both direct and indirect effects could be reviewed in the current study.

Next, the workplace mental health concepts distinguished are *stress, fatigue, sleep quality, concentration, productivity, engagement, mental wellbeing, emotional exhaustion, depression, mood, and workplace satisfaction*. An extensive and comprehensive scoping review of health and wellbeing concepts in buildings [1] was the basis for the composition of this selection of concepts. These concepts have been operationalized by existing survey scales retrieved from the literature and are measured by means of both two-daily point-in-time (PIT) surveys and a cross-sectional mental health (MH) survey during the measuring period.

Data collection resulted in 36 MH surveys and 321 momentary experiences, an average of

almost nine experiences per participant. Data was prepared by connecting data sources by means of pseudonyms in the surveys and timestamps from the sensor data.

### 3 Results and Discussion

A path model was found with acceptable goodness of fit indices (CFI>0.90;  $\chi^2$ >0.05; RMSEA<0.05) when including variable pairs significant on the 0.01 level from the bivariate analysis only. Moreover, low r-squared regressions and insignificant paths have been excluded from the model. However, one critical rule of thumb was breached, which prescribes a minimum of 200 cases for a path analysis. Nevertheless, the outcomes provide insights and give direction to future research.

The findings indicate that both subjective experience and objective IEQ conditions, as well as workplace *suitability* and *distraction* are related to workplace mental health. The path model outcomes demonstrate higher *engagement* when working in a well-illuminated workplace. Also, being distracted negatively affects self-reported *mental wellbeing* and the level of *engagement*. A perceived suitable workplace at home leads to diminished *fatigue*. While *mental wellbeing* would be reduced in case of *fatigue* and lower levels of *engagement*. Additionally, *fatigue* would result in diminished *concentration* which results in decreased *productivity* as well. An average *sound pressure level* above 58dB resulted in increased tension or nervous feelings. Being satisfied about the noise level increases *concentration*, *self-reported wellbeing*, *engagement*, and diminishes *tense arousal*.

The research has a few limitations. First, the use of CO<sub>2</sub>-concentration as a proxy for air quality at the workplace at home is questionable. Since odors; volatile organic compounds (VOCs); and fine particle matters (PMs) might play a crucial role as well. The CO<sub>2</sub>-concentration is mainly a proxy related to the number of people, and thus more suitable to measure the office environment. Also, it should be noted that the current study was executed during governmental stay-at-home orders due to the covid-19 pandemic. This is a very different situation than being able to freely choose your work location. In addition, this study did not account for reduced mental wellbeing of participants due to covid-19. Nonetheless, this research stresses the importance of IEQ for supporting workplace mental health both for

employers and employees. The outcomes give insights in valuable interventions concerning noise and/or lighting levels to increase mental wellbeing of employees. Which potentially results in increased (business) performance as well.

### 4 Conclusions

This study is one of the first to explore workplace mental health in relation to multiple and both objective and subjective IEQ conditions in the home workplace environment. Although the results should be validated with larger samples, the outcomes give valuable insights in the complex network of variables influencing one's workplace mental health state. Since working from home is expected to be more common in a post-covid world, the relevance and importance of future research is obvious. Future research could make a comparison between working in an office and at home in relation to both work-life balance and workplace mental health.

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### 6 References

- [1] Hanc, M., McAndrew, C., & Ucci, M. (2019). Conceptual approaches to wellbeing in buildings: A scoping review. *Building Research & Information*, 47(6), 767-783. doi:10.1080/09613218.2018.1513695
- [2] Hoisington, A.J., Stearns-Yoder, K.A., Schuldt, S.J., Beemer, C.J., Maestre, J.P., Kinney, K.A., Postolache, T.T., Lowry, C.A., & Brenner, L.A. (2019). Ten questions concerning the built environment and mental health, 58-69. doi:10.1016/j.buildenv.2019.03.036 *Building and Environment*, 155
- [3] Mujan, I., Anđelković, A., Munćan, V., Kljajić, M., & Ružić, D. (2019). Influence of indoor environmental quality on human health and productivity - a review. *Journal of Cleaner Production*, 217, 646-657. doi:10.1016/j.jclepro.2019.01.307
- [4] Parkinson, T., Parkinson, A., & de Dear, R. (2019). Continuous IEQ monitoring systems: Context and development. *Building and Environment*, 149, 15 - 25.