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Satisfaction with activity-support and physical home-workspace characteristics in relation to mental health during the COVID-19 pandemic

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A B S T R A C T

Previous research indicates that employees' mental health might be influenced by their satisfaction with physical office characteristics, such as noise, daylight, and ventilation. However, similar research on mental health in relation to working from home (WFH) is limited. Therefore, this study aimed to identify the relationships between satisfaction with physical home workspace characteristics and support of work activities and mental health while WFH during the COVID-19 pandemic. Relationships were analysed using a path analysis approach, based on a sample of 1219 office workers, who had to work fully from home. The internal relationships between the ten considered mental health variables were also studied. Results showed that satisfaction with daylight, artificial light, greenery, and views outside were directly related to one of the mental health variables and indirectly to several others. Surprisingly, satisfaction with temperature, noise, ventilation, and air quality did not seem to play a role at the home workplace. In addition, unlike at the office, personal characteristics did not relate to workspace satisfaction nor perceived support of activities at home. Furthermore, all mental health variables were related to at least one other mental health variable. Workplace managers could use these insights to formulate recommendations for employees on how to design their home-workspace.

1. Introduction

Since the beginning of the twenty-first century, working from home (WFH) has gained increased attention. WFH was considered to increase people's work-life balance and well-being (Ng, 2010), (Nakro & Ren et al., 2019) by offering flexibility (Grant et al., 2013) and enhanced concentration (Ng, 2010), (Montreuil & Lippel, 2003). Early 2020, the occurrence of the COVID-19 pandemic resulted in an extraordinary situation where office workers were obliged to WFH, which significantly increased the percentage of homeworkers (Oakman et al., 2020). Consequently, employees rapidly needed to adapt to their new work environment at home. WFH before COVID-19 had both negative and positive consequences on employees’ mental health, depending on the fit between the person and the environment (Bentley et al., 2016). As Carnevale and Hatak (Carnevale & Hatak, 2020) explain, the drastic change in employees’ work environment might lead to the experience of a misfit between employees' needs and attributes of the work environment. According to the person-environment fit theory, a good fit between the work environment and individuals’ needs results in increased productivity or well-being, while a poor fit might result in stress, depression, or burnout. It is therefore important for employees and employers to discover these misfits timely, to reduce possible consequences for both (Williamson et al., 2021).

The physical work environment can be explained as the space where people perform their work activities (Armitage et al., 2021). Before the pandemic, several physical home-workspace characteristics affected people’s decision to WFH, such as the availability of space (Moos & Skaburskis, 2008) and the experience of visual and auditory privacy (Sander et al., 2021). Due to obligatory, fulltime WFH, home-workspace characteristics (e.g., window views, room size, (day)light, temperature, noise insulation, and furniture) have become even more important (Awada et al., 2021). Employees with a dedicated home-workroom experienced fewer mental health issues, such as fewer depressive symptoms, stress, and mood swings, increased sleep quality, concentration, and productivity, and more engagement (Awada et al., 2021), (Xiao et al., 2021). However, for those employees who work from their...
bedroom or a small part of the living room, WFH might be detrimental to their well-being (Peters & Halleran, 2020). These employees might thus experience a misfit between their needs and the environmental attributes.

The obligation to WFH also hinders spontaneous interactions between colleagues (van den Berg et al., 2020), (Waizenegger et al., 2020), and endangers knowledge transfer and cooperation (Bjursell et al., 2021). Employees might feel socially isolated, resulting in less involvement and engagement at work (Bjursell et al., 2021). The absence of physical meeting spaces (especially during COVID-19) can also feel overwhelming, causing fatigue, exhaustion, and disengagement (Waizenegger et al., 2020). Those who mainly perform concentrated tasks (i.e., tasks that require the ability to select goal-specific information, while ignoring distractions (Schwartz & Kaplan, 2000)) might be more satisfied with WFH and rate their mental health more positively (Bjursell et al., 2021).

However, although some COVID-19-related studies identified an influence of obligatory WFH on mental health (Oakman et al., 2020), (Pieh et al., 2020), or investigated the experience of different home-workspace characteristics (Batool et al., 2021), (Cuervo-Vilches et al., 2021a), the relationship between the satisfaction with physical home-workspace characteristics and mental health is under-investigated. These studies are either literature reviews of evidence gathered before the pandemic (Oakman et al., 2020), they ignore the physical workplace quality at home (Pieh et al., 2020), or only look at one or a few design aspects such as window views (Batool et al., 2021) or (day)light, temperature, air quality, and noise (Xiao et al., 2021).

Some extensively studied the physical home-workspace but did not include health outcomes (Cuervo-Vilches et al., 2021a), or they focused on effects of a few design characteristics on productivity (Awada et al., 2021). The current study contributes to existing knowledge with a more holistic approach, including nine physical home workspace characteristics and ten indicators of mental health. In addition, to the best of the authors’ knowledge, it is the first study including the relationship between satisfaction with the support of specific work activities at home and mental health.

The first aim of this study is to examine the relationships between personal characteristics, satisfaction with physical workspace characteristics, perceived activity support, and mental health while WFH fulltime. The second aim is to gain insights in the internal relationships between the mental health variables. The use of both mental well-being (i.e., well-being, productivity, mood, sleep quality, engagement) and mental ill-being (i.e., fatigue, depressive symptoms, burnout, stress) variables, as suggested by Bergefurt et al. (Bergefurt et al., 2022), is another novelty of this study. It creates more understanding for practice of who can WFH in a healthy way, and how home-workspaces can be changed to contribute to office workers’ mental health. Academics can use these findings to study the influence of the home-workspace on mental health more holistically.

