

# BMJ Open Ageing workers' mental health during COVID-19: a multilevel observational study on the association with the work environment, perceived workplace safety and individual factors

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## ABSTRACT

**Objectives** The stress and anxiety associated with the predisposition of ageing workers to severe COVID-19 illness, once occupationally infected, jeopardise their mental health. This study aimed to investigate the association between individual level, work environment exposure factors and perceived workplace safety with a decline in mental health of ageing workers from different industry sectors.

**Design** Observational study, prevalence assessment of survey added to longitudinal cohort data.

**Setting** The Survey of Health, Ageing and Retirement in Europe (SHARE) from 27 countries in Europe and Israel participating in the COVID-19 survey (summer 2020) and having prepandemic waves' SHARE data.

**Participants** Workers aged 50–70 (n=6449) who attended their workplaces at least partially after the pandemic broke out.

**Primary outcome measure** Perceived decline in mental health compared with preoutbreak status.

**Results** Multilevel analyses demonstrated that 24.5% (95% CI 23.5% to 25.5%) of ageing workers in Europe experienced mental health decline associated with national-level self-reported COVID-19 burden. Workplace safety perception was the strongest predictor, as each one-point increase in unsafe perception was associated with 60% of mental health decline (OR=1.6, 95% CI 1.47 to 1.74), explaining 30% of increased reported mental health symptoms of ageing workers. Safety perception mediates the mental health outcomes of the work environment, such as workplace contagion risk and work location. Female gender (OR=1.77, 95% CI 1.55 to 2.02), financial difficulties (OR=1.19, 95% CI 1.1 to 1.28), higher vulnerability index (comorbidities, age >60) (OR=1.11, 95% CI 1.05 to 1.18), pre-existing mental problems (OR=1.78, 95% CI 1.55 to 2.04) and increased national burden of COVID-19 (OR=1.01, 95% CI 1.0 to 1.02) were associated with declines in mental health, whereas exclusively working on-site was protective.

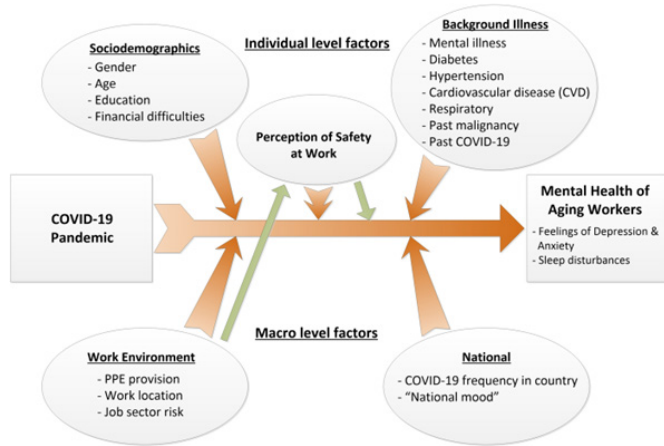
**Conclusion** Vulnerable subgroups for mental health declines among ageing workers were revealed, which warrant their screening and employers' evaluation of workplace conditions of ageing workers to prevent mental health-related implications. Workplace interventions should aim to reduce work environment influences on infection risk and mental distress.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Extensive panel data (Survey of Health, Ageing and Retirement in Europe) applied identical, comparable study design, data collection and measures across 27 European countries and various industry sectors characterised by different infection risks.
- ⇒ Obtaining background clinical, sociodemographic and occupational data from prepandemic waves facilitates causality and a broad-based assessment of potential prognostic and modifiable factors associated with mental health declines of ageing workers.
- ⇒ Multilevel analyses applied to adjust for microlevel and macrolevel factors.
- ⇒ Unbalanced target population distribution between countries, COVID-19-related variables obtained once in the pandemic limiting their analysis to prevalence assessment and potential unmeasured variables attributed to secondary analyses of the data limit generalisation.

