Association between workplace and mental health and its mechanisms during COVID-19 pandemic: A cross-sectional, population-based, multi-country study

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ABSTRACT

Background: The COVID-19 pandemic worsens populations’ mental health. However, little is known about the COVID-19-related mental health among remote workers.

Methods: We retrieved data from survey of Health, Ageing and Retirement in Europe, covering 27 countries. Eligible people were those employed. The main outcome is the mental disorder, covering four aspects: depression, anxiety, sleep disorder, and loneliness. Country-specific weighted mixed models were fitted to estimate the association of workplaces with mental health, controlled for age, gender, education level, living alone, making ends meets, working hours, closing to suspected or confirmed COVID-19 cases, received anti-virus protection, social contact, disability, and chronic disease. Moderate analyses were conducted to explore possible mechanisms.

Results: 11,197 participants were included, among them 29.3% suffered at least one worse mental disorder. After controlling for covariates, compared with those who worked at the usual workplace, those who worked at home only or part of the time did not associate with worse mental disorders (p-value ≥0.1395), and those who worked at neither the usual workplace nor home had a 55% higher likelihood of suffering from worse mental disorders (OR = 1.55, 95%CI 1.03–2.36). The mediation analyses identified three indirect pathways by which workplaces influence mental health, including making ends meets, social contact, and receiving anti-virus protection. Detailed results on subtypes of mental disorders were also provided.

Limitations: All assessments were self-reported, resulting in a risk of method bias.

Conclusions: During the COVID-19 pandemic, working at other places, neither at the usual workplace nor home, worsened mental health. Evidence provided in this study will contribute to more nuanced and practical public health policy strategy making.

1. Introduction

The spread of the SARS-CoV-2 has brought about unexpected changes to people’s lives in many ways, one of which is driving people worldwide to work from home (Vyas and Butakhieo, 2021). Working from home (WFH), also known as remote work, telework, or mobile work, is expected to reduce the risk of COVID-19 infection and has been widely implemented as part of the social distancing policies (Kawashima et al., 2021).

Piles of evidence have shown that increased mental problems, such as depression, anxiety, distress, and insomnia, are related to both the COVID-19 pandemic and social distancing policies. However, few studies have focused on those WFH, and the majority of available evidence comes from pre-COVID-19 with inconsistent results. Two surveys from the US (Xiao et al., 2021a, 2021b) and Japan (Shimura et al., 2021) reported decreased mental well-being among those WFH during the COVID-19 pandemic. On the contrary, the surveys conducted in China (Zhang et al., 2020), Bangladesh (Ara et al., 2020), and another two

Abbreviations: ADL, Activities of daily living; CI, Confidence interval; GLMM, Generalised linear mixed model; OR, Odds ratio; SHARE, Survey of Health, Ageing and Retirement in Europe; WFH, Working from home.

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This text segment contains information about the COVID-19 pandemic and its impact on mental health, particularly focusing on remote workers. It discusses the potential predictor factors for mental well-being, including neurobiological and immunological biomarkers, and emphasizes the role of neurobiological factors. The text also highlights possible mechanisms for the effects of external events on mental health, noting the direct or indirect worsening of mental health due to factors such as financial stress, social exclusion, and stigma. The text emphasizes the importance of understanding the factors in the new environment that contribute to mental health during the pandemic.

The SHARE study, conducted by international research ethics principles, explored the influence of the COVID-19 pandemic on mental health, covering aspects such as depression, anxiety, sleep disorders, and loneliness. The study found that remote working (WFH) could have negative or positive impacts on mental health, and that the effects of WFH may depend on various moderators such as income, education, and social exclusion.

The key measures for mental health included depression, anxiety, sleep disorders, and loneliness. The text describes how these were assessed using standardised questionnaires and telephone assessments. The SHARE study noted the importance of considering both work and life aspects when examining the association between WFH and mental health.

2. Methods

2.1. Study design and participants

The study used publicly available data from the SHARE project (Survey of Health, Ageing and Retirement in Europe). SHARE is a biennial nationally representative individual survey on people aged ≥50 covering 27 countries. Importantly, it ran during the 2020 COVID-19 pandemic. Each participant completed a standardised questionnaire via internet/telephone assessments, described elsewhere.