2. Literature review

2.1. Mental health

Mental health is defined as “a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” (23, p. 10). Bergefurt et al. (Bergefurt et al., 2022) introduced ten work environment-related mental health indicators, namely stress, fatigue, depressive symptoms, burnout, well-being, productivity, mood, sleep quality, and engagement. These indicators will shortly be summarized.

All humans experience stress from time to time. Stress is a response to psychosocial and environmental factors (Beute & de Kort, 2014), (Thayer & Brosschot, 2005), that arises because of physical, task, role or interpersonal demands (Quick et al., 2017, pp. 467–474). The experience of stress can induce a change in mood, namely an increase in negative affect and a decrease in positive affect (Beute & de Kort, 2014), (Mark et al., 2016, pp. 29–36). Under high job demands, individual energetical resources may not be sufficient to execute the work task at hand, which can lead to (reversible) mental fatigue. Mental fatigue might result in job performance failures (Bakker et al., 2004), or eventually in more chronic effects due to insufficient recovery from high work demands, such as feelings of burnout, exhaustion or even depression (Schaufeli & Bakker, 2004a, 2004b), (Demerouti et al., 2002). Burnout consists of two dimensions, namely exhaustion and disengagement from the job (Demerouti & Bakker, 2007). While exhaustion primarily results from high job demands or prolonged workplace stress, disengagement is caused by lacking individual resources (i.e., low vigour, dedication, and absorption) (Bakker et al., 2004), (Schaufeli & Bakker, 2004b) or a negative mood (Rodríguez-Muñoz et al., 2014).

Furthermore, work stress can cause poor sleep quality (Knudsen et al., 2007). A worse sleep quality, a short total sleep time and stress during the day may also lead to increased feelings of fatigue (Akerstedt et al., 2014). Among burned-out individuals specifically, poor sleep quality impairs recovery from fatigue (Sommerschein et al., 2007). The inability to recover from fatigue reduces people’s ability to concentrate or focus attention on their job (Clements-Croome, 2006), and restricts their ability to direct cognitive resources to one single goal (Beurskens et al., 2000), (Obayashi et al., 2019). As Clements-Croome and Kaluurachchi (Clements-Croome & Kaluurachchi, 2016) indicated, reduced concentration can cause productivity and well-being deficiencies. For employees to work productively, high and sustained levels of concentration are required (Clements-Croome et al., 2019).

2.2. Satisfaction with physical home-workspace characteristics

In the absence of sufficient physical workspace resources, people cannot adequately perform their job, resulting in short-term, reversible consequences (e.g., stress, fatigue, and decreased concentration (Bakker et al., 2004), (Clements-Croome, 2006), (Vischer, 2007)), or long-term, severe consequences (e.g., sleep quality- and well-being issues, increased burnout complaints (i.e., disengagement and exhaustion), and depressive symptoms (Bakker et al., 2004), (Friedberg, 2013)). Al Horr et al. (Al Horr et al., 2016) define these physical workspace resources as noise and acoustics, thermal comfort, indoor air quality and ventilation, light and daylight, and biophilia and views outside. Even for simple tasks, failures in such workspace resources can adversely affect employees’ health and well-being (Wineman & Barnes, 2018).

Research has shown that auditory privacy and background noise are the strongest dissatisfiers in the office environment (Rolf et al., 2018). Especially in open-plan offices, conversations between colleagues can easily be overheard due to lacking acoustical quality (Kaarlola-Tuomaina et al., 2009). Both privacy issues and high background noise create unwanted interruptions that reduce employees’ productivity (Candido et al., 2019) and concentration (Sander et al., 2019a), (Di Blasio et al., 2019). These factors are also frequently mentioned as sources of dissatisfaction and stress (Wineman & Barnes, 2018). At home, such sources of noise are less frequently experienced, although different noise sources, such as noise from doorbells, conversations between household members, sounds from television, outdoor construction works and road traffic, can all affect concentration and well-being (Puglisi et al., 2021), (Torresin et al., 2021). The limited research on WFH also shows that employees who have a dedicated workroom with ergonomic furniture developed fewer mental health issues (Xiao et al., 2021), (Puglisi et al., 2021), (Torresin et al., 2021). The limited research on WFH also shows that employees who have a dedicated workroom with ergonomic furniture developed fewer mental health issues (Xiao et al., 2021), (Puglisi et al., 2021), (Torresin et al., 2021).
2000), (Sander et al., 2019b), pleasant temperatures (21–25 °C) stimulate productivity (al Horr et al., 2016). Satisfaction with air quality, humidity and temperature also contributes to employees’ productivity and mood (Roksams & Haynes, 2019a). Research on the home-workspace shows that employees who are satisfied with IEQ (Indoor Environmental Quality) factors developed fewer mental health issues and rated their productivity more positively (Awada et al., 2021), (Xiao et al., 2021)

Furthermore, exposure to daylight or artificial bright light is a prerequisite for employees’ mental health. Under bright light conditions, people generally report higher concentration- and mood-levels (van Duijnhooven et al., 2019) (although such effects are not reported consistently, for reviews see Lok et al. (Lok et al., 2016) and Souman et al. (Souman et al., 2018)). Satisfaction with (day)light also contributes to employees’ mood and productivity (Roksams & Haynes, 2019a). In contrast, lacking (day)light exposure results in long-term mental health issues, including sleep quality issues (Itubalek et al., 2010), burnout complaints (Alimoglu & Donmez, 2005), and depressive symptoms (Boubekrni et al., 2014), (Harb et al., 2015), Cuerdo-Vilches et al. (Cuerdo-Vilches et al., 2021b) highlighted that sufficient daylight entrance is also important in the home-workspace. During the COVID-19 lockdown, employees located their workspace close to a window for daylight and views outside (Batool et al., 2021).