## INTRODUCTION

COVID-19 pandemic profoundly affected the global workforce and was early recognised as a work-related disease, increasing in severity with age.<sup>1 2</sup> Specifically, having a weaker viral immune response and higher prevalence of comorbidities, older workers are at tremendous risk for death if being infected with COVID-19.<sup>3</sup> Furthermore, the risk for becoming infected during work is associated with stress and anxiety which further jeopardise the ageing workers' mental health. However, the older worker population group is largely unexplored. Despite the common call to 'stay-at-home' often aimed at the elderly, many ageing workers keep working in their usual workplace during COVID-19 surges, exposing them to workplace contagion risk. That risk is not always managed successfully, with an estimated 20% of infections among working-age adults attributed



**Figure 1** A conceptual framework: individual-level and macrolevel work environment and national factors can modify the mental health of ageing workers. PPE, personal protective equipment.

to workplace COVID-19 transmission.<sup>4 5</sup> Job sectors with greater public interaction are expected to have a higher risk of occupational transmission of COVID-19, infections among healthcare workers (HCWs) have been well documented in the literature.<sup>6–9</sup> However, less well-equipped essential industry sectors have also been hit hard by COVID-19, but these sectors are understudied.<sup>10</sup> There is evidence of accumulating occupational transmission and excess mortality among non-HCWs.<sup>2 11</sup>

Besides the proximity to potential SARS-CoV-2 carriers in specific industries and jobs, the risk of contracting COVID-19 depends on the workplace infection control measures, including personal protective equipment (PPE) provision and workplace social aggregation reduction by telework/working remotely from home.<sup>2 12</sup> Complementary to occupational factors that influence the *risk of infection*, an individual worker's characteristics can determine the *severity of illness* once acquired, such as personal vulnerability due to comorbidities or age.<sup>1</sup> As illness and death risks increase exponentially with age, COVID-19 poses considerable challenges to populations with higher proportions of older people, such as Europe—the continent where age distribution skews oldest.<sup>13</sup>

Employees' concerns are heightened with the widespread COVID-19 transmission in the workplace and their perceived inadequacy of workplace control measures.<sup>14 15</sup> These worries are a significant source of stress predisposing workers to poor mental health, manifested by sleep disturbances, depression, anxiety and post-traumatic stress disorder.<sup>16–18</sup> In addition to concerns related to workplace safety and the older age's elevated risk for severe morbidity and mortality from COVID-19, ageing workers have additional stress related to low job security associated with lower levels of education, technological skills and work capacity relative to younger workers.<sup>6 7 9</sup> Except for age, other sociodemographic and clinical characteristics were associated with adverse psychological consequences in the general population during the COVID-19: female gender, higher education

level, residence in high COVID-19 burden areas, financial concerns, low job security and pre-existing psychological or physical comorbidities.<sup>17 19–22</sup>

Our conceptual framework incorporates individual worker-level characteristics, and the macrolevel national and work environment factors that potentially adjust the adverse effects of the COVID-19 pandemic on the ageing workers' perceived mental health (figure 1). At the individual level, we suggest that sociodemographic and clinical characteristics representing personal vulnerability to severe COVID-19 or mental health decline play a role in perceived mental health. At the national level, we hypothesise that the high national COVID-19 burden, previously associated with increased depression among retired elderly,<sup>19</sup> also affects ageing workers. Our model outlines the organisational work environment aspect of PPE provision, work location and job sector risk for occupational transmission. Furthermore, we hypothesised that a higher perception of workplace safety is crucial in protecting against the mental health decline of ageing workers and mediates the work environment aspects noted above.