The SHARE study was guided by the Ethics Council of the Max Planck Society and the Declaration of Helsinki. SHARE was reviewed and approved by the Ethics Council of the Max Planck Society.

2.2. Key measures

**Mental health.** The SHARE collected data on mental health during the COVID-19 pandemic on an individual's mental health covering four aspects: depression, anxiety, sleep disorders, and loneliness. The items used were:

- For depression, "In the last month, have you been sad or depressed?" with response yes or no; for anxiety, "In the last month, have you been felt nervous, anxious, or on edge?" with response yes or no; for sleep disorder, "In the last month, have you had trouble sleeping recently?" with response "Trouble with sleep or recent change in pattern" or "No trouble sleeping"; and for loneliness, "In the last month, how much of the time do you feel lonely? Often, some of the time, or hardly ever or never?".

For those with an answer "yes", "Trouble with sleep or recent change in pattern", "Often", or "Some of the time", the severity of their mental problem for each aspect was separately evaluated by another item, "Has this been more so, less so, or about the same as before the outbreak of Corona?". In this study, participants with the answer "more so" were coded as depressed than before, nervous or anxious than before, sleeping difficulty than before, or lonely than before. Participants who suffered at least one of the above four problems were judged as suffering worse mental health overall.

**Workplace** was collected with one item "Since the outbreak of Corona, some people worked at home, some at their usual workplace outside their home, some both. How would you describe your situation?" with answer worked at home only, worked at the usual workplace, worked from home and at the usual workplace, and none of these.

2.3. Covariates

We examined the following socio-demographic variables: age (years), gender (male vs female), education level, and living alone (yes vs no). The education level was matched from previous waves, and was divided into four categories based on the International Standard Classification of Education: primary education or lower, lower secondary education, upper secondary education, and post-secondary education or above. We also examined the following variables that were plausible risk or protective factors for worse mental health during the COVID-19 pandemic.

**Making end meets** was collected with one item "Thinking of your household's total monthly income since the outbreak of Corona, would you say that your household is able to make ends meet with great difficulty, with some difficulty, fairly easily, or easily?", with answering latter two choices coded as yes in this study.

**The working hour** was collected with one item "Did you increase your working hours since the outbreak of Corona?" with the answer yes or no.

**Disability** was assessed by six basic activities of daily living (ADLs) (dressing, walking across a room, bathing, eating, getting in and out of bed, toileting) and nine instrumental ADLs (using maps, preparing a hot meal, shopping for groceries, making phone calls, taking medications, doing work around the house or garden, managing money, leaving the house, and doing personal laundry) (Chen et al., 2022; Steptoe and Di Gessa, 2021). ADL was assessed by item "if you have any difficulty with these activities because of a physical, mental, emotional or memory..."
problem. Exclude any difficulties you expect to last less than three months. The data was matched from the last wave, and participants who responded positively to one or more items were defined as having ADL disability (Stephoe and Di Gessa, 2021).

Chronic disease was judged from self-assessed conditions by an item “Do you have any of the following illnesses or health conditions?” with options hip fracture, diabetes, hypertension, heart attack, chronic lung disease, cancer, and other self-mentioned illnesses or health conditions.

Social contact. The first question asked, “Since the outbreak of Corona, how often did you have personal contact, that is, face to face, with the following people from outside your home?”, with five responses: daily, several times a week, about once a week, less often, and never. The question was asked separately in relation to own children, own parents, other relatives, and other non-relatives like neighbours, friends, or colleagues. A parallel set of the question was asked regarding the frequency of “contact by phone, email or any other electronic means” with these same relationship categories. For this study, we categorized participants with the response of less often or never or for at least one of the above questions as contact less often or never.

Close to suspected or confirmed COVID-19 cases was judged based on four items “Since the outbreak of Corona, did you or anyone close to you experience symptoms that you would attribute to the Covid illness, e.g. cough, fever, or difficulty breathing?”, “Have you or anyone close to you been tested for the Coronavirus and the result was positive, meaning that the person had the Covid disease?”, “Have you or anyone close to you been hospitalized due to an infection from the Coronavirus?” and “Has anyone close to you died due to an infection from the Coronavirus?”, with a response yes or no. Participants who responded “yes” to at least one of the above questions were categorized as close to suspected or confirmed COVID-19 cases.