Views outside and natural elements (i.e., biophilic elements) are important for people’s mental health. The presence of natural elements can increase their productivity and well-being (Elsadek, 2020, pp. 1–12). Satisfaction with biophilic elements positively affects employees’ stress and productivity (Aristizabal et al., 2021). In contrast, those who work in offices without biophilic elements feel more stressed (Sander et al., 2019b). Daily exposure to both daylight and nature is related to better affective states, and the effects of exposure to nature are particularly beneficial to those in need of restoration (e.g., from stress or work pressure) (Beute & de Kort, 2018). Research shows that the visibility of plants from windows or balconies, having plants indoors or a garden at home is associated with less depressive symptoms. Especially during the pandemic, these aspects contributed to a restorative environment while WFH (Dzhambov et al., 2021). Although research did not study the influence of satisfaction with all these office-aspects on all mental health variables while WFH, it is expected that:

Hypothesis 1. Office workers’ satisfaction with the air quality, ventilation, temperature, artificial light, daylight, noise, privacy, biophilia, and views outside positively relates to their mental health.

2.3. Satisfaction with support of work activities at home

According to self-determination theory, people strive for satisfaction of three psychological needs, namely competence (i.e., ability to control/adapt to environment), autonomy (i.e., tendency towards self-organization and -regulation) and relatedness (i.e., connection to others) (Deci & Ryan, 2000). To promote employees’ well-being and health (Ko z uzunski et al., 2018), (Hanc et al., 2019), the office-workspace should support the fulfillment of these needs, by facilitating interactions, creating suitable conditions, offering required tools and facilities, and by allowing freedom of choice, for instance in where to perform these activities. This pertains to a broad set of themes, such as privacy, social interactions, territoriality and personalization, status expression, autonomy, aesthetics, and relaxation. These needs may vary between persons, jobs, or tasks. For instance, those who frequently perform non-concentrated tasks rate the importance of privacy lower, while those who spend more time on phone calls rate the importance of territoriality and communication higher (Budle et al., 2019).

At home, the psychological need for relatedness might not be satisfied, because informal, spontaneous interactions between colleagues are not well supported. Employees might feel disconnected from their colleagues, or even disengaged from their job (Oakman et al., 2020), (Diab-Bahman & Al-Enzi, 2020). Although virtual interactions partly replace face-to-face interactions, it is substantially harder to place interactions in context, judge opponents’ reactions, use non-verbal communication, or to make gestures (Osland et al., 2011). Work activities that require concentration are however better supported while WFH (Okuyan & Begen, 2021). Therefore, employees might be less satisfied with the support of informal activities, and more satisfied with the support of concentrated activities while WFH. The following hypothesis is therefore composed:

Hypothesis 2A. Office workers’ satisfaction with the support of concentrated work, and formal and informal interactions at home positively relates to their mental health.

Employees’ satisfaction with the support of work-activities depends partly on the design and facilities of the office-workspace. In a well-designed office with ergonomic furniture, adequate daylight and acoustics, and control over temperature and air quality, formal and informal interactions are well-supported (Osland et al., 2011). Especially for formal interactions and concentrated tasks, employees appreciate low noise levels and enclosed workspaces, while for informal interactions, these attributes are less important (Prei den Berg et al., 2020).

At home, the psychological need for autonomy might be better supported, because employees can adapt the home-workspace to their preferences. Adequate room size, (day)light, temperature, furniture, and noise insulation contribute to the perceived suitability of the home-workspace (Cuerdo-Vilches et al., 2021a). Especially when employees have a dedicated workroom at home, communication with colleagues becomes more effective due to fewer distractions than at the office (Ng, 2010), (Awada et al., 2021). However, as Moretti et al. (Moretti et al., 2020) highlight, most homeworkers indicate greater autonomy, impaired interactions with colleagues, and distractions in the domestic environment as the worst disadvantages of WFH. Especially when employees are required to WFH even though their home-workspace is not suitable, their productivity is likely to reduce (Ng, 2010). Although not investigated before, it is thus likely that:

Hypothesis 2B. Office workers’ satisfaction with the support of concentrated work, and formal and informal interactions at home relates to their satisfaction with physical home-workspace characteristics.

2.4. Personal characteristics

Several personal characteristics influence employees’ mental health at work. For instance, females generally experience more stress outside the office (Lindberg et al., 2018), while older-aged employees can more easily deal with such work stressors at the office (Jutke Lanfer et al., 2021)– (Mache et al., 2020). Neurotic employees are prone to emotional disturbance and physiological arousing states, which reduces their sleep quality and hedonic tone, and increases tense arousal and stress (Kriz an and Hisler, 2019), (Srivastava, 2010). Long workhours (i.e., more than 60 h per week) also reduce people’s sleep quality (Gunnarsson et al., 2007) and productivity, and increase feelings of fatigue (Collinew & Sauermann, 2017) and depressive symptoms (Kim et al., 2013), (Virtanen et al., 2012). WFH increases the flexibility in workhours, but can also cause overworking. This might result in more stress (Ray & Pana-Cryan, 2021). Especially among homeworkers who share their workspace with family members, decreased well-being, engagement, and productivity is experienced (Adisa et al., 2021). It is thus expected that:

Hypothesis 3A. Office workers’ age, gender, personality, workhours, and workspace type are related to their mental health.