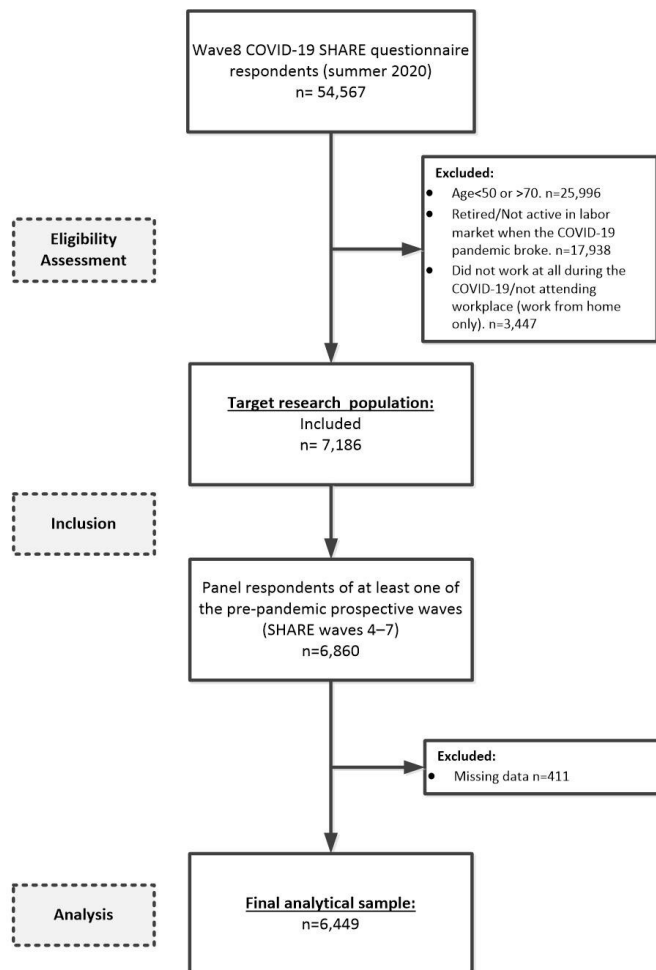
This study aims to investigate the work environment COVID-19 risk context and the multilevel complexity of occupational, socioeconomic, clinical and national factors associated with self-reported declines in the mental health of ageing workers from different industries during the COVID-19 pandemic. A secondary aim was to assess the extent to which ageing workers perceive the workplace as an unsafe environment from COVID-19 exposure and investigate the perceived safety relationship with mental health and work environment factors.

## METHODS

### Data source and study design and population

Data were obtained from waves 3–8 (2009–2020) of the Survey of Health, Ageing and Retirement in Europe (SHARE) including Job Episode Panel.<sup>23–29</sup> Prevalence assessment of wave 8 COVID-19 questionnaire was added (using the unique participant's identifier) to the panel survey of SHARE, based on nationally representative probability samples of 29 countries in Europe and Israel that encompass multidimensional information on 140 000 people aged  $\geq 50$  years. For methodological details of SHARE and the waves' schedules, see ref 30 31 and online supplemental figure 1. Figure 2 describes the selection process. Our target study population focused on working men and women aged 50–70 who actually worked after the pandemic broke while attending their workplaces (worked at least partially on-site), and participated in the eighth wave COVID-19 telephone interviews conducted between June and August 2020.<sup>32</sup>

The sample was limited to participants who were panel respondents in at least one of the prepandemic prospective waves (SHARE waves 4–7), restricting our sample to 27 countries. After applying the exclusion criteria, we retained 6860 participants. The analytical sample



**Figure 2** Flow chart depicting the formation of the target population sample and reaching the final analytical sample. SHARE, Survey of Health, Ageing and Retirement in Europe.

included 6449 respondents, after those with missing data were excluded (n=411).

### Study variables

The outcome measure obtained from the COVID-19 questionnaire was a binary variable representing the perceived decline in mental health. It was measured by the participant's reporting a worsening change compared with the preoutbreak status of at least one of the following: feelings of depression, anxiety and nervousness, and experiencing sleep troubles (online supplemental table 1). The main independent variable (IV) was the individual-level perception of workplace safety, which served as the primary predictor and was measured by an ordered Likert-scaled item ('How safe did you feel health-wise at your workplace') ranging from 0 ('very safe') to 3 ('very unsafe'). It was dichotomised for mediation analyses and investigating associations with work environment factors.