Received any anti-virus protection was judged with one item “Did you get any protection such as masks, gloves, protective screens, disinfection fluid?” with response yes or no.

2.4. Statistical analysis

Survey weighting was used to account for sampling design (including the unequal probability of selection, clustering, and stratification). To describe the basic characteristics, categorical variables were reported as number and weighted percentage (95% confidence interval), and continuous variables were reported as weighted mean (95% confidence interval).

To estimate the association between workplace and mental disorders, we adopted weighted generalised linear mixed models (GLMM), with mental disorder as the dependent variable and workplace as the predictor, controlling for other covariates. Intercept and workplace were treated as random variables at the country level.

To explore the possible mechanisms by which the workplace influence the mental disorder, we further conducted six weighted multi-level mediation analyses to test whether the workplace worse people’s mental health during the COVID-19 pandemic via the following pathways: a, influencing their likelihood of making ends meets; b, influencing their working hours; c, influencing their frequency of social contact; d, influencing their likelihood of living alone; e, influencing their sensitivity to suspected or confirmed COVID-19 cases close to them; and f, influencing their likelihood of receiving anti-virus protection. As indicated by our results, it was working at other places, neither at the usual workplace nor home, that worsened the mental health during the COVID-19 pandemic. In the mediation analysis, for ease of understanding and interpretation of the results, workplace was only divided into a binary variable (working at usual workplaces, home, or both, vs neither), with former as reference.

Analyses were performed using R (v3.6.0). Statistical significance was defined as P < 0.05. All tests were two-tailed.

3. Results

After excluding 41,113 respondents who were retired, laid off, or unemployed, a total of 11,197 respondents from the SHARE were included in this study. Table 1 summarises their basic characteristics. The average age was 59.4 years old. Among these respondents, 47% were female, more than 75% received upper secondary or above education, 18.7% lived alone, 68.4% made end meets at least, 7.2% had at least one ADL difficulty, and 51.7% suffered at least one chronic disease. 52.1% of respondents worked at the usual workplace, 14.3% worked at home only, and 18.2% worked at other places. 24.4% of the respondents believed that they are close to suspected or confirmed covid-19 cases, and more than half of respondents (57.2%) received anti-virus protection. Only a few respondents (0.2%) contact less often than before. As for mental health, 29.3% suffered at least one worse mental problems, specifically 21.1% of respondents felt more nervous or anxious than before, 14.8% of respondents became more depressed than before, 14.8% of respondents had more sleeping difficulty than before, and 7% of respondents felt lonelier than before.

Table 2 presents the regression results on mental disorders. Compared with those who worked at the usual workplace, those who worked at home only and those who shifted between the usual workplace and home did not associate with worse mental disorders as well as their subtypes (p-value > 0.1395). In contrast, those who worked at other places (neither usual workplace nor home) had a 55% higher likelihood of suffering from worse mental problems (OR = 1.55, 95%CI 1.03–2.36), including an 80% higher likelihood of experiencing depression (OR = 1.80, 95%CI 1.07–3.03), a 60% higher likelihood of experiencing sleep difficulty (OR = 1.60, 95%CI 1.15–2.23), and a 73% higher likelihood of experiencing nervous or anxiety (OR = 1.73, 95%CI 1.13–2.69), but working at other places had no association with a worse feeling of loneliness (OR = 0.99, 95%CI 0.51–1.92).