Some personal characteristics also influence employees’ satisfaction with physical workspace aspects. In general, females are less satisfied with their workspace (Bluysen et al., 2011), because they are more
sensitive to deviations from optimal comfort levels (Wang et al., 2018). Females have higher noise annoyance levels (Di Blasio et al., 2019), (Beheshti et al., 2019), and feel more uncomfortably cold than their male colleagues (Karjalainen, 2007). Introverted and neurotic employees also have lower noise annoyance levels than more extroverted colleagues (Beheshti et al., 2019), (Oseland & Hodsmann, 2018).

In the home-work context, research shows that younger employees who live with young children, often in a small house without a dedicated workroom rate their home-workspace more frequently as inappropriate. These employees also indicate the IEQ (i.e., light, air quality, and noise) as poor (Cuerdo-Vilches et al., 2021b). It is furthermore expected that females and those who share their workspace with others are less satisfied with the home-workspace, because they are less satisfied with WFH in general (Naikosen et al., 2019). Therefore, the following hypothesis is composed:

**Hypothesis 3B.** Office workers’ age, gender, personality, workhours, and workspace type are related to their satisfaction with the physical home-workspace.

While some employees, such as younger-aged employees, and those who score high on extraversion and openness, are reported to prefer collaboration and face-to-face interactions in informal office-rooms, older-aged employees and closed-minded employees prefer to meet in formal office-rooms (Oseland, 2013, pp. 1–22), (Joy & Haynes, 2011). For younger-aged employees and those who score higher on extraversion and openness it might thus be easier to adapt to WFH. Therefore, they might be more satisfied with the support of different home-work activities. Research shows that WFH is especially valued for concentrated tasks (Joy & Haynes, 2011). Workspace type and number of workhours might also be related. These findings lead to the following hypothesis:

**Hypothesis 3C.** Office workers’ age, gender, personality, workhours, and workspace type are related to their satisfaction with the support of work activities at home.

### 2.5. Conceptual model

Fig. 1 shows the conceptual model, in which the expected causal relationships are drawn that correspond to the hypotheses. The double-sided arrowed line between satisfaction with physical home-workspace and satisfaction with support of work activities at home indicates that this correlation will be tested in two directions, for lack of insights from existing studies. Personal characteristics are assumed to be exogenous, while all other variables are endogenous.

### 3. Methods

#### 3.1. Data collection

Data were collected through a cross-sectional online survey, distributed between September 2020 and January 2021. Participants were recruited via three [nationality disclosed for blind peer review] private organizations and one public organization by a direct email from their HRM departments with a link to the survey. The total sample consisted of 1219 respondents, of which 826 indicated to work at a public organization and 393 at a private company. Because the independent and dependent variables were captured at the same point in time and the same survey was used, there is a risk of common method bias. This occurs when the variance in the model is attributable to the research method and not to the measures of the variables (Chang et al., 2010). To identify the potential common method bias, two methods were used. First, multicollinearity tests were run to check whether two or more predictors measured the same underlying construct (Kock, 2015). Variance inflation factors (VIF) were determined to measure the strength of correlations between predictors. A generally accepted rule of thumb indicates that $1 \leq \text{VIF} \leq 5$ (Daoud, 2018). In the current study, VIF was lower than 5 for all predictor variables. Another method to identify potential common method bias is measuring the Harman’s single factor score. As a rule of thumb, common-method bias is absent if the total explained variance in a single factor solution of the variables included in the measurement is below 50% (Fuller et al., 2016). In the current study, the total explained variance by a single factor for all mental health constructs equals 36.1%. Therefore, it was concluded that the common method bias is unlikely or very small.

#### 3.2. Measures

Table 1 shows an overview of the scales that were used. To test the internal consistency of the set of items for each factor, Cronbach’s Alpha and inter-item correlation coefficients (2 variables) were calculated. Cronbach’s Alpha ($\alpha$) should be between 0.7 and 0.9 (Tavakol & Dennick, 2011, pp. 53–55), and the inter-item correlation should be between...
At the 0.05 (t be determined simultaneously (Lleras, 2005, pp. 25). Direct relationships between independent and dependent variables can be examined using structural equation modelling (SEM), in which multiple direct and indirect relationships are considered. These relationships were used as input for the path analysis. Path analysis is a special case of SEM. In the survey, all possible internal and external relationships were tested, and an acceptable model was found (Stréiner, 2005), (Hu et al., 2009). 0.2 and 0.4 (Field, 2017). As Table 1 shows, for all mental health variables, except for sleep quality, acceptable values of Cronbach’s Alpha were found. Since the Health at Work Survey is a validated scale to measure sleep quality, it was decided to keep the original items. For each of the five personality types, the inter-item correlation was measured (see Table 2). Since the inter-item correlation was low for agreeableness, it was decided to delete this personality indicator from further analysis.

### 3.3 Analytical approach

First, bivariate analyses were conducted to get insight in significant hypothesized relationships. All possible relationships were tested, including internal (e.g., between satisfaction with support of online interactions and concentrated work) and external relationships (e.g., between age and stress). The internal relationships between personal characteristics were not considered. The significant relationships were used as input for the path analysis. Path analysis is a special case of structural equation modelling (SEM), in which multiple direct and indirect relationships between independent and dependent variables can be determined simultaneously (Lleras, 2005, pp. 25–30). The backward stepwise process was used, in which relationships that were insignificant at the 0.05 (t < 1.96) significance level were deleted. This process was repeated until all possible internal and external relationships were tested, and an acceptable model was found (Stréiner, 2005), (Hu et al., 2009). The root mean square error of approximation (RMSEA) was used as model fit criterion, and should be below 0.05 (Golob, 2003).