Work environment IVs evaluated were PPE provision by the employer (masks, gloves, protective screens or disinfection fluid) and work location (usual workplace or a hybrid pattern: of home (remote) and workplace (on-site)). Modified European Classification of Economic

Activities (NACE) retrieved from panel data was used to determine the respondent's job sector risk of occupational COVID-19. Occupational risk stratification was based on potential workplace exposure and transmission risk, which relate to social aggregation tendency at work, frequent general public close contact, potential implementation of control measures, etc, as described elsewhere.<sup>33</sup> We categorised the 14 groups of modified NACE into low, medium and high risks, as described in online supplemental table 1.

Clinical IVs were obtained primarily from previous panel waves, except for COVID-19 in the respondent (either symptoms or positive test results). A vulnerability index representing the degree of enhanced risk of severe COVID-19 in case of infection was constructed as the sum of the following risk-relevant comorbidities<sup>13</sup> (cardiovascular disease, hypertension, diabetes, chronic pulmonary disease and cancer history) and age  $\geq 60$ , and ranged from 0 to 6. The presence of mental disorder history (no/yes) was defined as at least one of the following: ever treated for depression, anxiety or sleep disorders and/or ever diagnosed with affective disorders and/or defined as a depression case by the Euro-D scale.

We adjusted for individual socioeconomic and demographic variables of age and gender. The highest education level achieved is classified into the seven categories of the International Standard Classification of Education 1997. Financial status was reflected by the perceived income adequacy of whether the household could make ends meet with the responders' monthly household incomes (0—easily, 3—with great difficulty).

Finally, we included in our model a second-level variable of the country-specific proportion of workers having someone familiar in their environment with COVID-19 diagnoses or symptomatic illness (COVID-19 frequency in country). Another macrolevel national component was the random effect from the model of between-country variability in the mental health status of residuals, reflecting a 'national mental health' of a country's ageing workers' population during summer 2020.

A detailed description of the variables used is found in online supplemental table 1.

### Statistical analyses

Descriptive statistics were used to report the general characteristics of the study population. To investigate the factors associated with mental health and perceived workplace safety, we estimated the multilevel random intercept models for a binary-dependent variable using hierarchical generalised linear models. The individuals (first-level) and national (second-level) variables were in a fixed configuration and nested within the 27 countries. Only variables with  $p < 0.1$  in first-level models were included in the subsequent parsimonious models. All IVs were checked for collinearity that was not found. Missing data were characterised (online supplemental table 2 and figure 2). Since missing data were  $< 5\%$  missingness treatment for education level was made by completion

with the national average as calculated from the existing cohort. However, in other cases, respondents with missing data were omitted. We used Baron and Kenny's stepwise approach to test whether workplace safety perception mediates the association between each work environment factor (industry risk, work location) separately and mental health status (outcome).<sup>34</sup> We first explored the potential of workplace safety perception as a mediator by evaluating the correlation between each work environment factor (exposure) separately with workplace safety perception (mediator) and mental health (outcome) with logistic regression. For the exposure with significant correlation ( $p < 0.05$ ), we performed the mediation analysis. We first fitted a logistic regression model where mental health was the response variable and the work environment factor was the predictor. We also fitted a logistic regression model where workplace safety perception was the response variable, and workplace safety perception and industry risk were the predictors. Finally, we used the outputs of these two models for mediation analysis using the R package 'mediation' to obtain total, direct and indirect effects, and proportion mediated. We estimated 95% CIs of the effects specifying a non-parametric bootstrapping procedure with 1000 resamples. We performed descriptive analyses using SPSS V.26 (IBM) and multivariate and multilevel modelling with R software (V.4.0.3).

### Patient and public involvement

Patients and/or the public were not involved in this research's design, conduct, reporting or dissemination plans.