Table 3 presents the proportion of the effect of the workplace on

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Age (year)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gender (=Female)</td>
</tr>
<tr>
<td>Education level</td>
</tr>
<tr>
<td>Primary education or lower</td>
</tr>
<tr>
<td>Lower secondary education</td>
</tr>
<tr>
<td>Upper secondary education</td>
</tr>
<tr>
<td>Post-secondary education or above</td>
</tr>
<tr>
<td>Live alone (=true)</td>
</tr>
<tr>
<td>Make end meets at least (=true)</td>
</tr>
<tr>
<td>Working hour increased (=true)</td>
</tr>
<tr>
<td>Any suspected or confirmed covid-19 cases close to you (=true)</td>
</tr>
<tr>
<td>Received any anti-virus protection (=true)</td>
</tr>
<tr>
<td>Contact less often or never (=true)</td>
</tr>
<tr>
<td>Any adl difficult (=true)</td>
</tr>
<tr>
<td>Any chronic disease (=true)</td>
</tr>
<tr>
<td>Workplace</td>
</tr>
<tr>
<td>Worked at the usual workplace</td>
</tr>
<tr>
<td>Worked at home only</td>
</tr>
<tr>
<td>Both</td>
</tr>
<tr>
<td>Neither</td>
</tr>
<tr>
<td>Any mental disorders</td>
</tr>
<tr>
<td>Depressed than before (=true)</td>
</tr>
<tr>
<td>Sleeping difficulty than before (=true)</td>
</tr>
<tr>
<td>Lonely than before (=true)</td>
</tr>
<tr>
<td>Nervous or anxious than before (=true)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Data for age present as weighted mean (95% CI). NP, not applicable.
mental disorders explained by the indirect effect via the possible inter-
venable variables in Table 1. Compared with working at the usual
workplace or home, working at other places did not influence mental
disorders and their subtypes by increasing people's working hours (p-
value $\geq 0.352$), by increasing people's likelihood of living alone (p-
value $\geq 0.264$), or by making people more sensitive to whether they are
close to suspected or confirmed COVID-19 cases (p-value $\geq 0.434$), but
did influence the mental problems and their subtypes by decreasing
people's likelihood of making ends meets (p-value $\geq 0.014$). The indirect
pathway via making ends meets or contacting less explained 70.7% of the
total effect of workplace on mental disorders and subtypes, while the indirect
pathway via receiving anti-virus protection explained 70.7% of the total
effect of workplace on feeling alone.

4. Discussion

4.1. Statement of principal findings

Using a comprehensive dataset, we found that compared with those
who only worked at the usual workplace, WFH full or part of the time
did not worsen their mental health, while people working at other places
(neither at the usual workplace nor home) had a 55% higher likelihood of
experiencing worse mental health. We also found that besides the
direct effect, working at other places had indirect associations with
worse mental health via changing people's ability to make ends meets,
frequency of social contacting, and chance of receiving anti-virus pro-
tection, but not via changing people's working hours, likelihood of living
alone, or by making people more sensitive to whether they are close to
suspected or confirmed COVID-19 cases.

4.2. Possible explanations and comparison with other studies

Our finding on those WFH full or part of the time keeps in line with
studies conducted in China (Zhang et al., 2020), Bangladesh (Ara et al.,
2020), Spain (Ruiz-Frutos et al., 2021), the UK (Andersson, 2021), and
the US (Abrams et al., 2021; McDowell et al., 2021), all of which also
concluded no association between remote working and worse mental
health. Although few studies, like the ones conducted in India (P, 2021)
and Poland (Izdebski and Mazur, 2021), reported different results,
which were compared to those who worked in the traditional workplace,
people who worked remotely more often signalled an intensification of
the symptoms of mental health disorders. The inconsistency of results
could be owing to differences in the characteristics of sampled
participants. The average age of participants in our study was 59.4 years old, it was higher than that (45 years) in the study conducted in Poland (Jazdelski and Mazur, 2021). Studies stated that WFH during the COVID-19 pandemic could be more beneficial for older (senior) workers, especially for mental health. The subgroup analysis (subtype of mental disorders and subtype of workers) and the mechanism exploration allowed for more specific analysis on the association between workplace and mental health using population-based or single place-based data (Sasaki et al., 2020). It was easy to understand that both are significant indirect pathways for workplace influencing mental disorders.

We further explored the possible mechanism by which workplaces influence mental disorders. The well-documented associations of higher sociometric status, higher social activity, assistance team (Atzendorf and Gruber, 2021; Russo et al., 2021; Tavares, 2017) with better mental health were also confirmed in our study. For remote workers who worked neither at the usual place or home, they could pay more for drinks, meals and accommodation while may not get more income due to serious deterioration of the economy, and have less face-to-face communication with their colleagues, families, or friends (Shimazu et al., 2020). It was easy to understand that both are significant indirect pathways for workplace influencing mental disorders. Although the association of living alone and worse mental health was also documented (Chen et al., 2020; Cuyt et al., 2021; Guo et al., 2020; Li and Wang, 2020) and confirmed in our study, it was not a significant indirect pathway for the workplace. The possible explanation is that it was the social activity by which living alone worked on mental health, and social activity was specifically controlled or explored in our study.