### 4. Results

#### 4.1 Sample descriptives

Table 3 summarizes the sample characteristics of all respondents that indicated to fully WFH. Slightly more males than females responded to the survey. The mean age equals 43. Respondents worked on average 36 h according to their contract, and 38 h from home during the previous two weeks. Many employees (75%) indicated to have a private workspace at home. Most respondents indicated conscientious personality traits, followed by extraversion, openness, and neuroticism. Regarding physical home-workspace satisfaction, people were most satisfied with privacy, air quality, and ventilation, and least satisfied with views outside, artificial light, and greenery. Regarding activity support, people were most satisfied with the support of concentrated work and least satisfied with the support of informal interactions.

Furthermore, the mean scores for stress and worry, depressive symptoms, exhaustion, disengagement, tension, fatigue, concentration, well-being, and productivity were on the positive side of the scales, which indicates that, on average, office workers rated their sleep quality, concentration, well-being, and productivity rather positively. The mean scores for stress, depressive symptoms, exhaustion, disengagement, hedonic tone, tense arousal, and fatigue were on the low side of the scales. This indicates that, on average, office workers did not feel stressed, depressed, exhausted, or disengaged. Employees also indicated, on average, to feel happier or more satisfied than sad or low-spirited, and calmer and more relaxed than tense and nervous. Nonetheless, the larger
standard deviations for several mental health indicators show that not all respondents perceived their mental health positively.

4.2. Path analysis

Paths were specified according to the results of the bivariate analyses, which indicated that the number of contract hours was not significantly related to any other variable (M = 35.58, SD = 7.58). Therefore, this variable was not included in the path analysis. In the path analysis, gender, age, number of hours worked the previous two weeks, shared or private workspace, the personalities extraversion and openness, satisfaction with temperature, sound/noise, ventilation, and air quality, and satisfaction with the support of informal and formal interactions were deleted because they were not found to be significantly related to any other variable when tested simultaneously.

Results of the path analysis revealed a satisfactory fit of the final model. Chi-square (χ² = 509.80) divided by the degrees of freedom (df = 129) should have a value between 2 and 5, which is satisfied (χ² / df = 3.93). The Normed Fit Index (NFI = 0.98) and the Goodness of Fit index (GFI = 0.96) should both be close to 1. NFI indicates the relative position of the current model between the independent and saturated model. GFI indicates the fit between the hypothesized and the observed proportion of variance. The root mean square error of approximation (RMSEA = 0.049) should be below 0.05 and can be interpreted as the square root of population misfit per degree of freedom (Hayashi and Yuan). The value of the model’s Akaike information criterion (AIC = 669.42) should be close to the saturated AIC (AIC saturated = 420.00) (Golob, 2003).

Table 4 shows the direct and indirect unstandardized effects between personal- and home-workspace characteristics and mental health, and between the mental health characteristics. All effects in the table are significant at the 0.05 significance level (t ≥ 1.96). The R-square values vary between 0.21 and 0.67, which means that the personal-and-home-workspace characteristics explained between 21% and 67% of the total variance of mental health.

4.3. Direct relationships – personal- and satisfaction variables

Figs. 2 and 3 show the significant relationships that were found in the path analysis. They both show sections of the same overall path model, but the relations between the ten mental health indicators are shown separately in Fig. 5 for clarity-reasons. Fig. 2 and Table 4 show that employees who were satisfied with daylight were less stressed, and that satisfaction with artificial light at the home workspace was related to feeling happier and more satisfied (i.e., hedonic tone). Satisfaction with views outside was associated with higher concentration, and satisfaction with greenery with higher well-being. Therefore, hypothesis 1 is accepted. Furthermore, internal relationships were found between artificial light, daylight, privacy, and views outside. The significant standardized path coefficients were all relatively small (except for artificial light – daylight).

In addition, satisfaction with support of online interactions was associated with reduced disengagement, and satisfaction with support of concentrated work with increased concentration. Hypothesis 2A is thus accepted, although both standardized path coefficients were rather small. Satisfaction with privacy and artificial light were both associated with higher satisfaction with support of concentrated work. Satisfaction with privacy and daylight were also associated with higher satisfaction with support of online interactions. Hypothesis 2B can thus also be accepted. The standardized path coefficient of the relationship between satisfaction with privacy and support of online interactions was relatively large (β = 0.34). Particularly strong was the relationship between satisfaction with the support of online interactions and satisfaction with the support of concentrated work (β = 0.75).

From the personal characteristics, conscientiousness was associated with higher concentration and productivity, while neuroticism was related to increased stress and tense arousal. A relatively large standardized path coefficient (β = 0.48) was found for the relationship between neuroticism and stress. Hypothesis 3A can thus be accepted. However, no direct relationships were found between personal characteristics and satisfaction with the physical home-workspace or the experienced support of work activities at home. Therefore, Hypothesis 3B and 3C are rejected.

4.4. Direct internal relationships – mental health variables

Fig. 3 indicates that each of the mental health variables was significantly related to at least one other mental health variable. Stress was associated with feeling more sad, low-spirited (hedonic tone), tense and nervous (tense arousal), depressed, exhausted, and with reduced concentration and sleep quality. The standardized path coefficients between stress and tense arousal (β = 0.66) and between stress and depressive symptoms (β = 0.40) were high. In addition, tense arousal was associated with reduced hedonic tone, well-being, and concentration, and with feeling fatigued and exhausted. The relationship between fatigue on tense arousal was relatively strong too (β = 0.43). Hedonic tone was related to increased depression, fatigue, disengagement, and reduced sleep quality.