## RESULTS

### Descriptive analyses of the ageing workers' sample

Table 1 gives a descriptive overview of the characteristics of the ageing workers' sample ( $n=6449$ ), followed up for an average of 6.9 years (range 0.5–17) in 3.5 waves (range 1–7) until the COVID-19 telephone interview. Consistent with European estimates from the literature,<sup>35</sup> 25% of respondents indicated a history of mental disorder, two-thirds were working in industry sectors considered to have a medium and high risk of COVID-19 occupational transmission and most worked during COVID-19 on-site only. At the national level, an average of 20% (IQR=8%–32%, total range 3%–62%) of participants among the 27 investigated countries reported having someone familiar in their environment with COVID-19 diagnoses or illness. See online supplemental table 3 for participants' distribution across countries.

### Factors associated with mental health decline during COVID-19

The overall prevalence of self-reported declines in the mental health of ageing workers during the COVID-19 pandemic was 24.5% (table 1). Table 2 outlines the results of multilevel logistic regression analysis models, evaluating the factors associated with mental health

**Table 1** Pooled sample characteristics ( $n=6449$ )

Variables	N (%)	Mean (SD)
Level 1: individual-level measures		
Demographics and SES		
Age (50–70 years)	6449	60.5 (4)
Gender: female	3421 (53)	
Ends meet		
Easily	4726 (73.3)	
With difficulty	1723 (26.7)	
Education level*		
Low	871 (13.5)	
Mid	3480 (54)	
High	2098 (32.5)	
Clinical factors		
Past COVID-19 illness	211 (3.3)	
Vulnerability COVID-19 index (0–6)†	6449	1.34 (1)
History of mental disorder	1614 (25)	
Mental health declines	1581 (24.5)	
Work environment		
Perceived workplace safety		
Safe	2906 (45.1)	
Somewhat safe	2925 (45.4)	
Somewhat unsafe	548 (8.0)	
Unsafe	107 (1.6)	
Industry risk for COVID-19		
Low	2242 (34.8)	
Mid	2444 (37.9)	
High	1763 (27.3)	
Work location		
Hybrid (workplace and home)	1398 (21.7)	
On-site (usual workplace)	5051 (78.3)	
PPE provision	5547 (86)	
Level 2: national level		
COVID-19 frequency in country (%)‡	27	20 (15)

\*For descriptive purpose only, ISCED-97 was grouped into 0–2=low, 3–4=mid and 5–6=high.

†Sum of age  $\geq 60$  years and number of background comorbidities associated with severe COVID-19 (hypertension, diabetes, chronic obstructive pulmonary disease, cardiovascular disease and cancer history).

‡Country-level proportion of workers having someone familiar in their environment with COVID-19 diagnoses or illness (household members, close relatives, friends or colleagues).

.ISCED, International Standard Classification of Education; PPE, personal protective equipment; SES, socioeconomic status.

status, adjusted for country affiliation. The M0 intercept OR=0.31 (95% CI 0.26 to 0.35) indicated that, on average, the overall population is protected from mental health reductions. Moreover, participants characterised by reference category (or centred mean for the continuous variable in level 2) are further protected, as implied by the smaller intercepts of the models.

The results further confirmed a significant negative effect on the mental health of gender (women), financial difficulties, higher vulnerability index (sum of

**Table 2** Multilevel logistic models for mental health decline of first-level and second-level variables nested within countries