### 4.3. Strengths and limitations

To our knowledge, this is the first study to systematically assess the association between workplace and mental health using population-based and multi-national representative data. This study contributes to our understanding of how workplaces influence employees' mental health. The subgroup analysis (subtype of mental disorders and subtype of remote workers) and the mechanism exploration allowed for more nuanced and practical public health policy strategies to be made. Specifically, our findings recommend that under the COVID-19 pandemic, WFH is a mental health-friendly social distancing measures (especially for the senior workers), but a mental health-unfriendly one for those remote workers working at other places. For the later one, our findings also recommend that increasing their sense of local belonging by helping them connecting with local volunteer teams or medical assistance team may be an effective measure to maintain their mental health.

A key limitation of this study is the cross-sectional design. Although the items used to collect the individual's mental health were specified to compare with pre-outbreak of COVID-19, it still cannot ensure a causal inference. Secondly, it is plausible to expect the association between workplace and mental health is a cumulative relationship, but the data from the SHARE project only covered the early period of the COVID-19 pandemic. Thirdly, the data we used only included people aged 50 years old or above. As we discussed, our results may not generalise to younger employees. Fourthly, due to cultural reasons, the acceptance of remote working in European countries has always been relatively high, so the supporting measures for remote working during the COVID-19 pandemic are relatively complete. This further limits the generalisation of our research to countries or regions where remote working is not well-accepted, especially for the finding of insignificant association between WFH and worse mental health identified in our study.

### Table 3

Proportion of effect explained by the indirect effect.*

<table>
<thead>
<tr>
<th>Indirect effect via of</th>
<th>Any mental disorders (TRUE)</th>
<th>Depressed than before (TRUE)</th>
<th>Sleeping difficulty than before (TRUE)</th>
<th>Lonely than before (TRUE)</th>
<th>Nervous or anxious than before (TRUE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make at least end meet (TRUE)</td>
<td>11.4(0.4)</td>
<td>9.9(0.4)</td>
<td>9.2(1.2)</td>
<td>22.8</td>
<td>17.0(2.7)</td>
</tr>
<tr>
<td>hour (TRUE)</td>
<td>0.080</td>
<td>0.0360</td>
<td>0.0180</td>
<td>0.370</td>
<td>0.0320</td>
</tr>
<tr>
<td>Working hour (&lt; TRUE)</td>
<td>0.0400</td>
<td>0.0060</td>
<td>0.0080</td>
<td>0.370</td>
<td>0.0320</td>
</tr>
<tr>
<td>Contact less / often or never (TRUE)</td>
<td>0.048</td>
<td>0.0100</td>
<td>0.0480</td>
<td>0.370</td>
<td>0.0320</td>
</tr>
<tr>
<td>Live alone (&lt; TRUE)</td>
<td>0.048</td>
<td>0.0100</td>
<td>0.0480</td>
<td>0.370</td>
<td>0.0320</td>
</tr>
<tr>
<td>Any case cohort case close to you (&lt; TRUE)</td>
<td>0.0480</td>
<td>0.0100</td>
<td>0.0480</td>
<td>0.370</td>
<td>0.0320</td>
</tr>
<tr>
<td>Received anyone anti-virus (&lt; TRUE)</td>
<td>0.0260</td>
<td>0.0380</td>
<td>0.0320</td>
<td>0.370</td>
<td>0.0320</td>
</tr>
</tbody>
</table>

* Data present as proportion (95%CI) and p value, extracted from multilevel mediation analysis. As indicated in the results in Table 2 that it is working at other places, neither at the usual workplace nor home, that worse the mental health during the COVID-19 pandemic. In the mediation analysis, to easy the understanding and interpretation of the results, the workplace was only divided into a binary variable (working at usual workplaces, home, or both, vs neither), with former as reference.