Furthermore, reduced sleep quality increased fatigue and
| Variables          | Sleep quality Direct | Sleep quality Indirect | Stress Direct | Stress Indirect | Depressive symptoms Direct | Depressive symptoms Indirect | Exhaustion Direct | Exhaustion Indirect | Disengagement Direct | Disengagement Indirect | Hedonic tone Direct | Hedonic tone Indirect | Daylight Direct | Daylight Indirect |
|--------------------|----------------------|------------------------|--------------|-----------------|--------------------------|------------------------------|---------------------|---------------------|------------------------|------------------------|---------------------|-----------------------|-----------------|-------------------|
| Personality        | Conscientiousness    | -.04 (6.37)            | .02 (5.43)   | -.16 (7.03)     |                          |                              |                     |                     |                        |                        |                     |                       |                 |                  |
|                    | Neuroticism          | .25 (17.28)            | .72 (18.04)  | .41 (13.56)     | .29 (15.34)              |                              |                     |                     |                        |                        |                     |                       |                 |                  |
| Satisfaction with  | Daylight             | .09 (3.66)             | .21 (3.76)   | .06 (3.77)      | -.16 (3.93)              | -.16 (4.93)                  | .07 (3.69)          |                     |                        |                        |                     |                       |                 |                  |
|                    | Privacy              | .02 (3.32)             | -.04 (3.40)  | .01 (3.72)      | .04 (4.63)               | -.13 (4.23)                  | .01 (3.35)          | .18 (7.92)          |                        |                        |                     |                       |                 |                  |
|                    | Views outside        | .02 (3.51)             | -.05 (3.60)  | .02 (4.46)      | .05 (4.60)               | .09 (4.54)                   | .02 (12.36)         |                     |                        |                        |                     |                       |                 |                  |
|                    | Artificial light     | .08 (4.16)             | -.09 (3.67)  | -.05 (4.41)     | -.10 (4.65)              | -.12 (4.87)                  | .10 (2.66)          | .03 (3.60)          | .41 (16.52)            |                        |                     |                       |                 |                  |
| Satisfaction with  | Online interactions  | .05 (3.48)             | -.27 (3.50)  |                     |                          |                              |                     |                     |                        |                        |                     |                       |                 |                  |
| Mental health      | Sleep quality        | -.33 (10.23)           | -.12 (7.08)  |                     | .19 (17.16)              | .11 (14.74)                  | .20 (5.33)          | .53 (17.34)         | .47 (16.80)            | .21 (8.35)              | .11 (6.88)         |                       |                 |                  |
|                    | Stress               | .01 (6.14)             | -.05 (2.27)  | -.11 (8.48)      | .03 (6.31)               |                              |                     |                     |                        |                        |                     |                       |                 |                  |
|                    | Depressive symptoms  | .15 (8.54)             |                     | .20 (11.59)      | .03 (6.03)               | .33 (11.66)                  | .35 (5.39)          | .18 (7.72)          |                        |                        |                     |                       |                 |                  |
|                    | Tense arousal        | -.07 (5.18)            |                     | .07 (9.43)       | .26 (6.70)               | .31 (14.34)                  | .21 (9.09)          | .18 (7.05)          |                        |                        |                     |                       |                 |                  |
|                    | Fatigue              | .01 (7.99)             |                     | .13 (17.53)      | .05 (9.99)               | .03 (8.40)                   |                     |                     |                        |                        |                     |                       |                 |                  |
|                    | Concentration        | .02 (8.84)             |                     | .02 (6.55)       | -.14 (9.25)              | -.01 (4.97)                  |                     |                     |                        |                        |                     |                       |                 |                  |
| Well-being         | -.11 (5.53)          |                     | .01 (3.67)      |                     | .07 (4.07)               |                        |                     |                     |                        |                        |                     |                       |                 |                  |
|                    | Productivity         | -.13 (6.40)            | .05 (5.28)     | -.02 (4.39)      | -.10 (5.12)              |                        |                     |                     |                        |                        |                     |                       |                 |                  |
| R-squared          | 0.21                 | 0.24                   | 0.56           | 0.61             | 0.26                      | 0.29                       | 0.44                |                     |                        |                        |                     |                       |                 |                  |