Predictors	M0: empty model		M1: level 1		M2: level 1+level 2	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
(Intercept)	0.311 (0.269 to 0.359)	<b>&lt;0.001</b>	0.114 (0.080 to 0.163)	<b>&lt;0.001</b>	0.112 (0.090 to 0.140)	<b>&lt;0.001</b>
Female			1.773 (1.550 to 2.028)	<b>&lt;0.001</b>	1.775 (1.552 to 2.029)	<b>&lt;0.001</b>
Ends meet (ref easily)			1.164 (1.077 to 1.258)	<b>&lt;0.001</b>	1.192 (1.102 to 1.288)	<b>&lt;0.001</b>
Education (ref low)			0.996 (0.941 to 1.055)	0.895		
Past COVID-19 infection			1.250 (0.914 to 1.710)	0.162		
Vulnerability COVID-19 index			1.118 (1.056 to 1.184)	<b>&lt;0.001</b>	1.117 (1.055 to 1.183)	<b>&lt;0.001</b>
History of mental disorder			1.821 (1.588 to 2.089)	<b>&lt;0.001</b>	1.787 (1.558 to 2.049)	<b>&lt;0.001</b>
Feeling unsafe			1.596 (1.466 to 1.738)	<b>&lt;0.001</b>	1.604 (1.474 to 1.746)	<b>&lt;0.001</b>
Industry risk (ref low)			1.087 (1.000 to 1.182)	0.051	1.084 (0.999 to 1.177)	0.053
On-site work location			0.762 (0.654 to 0.887)	<b>&lt;0.001</b>	0.773 (0.668 to 0.893)	<b>&lt;0.001</b>
PPE			1.013 (0.849 to 1.210)	0.884		
COVID-19 frequency in country					1.013 (1.005 to 1.020)	<b>0.002</b>
Random effects						
$\sigma^2$	3.29		3.29		3.29	
$\tau_{00}$	0.111		0.098		0.06	
ICC	0.033		0.029		0.018	
N (countries)	27		27		27	
Observations	6449		6449		6449	
Marginal R <sup>2</sup> /conditional R <sup>2</sup>	0.000/0.033		0.101/0.127		0.110/0.126	
Deviance	7106.505		6687.476		6681.177	
AIC	7110.505		6711.476		6701.177	

Significant p values (<0.05) are indicated in bold.

.AIC, Akaike information criterion; ICC, intraclass correlation; PPE, personal protective equipment; ref, reference category.

comorbidities and age >60) and mental health history, which were unchanged in the direction of effect and significance with sensitivity analyses distinguishing cases with a history of mental health clinical diagnosis and a probable case as per depressive symptomatology scale (online supplemental tables 4 and 5). By contrast, working from the usual workplace during COVID-19 (as opposed to hybrid work) had a protective effect with reduced odds (32%) of declining mental health (table 2). In a multi-level model which included only the occupational domain (online supplemental table 6), an increase in industry COVID-19 risk level, as we predefined, was strongly associated with mental health decline (highest vs lowest risk; OR=1.58, 95% CI 1.36 to 1.84). However, after adjusting for gender, clinical background and second level, the effect lost significance (table 2 and online supplemental table 6). Nevertheless, gender-stratified multivariate regression analyses (online supplemental tables 7 and 8) did not demonstrate an association between industry risk and mental health decline. Education level, previous COVID-19 illness of the worker and PPE provision were not significantly associated with mental health status and therefore were further excluded. M2 included a second-level factor, representing the national COVID-19 burden as reported by the participants. Inclusion in M2 of the second-level indicator: the country-level proportion of participants reporting on COVID-19 in their vicinity

substantially reduced cross-national variation of mental health ( $\tau_{00}$ =0.06, SE=0.03) and further reduced the intraclass correlation (ICC) to 0.018. Age was not entered independently into the models due to its inclusion in the vulnerability COVID-19 index. Worker perception of workplace safety was the strongest predictor. Each one-point increment in perceived safety (out of four) protected against mental health decline by 60%, with partial R<sup>2</sup> explaining about 30% of the outcome.

### Unsafe perception of the workplace during COVID-19

About 10% of the ageing workers in Europe, as of summer 2020, felt unprotected at work (table 1). This finding is universal according to the rather small ICC across countries (0.04) and industry sectors (0.01) (not shown). To investigate further the relationship between unsafe workplace perception and work environment factors (as IVs), we used multilevel logistic regression nested within the 27 countries and adjusted for sociodemographics (table 3). While PPE provision protects against low perceived safety (OR=0.63, p<0.001), the odds of an unsafe workplace perception were significantly elevated with the increase in industry risk level for contagion (OR=2.03, p<0.001 in high vs low-risk industries), and among those working from their usual workplace only (OR=1.7, p<0.001). The latter was opposed to the beneficial effect on mental

**Table 3** Association of work-related factors with the perceived workplace as unsafe during COVID-19 (multilevel-adjusted logistic regression), n=6449