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**Participants**

<table>
<thead>
<tr>
<th>Table 3 Proportion of effect explained by the indirect effect. (TRUE)</th>
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</thead>
</table>
| The average age of participants in our study was 59.4 years old, it was higher than that (45 years) in the study conducted in Poland (Jazdelski and Mazur, 2021). Studies stated that WFH during the COVID-19 pandemic could be more beneficial for older (senior) workers and their mental health, because WFH could provide them with more flexible schedules and increased freedom and work-life balance (Abrams et al., 2021; Guo et al., 2020; Witteveen and Velthorst, 2020; Xiao et al., 2021a, 2021b) and frequent social activity (Atzendorf and Gruber, 2021; Russo et al., 2021; Tavares, 2017) with better mental health were also confirmed in our study. For remote workers who worked neither at the usual place or home, they could pay more for drinks, meals and accommodation while may not get more income due to serious deterioration of the economy, and have less face-to-face communication with their colleagues, families, or friends (Shimazu et al., 2020). It was easy to understand that both are significant indirect pathways for workplace influencing mental disorders. Although the association of living alone and worse mental health was also documented (Chen et al., 2020; Cuyt et al., 2021; Guo et al., 2020; Li and Wang, 2020) and confirmed in our study, it was not a significant indirect pathway for the workplace. The possible explanation is that it was the social activity by which living alone worked on mental health, and social activity was specifically controlled or explored in our study.**

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A key limitation of this study is the cross-sectional design. Although the items used to collect the individual's mental health were specified to compare with pre-outbreak of COVID-19, it still cannot ensure a causal inference. Secondly, it is plausible to expect the association between workplace and mental health is a cumulative relationship, but the data from the SHARE project only covered the early period of the COVID-19 pandemic. Thirdly, the data we used only included people aged 50 years old or above. As we discussed, our results may not generalise to younger employees. Fourthly, due to cultural reasons, the acceptance of remote working in European countries has always been relatively high, so the supporting measures for remote working during the COVID-19 pandemic are relatively complete. This further limits the generalisation of our research to countries or regions where remote working is not well-accepted, especially for the finding of insignificant association between WFH and worse mental health identified in our study.**

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**Fifthly**
when evaluating the relationship between workplaces and employee mental health, it is also necessary to be aware of whether the employee experienced remote working before the COVID-19 pandemic (Niu et al., 2021), the type of their work, and the reasons for remote working (Gimenez-Nadal et al., 2020; Lunde et al., 2022). Mental issues related to the health emergency, such as anxiety, depression, sleep disorders, and drugs and alcohol addiction are more likely to affect healthcare workers, migrant workers, and workers in contact with the public (Giorgi et al., 2020). Other potential confounders such as work-family conflict, and managerial or organisational support might also mediate the association between workplace and mental health (Oakman et al., 2020). However, due to the availability of related data in SHARE, we were unable to consider these factors in the present study. Future studies with these factors included are needed.

Besides the above limitations, there are two unanswered questions worth addressing in future work. First, what the result is for people laid-off or involuntary unemployed. The COVID-19 pandemic has led to high rates of unemployment across countries (Parolin, 2020). Evidence has suggested a positive association between experiencing a decreased workload and feelings of depression during the COVID-19 lockdowns, and this association was somewhat stronger among the most vulnerable socioeconomic groups (Wittevrouw and Velthorst, 2020). The pathway via making end meets may be underestimated in our study, as we only included employed people. Evidence on those transferred from employed to involuntarily unemployed needs more focus in future. Second, what the specified result is for the self-employed. The data in SHARE disable us to give a further exploration, studies on this issue are also needed.

5. Conclusion

Using population-based and multi-national representative data, we found that working at home only or part of the time did not worsen employee’s mental health, compared with only working at the usual workplace. But people working at other places (neither at the usual workplace nor home) had a higher likelihood of experiencing worse mental health. Workplace primary influenced mental health directly, and small part of the effect was explained by the indirect pathway via changing people’s ability to make ends meet, the frequency of social contacting, and the chance of receiving anti-virus protection. Evidence provided in this study could contribute to more nuanced and practical public health policy strategy making, but may not generalise to younger employees or to countries or regions where remote working is not well-accepted before the COVID-19 pandemic.

CRediT authorship contribution statement

Shanquan Chen had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Shanquan Chen.
Acquisition, analysis, or interpretation of data: Shanquan Chen.
Drafting of the manuscript: Pan Zhang and Shanquan Chen.
Critical revision of the manuscript for important intellectual content: Pan Zhang and Shanquan Chen.

Statistical analysis: Shanquan Chen.
Administrative, technical, or material support: Shanquan Chen.
Supervision: Shanquan Chen.

Funding/support

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Role of the funder/sponsor

The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Reproducible research statement


Conflict of interest

No interest needs to be reported.

Acknowledgment

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References