| Variables          | Tense arousal Direct | Tense arousal Indirect | Fatigue Direct | Fatigue Indirect | Concentration Direct | Concentration Indirect | Well-being Direct | Well-being Indirect | Productivity Direct | Productivity Indirect | Concentrated work Direct | Concentrated work Indirect | Online interactions Direct | Online interactions Indirect |
|--------------------|----------------------|------------------------|----------------|-----------------|--------------------|---------------------|------------------|---------------------|------------------------|------------------------|---------------------|------------------------|-------------------------|-------------------------|
| Personality        | Conscientiousness    | .94 (8.21)             | .10 (7.58)     | .14 (5.33)      | .10 (7.62)         |                     |                  |                     |                        |                        |                     |                       |                       |                        |
|                    | Neuroticism          | .30 (9.36)             | .49 (16.33)    | 2.13 (17.23)    | -.18 (15.91)       | -.27 (16.23)       | -.12 (12.56)      |                     |                        |                        |                     |                       |                       |                        |
| Satisfaction with  | Daylight             | -.14 (3.74)            | -.41 (3.72)    | .30 (4.08)      | .06 (3.82)         | .03 (4.00)         | .12 (6.87)        | .20 (6.97)          |                        |                        |                     |                       |                       |                        |
|                    | Privacy              | -.02 (3.38)            | -.07 (3.37)    | .13 (2.93)      | .01 (3.85)         | .01 (2.90)         | .04 (2.57)        | .23 (13.41)         | .33 (12.24)            | .03 (5.23)              |                     |                       |                       |                        |
|                    | Views outside        | -.03 (3.58)            | -.10 (3.56)    | .33 (2.92)      | .08 (3.87)         | .03 (4.51)         | .04 (3.54)        | .03 (6.00)          | .05 (6.07)             |                        |                     |                       |                       |                        |
|                    | Artificial light     | -.06 (3.65)            | -.34 (4.21)    | .20 (4.62)      | .05 (4.29)         | .02 (4.51)         | .12 (7.54)        | .05 (6.34)          | .08 (6.42)             |                        |                     |                       |                       |                        |
| Satisfaction with  | Online interactions  | .06 (2.43)             |                     |                  |                     |                     |                  |                     |                        |                        |                     |                       |                       |                        |
| Mental health      | Sleep quality        | -.82 (9.57)            | 1.99 (24.18)   | -.68 (7.79)     | .18 (7.54)         | .03 (7.11)         | .02 (7.07)        |                     |                        |                        |                     |                       |                       |                        |
|                    | Stress               | .65 (31.73)            |                     | .60 (7.90)      | -.26 (22.46)       | -.13 (14.60)      |                     |                     |                        |                        |                     |                       |                       |                        |
|                    | Hedonic tone         | 1.41 (9.17)            | .31 (5.96)     | -.37 (8.24)     | .18 (8.27)         | .07 (7.69)        | -.04 (7.64)       |                     |                        |                        |                     |                       |                       |                        |
|                    | Tense arousal        | 1.80 (17.60)           | .30 (5.96)     | -.27 (2.80)     | .45 (10.51)        | -.12 (7.71)       | .13 (11.42)       | -.07 (7.38)         |                        |                        |                     |                       |                       |                        |
|                    | Fatigue              | -.21 (12.23)           |                     | .03 (8.42)      | .01 (9.03)         | .02 (10.49)       |                     |                     |                        |                        |                     |                       |                       |                        |
|                    | Productivity         | .42 (17.72)            |                     |                 |                     |                     |                  |                     |                        |                        |                     |                       |                       |                        |
| R-squared          | 0.60                 | 0.48                   | 0.43           | 0.53            | 0.30               | 0.67               | 0.21              |                     |                        |                        |                     |                       |                       |                        |
exhaustion. Fatigue was associated with increased exhaustion and with reduced well-being and concentration. The association between fatigue and exhaustion was rather large ($\beta = 0.43$). In addition, reduced well-being was associated with increased depressive symptoms. Depressive symptoms were related to increased disengagement, and disengagement to increased exhaustion. Results furthermore indicated that concentration was associated to increased productivity and reduced disengagement. Especially the relationship between concentration and productivity was relatively strong ($\beta = 0.50$). Last, productivity was associated with higher well-being and fewer depressive symptoms.

4.5. Indirect relationships

Although direct relationships between physical home-workspace satisfaction and satisfaction with support of work activities and mental health were rather scarce (see Fig. 2), various indirect relationships were found (see Table 4). First, stress mediated the relationship between satisfaction with daylight at home and sleep quality, depressive symptoms, tense arousal, hedonic tone, concentration, and exhaustion. Similarly, hedonic tone mediated the relationships between satisfaction with artificial light and well-being, depressive symptoms,
disengagement, fatigue, and sleep quality. In addition, satisfaction with greenery was indirectly related to depressive symptoms, mediated by well-being and satisfaction with views outside indirectly related to disengagement via concentration.

5. Discussion, limitations, and implications

5.1. Discussion

This study aimed to examine the relationships between personal characteristics, satisfaction with physical home-workspace characteristics and with perceived activity-support at home, and mental health, plus the internal relationships between mental health variables. Results of this study are in line with the person-environment fit theory, because satisfaction with physical home-workspace characteristics related to both mental well-being indicators (e.g., well-being, concentration) (i.e., fit) and mental ill-being indicators (e.g., stress, tense arousal), thus suggesting both fit and misfit situations. These insights are highly valuable for workplace managers to understand how healthy workplaces at the office and at home could be designed to stimulate employees' mental health.

The current research showed that satisfaction with daylight, views outside, artificial light, privacy and greenery at the home-workspace were related to multiple mental health variables, while temperature, sound, ventilation, and air quality were not significantly related to mental health. These results are an important contribution to existing knowledge, because office-research usually shows that the latter IEQ factors are considered highly important for employees’ mental health (Kallio et al., 2020). It thus appears that, at home, other workspace design aspects are important than the mechanisms that are known from office studies. In addition, satisfaction with privacy, daylight, views outside and artificial light were highly interconnected at home, suggesting a complex mechanism with multiple input variables. Home-workers were most satisfied with their privacy, and least satisfied with the greenery, artificial light, and views outside. Although people generally choose where to live and how to decorate their homes themselves, they still may have had less access to greenery and views outside than in their offices. The offices in our sample generally offer quite abundant views outside, whereas at home some people might have created workstations in bedrooms, first-floor studies, or attics to find privacy. Especially under these suboptimal circumstances, when people were obliged to stay inside as much as possible, they might have desired access to a window, daylight, and views outside more (Batool et al., 2021).