Variable	OR (95% CI)*	P value
Industry risk of COVID-19		
Low	1	
Mid	1.741 (1.391 to 2.178)	<b>&lt;0.001</b>
High	2.035 (1.587 to 2.610)	<b>&lt;0.001</b>
Work location		
Hybrid (workplace and home)	1	
On-site work location	1.715 (1.349 to 2.180)	<b>&lt;0.001</b>
PPE provision		
No	1	
Yes	0.632 (0.497 to 0.802)	<b>&lt;0.001</b>

Significant p values (<0.05) are indicated in bold.  
 \*ORs were adjusted for gender, age, education and country affiliation (by applying multilevel methods where level 1 variables are nested within countries).  
 PPE, personal protective equipment.

health for those working exclusively on-site (OR=0.77, p<0.001).

#### Perceived workplace safety in COVID-19 mediates the effects of work environment factors on mental health

The perceived safety serves as a mediator of the work environment on mental health outcomes. The association between industry COVID-19 risk and mental health dropped in size with the mediation of perceived safety but remained significant and differed from zero, indicating a partial mediation, which explained 17% of the industry risk effect on mental health (online supplemental figure 3A). Perceived workplace safety significantly mediated 14% of the association between the work location and mental health in a suppressing mediation manner, as indicated from the opposite direction of estimates of direct and indirect effects, diminishing the net effect (online supplemental figure 3B). Equivalent analyses in the opposite direction indicated that changes in mental health status explained a smaller proportion of the difference in perceived safety, supporting the proposed direction of the causal pathway (not shown).

#### Cross-country variance in mental health

The ICC of 3.3% in M0 (table 2) indicated a non-negligible cross-national variation of mental health status ( $\tau_{00}$ =0.11, SE=0.05), comparable with between-country variation in other studies using SHARE. The inclusion of individual-level predictors barely decreased between-country variation in the mental health ( $\tau_{00}$ =0.1, SE=0.04), indicating potential attributes of national-level contextual factors on the unexplained variance remained. Inclusion of the indicator of the country-level proportion of participants reporting COVID-19 in their vicinity substantially reduced cross-national variation of mental health ( $\tau_{00}$ =0.06, SE=0.03) and further reduced the ICC

to 1.8%. Predictors in the final model (M2), both their fixed and random components, explained 13% (conditional R<sup>2</sup>) of mental health variance.

#### DISCUSSION

The COVID-19 pandemic has taken a global toll on the mental health of the understudied population of ageing workers who attend their workplace despite substantial health risks in different occupational settings. Thus, our research focused on capturing the work environment context and related factors associated with the mental health of ageing workers during COVID-19 for future targeted interventions. We found that one-quarter of a sample of ~6500 aged workers from different industry sectors and 27 countries reported a decline in mental health during the first summer of the pandemic. Multi-level factors were associated with self-reported mental health declines: universally prevalent unsafe workplace perception was the strongest predictor explaining 30% of mental health variability and mediated the effects of the macrolevel work environment (job industry risk and work location) on mental health; the national-level proportion of participants reporting COVID-19 in their vicinity accounts for the cross-national variation of mental health; individual-level analysis revealed subgroups with increased risk of mental health declines such as women, and those experiencing economic difficulties, pre-existing mental illness and comorbidities that predispose them to severe COVID-19.

#### Perceived safety at the workplace during COVID-19

In line with previous literature on younger workers, our study substantiates the robustness of the *safety perception* on the mental health of ageing workers. A study in small businesses during the COVID-19 demonstrated that employees' perceptions of safety and health climates were predominantly related to their mental self-reported well-being even when accounting for other work or life factors, such as changes to childcare or limiting social contacts.<sup>36</sup> The worker's perception of workplace safety is influenced by personal and organisational determinants, such as trust in organisational measures and coworkers, work environment modifications and psychosocial workplace factors.<sup>37 38</sup> In accordance, we verify the influence of macrolevel work environment determinants, namely job sector risk, PPE provision and work location, on the perceived safety during COVID-19. Moreover, general workplace safety perception predicts employee satisfaction and motivation and enhances safety measures use,<sup>37</sup> implying the benefit of workplace interventions in the COVID-19 context. Finally, we revealed that the unsafe perception of workers partially mediates the association between working in high-risk industry and declines in mental health and suppresses the protective effect on the mental health of on-site working. Our findings on the complex relationships between the work environment and the perceived safety of ageing workers on

their mental health are new to the literature and warrant in-depth research.