Furthermore, homeworkers who were satisfied with privacy were more satisfied with both support of online interactions and concentrated work activities. Satisfaction with support of concentrated work also related to satisfaction with support of online interactions. This suggests either that the inability to have online interactions creates issues with doing concentrated work, or that both activities share common needs and requirements, such as privacy. More than 75% of the sample had a private workspace at home. Additional analyses showed that employees who shared their workspace were less satisfied with their privacy (shared: M = 3.38, SD = 1.38, private: M = 4.27, SD = 1.17), and with support of their workspace to both perform concentrated work (shared: M = 3.33, SD = 1.29, private: M = 3.81, SD = 1.30) and online interactions (shared: M = 3.48, SD = 1.23, private: M = 3.74, SD = 1.23) than employees who had a private workspace. As Ng (Ng, 2010) argued, privacy issues depend on both people’s work activities and the size of the home. For employees who did not have a private workspace, privacy issues increased and disturbed their work activities more frequently. Further research could examine how disturbance at home relates to workspace-characteristics (e.g., size of workspace, cleanliness, wall colours), satisfaction with support of work activities, and mental health.

Personal characteristics were related to mental health, but, surprisingly, not to satisfaction with physical workspace characteristics and support of work activities. Personal characteristics may have played a lesser role in WFH than in other contexts because workers had already designed and decorated spaces at home according to their personal needs. Perhaps they could also more easily adapt the workspace to their momentary personal preferences, or they were more lenient towards their own physical environment’s shortcomings. In contrast, office-research indicates that extroverts were more stressed by insufficient environmental quality (Kallio et al., 2020), and that females were less satisfied with the privacy in open-plan offices (Anjum et al., 2005). It thus seems that personal characteristics do, to some extent, influence satisfaction with the office-workspace, but less so with the home-workspace, which is an important contribution to existing theory.

Last, this research shows that each of the ten mental health variables related to at least one other mental health variable. These findings are in line with the expectations of Bergefurt et al. (Bergefurt et al., 2022). It implies a salutogenic network of momentary moods and feelings that, over time, could develop in mental well-being or chronic mental ill-being while WFH. Notably, a significant relationship between productivity and well-being was found, which shows that productive homeworkers had their well-being higher. This finding corresponds to the WHO (WHO, 2004) definition, indicating that mental health is a state of well-being in which people can work productively and fruitfully. Moreover, it confirms the self-determination theory, that employees’ need for efficacy should be satisfied. Although productivity might not directly depend on employees’ mental health, it is highly important for employees to flourish and feel well (Rokkams & Haynes, 2019b). Therefore, the authors believe that the ten variables are highly valuable to measure mental health at work more holistically in future studies.

5.2. Limitations

Although this study gained valuable insights, it also has its limitations. First, no information about employees’ prior office workspace, physical health, housing type (e.g., apartment, terraced house or detached house), the number of children that lived at home, or the neighbourhood in which they lived (e.g., rural-or city-settings) was collected. Such control variables might contain valuable information, to get more sophisticated insights in employees’ satisfaction with their home-workspace and their mental health. Another limitation is the exclusion of the digital workspace, which became even more important during the pandemic. As Marsh et al. (Marsh et al., 2022) indicated, the increased use of digital workspace technologies has several drawbacks, such as technostress (i.e., stress that arises because of working with digital technologies), information overload and interruptions. Future research could consider how the digital workspace affects employees’ mental health. As Tarafdar et al. (Tarafdar et al., 2019) explained, technostress can also have positive outcomes, such as greater effectiveness and innovation of employees at work. Such insights are interesting to both workplace managers and employers as well as academia. Furthermore, due to the restrictions of the COVID-19 pandemic (e.g., curfew, limited social interactions), results of this study cannot easily be generalized to other contexts.

Next, this study used solely self-reported data, which might have resulted in an over- or under-estimation of employees’ mental health or satisfaction with their workspace at home. People might have had the tendency to give socially desirable answers (Félonneau and Becker, 2008). Furthermore, since a cross-sectional approach was used, data were collected at only one point in time. This means that results should be interpreted with care. Future studies could use a longitudinal approach instead, by collecting information at more points in time to observe changes and constants and could also add objective measures. Another limitation is that with a path analysis, the direction of causality cannot be established. However, previous research supported the directionality within the model. Although there are several limitations to this study, it also provides some important implications for practice and theory.
5.3. Implications

The COVID-19 context caused an extraordinary situation in which people were obliged to WFH, which provided unique research opportunities. For employers, current findings suggest that it is important to stimulate employees’ satisfaction with their home-workspace, because it significantly influences their mental health. Therefore, employers should allow employees to borrow office equipment, such as ergonomic chairs or desks. Such equipment might increase employees’ satisfaction with WFH. Employers should also support employees in having regular, informal contact between colleagues (e.g., short online coffee breaks). Employees are advised to reserve a small, dedicated part of their home to work from, since results showed that some privacy is highly important. Designers and architects might need to consider the changing need to have such a dedicated workspace at home in the future. Designers can also consider the development of ergonomic furniture, light, and other equipment needed to WFH, that can easily be converted for other purposes in small living environments. The finding that ten suggested mental health indicators were significantly related to each other also suggests relevant research directions. Future research could, for instance, try to develop a new mental health scale covering all ten indicators.

6. Conclusion and recommendations

This study provided new insights into the relationships between personal characteristics, satisfaction with physical home-workspace characteristics, satisfaction with support of home-work activities and mental health variables during the COVID-19 pandemic. By using a path model, it was possible to observe the indirect and direct relationships between these factors simultaneously. These results add valuable in

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