### Work environment: PPE provision

It is puzzling that 14% of workers still reported a lack of PPE access despite our study occurring 6 months into the outbreak in Europe. We demonstrated that PPE provision affects workers' mental health indirectly through their perceived workplace safety, consistent with a Canadian survey that associates mental health and HCWs' perceived adequacy of PPE.<sup>15</sup> Our insignificant direct effect of PPE provision on mental health is probably because workplaces with increased PPE access usually entail a higher risk for occupational COVID-19 transmission, an independent source of stress. Moreover, employers occasionally provide PPE with an insufficient protection level needed.<sup>39</sup>

### Work environment: work location

Our research raised conflicting directions regarding the impact of workplace location on mental health (on-site vs hybrid models). We found that working exclusively on-site confers a significant beneficial direct effect on mental health; however, it relates to lower perceived safety, which is associated with decreased mental health, therefore opposing the direct effect of work location on mental health. We assume that minimising the risk for workplace COVID-19 transmission by working from home can contribute to perceived workplace safety and holds additional benefits such as flexibility in working times, commuting time savings and increased time with the family. Nonetheless, ageing workers may feel socially isolated, challenged by low technological skills required for teleworking, non-ergonomic workstations associated with musculoskeletal disorders, disrupted work-life balance, imagined surveillance and communication overload and distractions from family members at home.<sup>40-44</sup> Our findings of better mental health among exclusive on-site ageing workers oppose a recent study highlighting the perceived preference of Generation Z for hybrid work models, implying a cohort effect.<sup>45</sup>

### Work environment: industry COVID-19 risk

In contrast to our study, the literature is focused on HCWs' mental health.<sup>46 47</sup> However, substantial distress exists among non-healthcare sectors with high COVID-19 transmission risk.<sup>4 5</sup> According to our risk classification, participants who worked in higher COVID-19 risk industries, HCWs and non-HCWs were more prone to mental health declines mediated by unsafe workplace perception. The strong attenuation of the effect of industry risk on mental health by women suggests possible gender inequality. Nevertheless, the lack of clear distinction in gender-stratified models implies more complex gender mental health relationships to be elucidated.

### Socioeconomic concerns

The socioeconomic disadvantage and lower job security of ageing workers are linked to the COVID-19-related

economic downturn that limits job opportunities and exacerbates age discrimination, particularly among women and those with chronic morbidity.<sup>8 9 48</sup> Our study corroborates that *financial concerns* are associated with mental health declines of ageing workers, as demonstrated among working, non-working and retired elderly population during the pandemic, and the general population during the pandemic.<sup>17 19 22</sup> In addition, the lower technological skills of many ageing workers may hinder teleworking as a control measure, resulting with their prolonged work interruption during the pandemic and its related financial consequences, as Brugiavini *et al* demonstrated using SHARE.<sup>49</sup>

### Sociodemographic inequalities

Differentiated occupational infection risk, which we demonstrated to affect mental health, cannot be isolated from sociodemographic inequalities that characterise workers in different industries, for example, gender.<sup>50</sup> Being a woman almost doubled the odds of worsening mental health in our study. Women, in general, are more vulnerable to depression, anxiety and stress reactions, and this gender tendency was demonstrated during the COVID-19 outbreak.<sup>20 21 35</sup> There is conflicting evidence in the literature regarding the effect of education level on mental health decline following the outbreak. Some studies demonstrate a positive association with higher education level, and others, including our research, found no association.<sup>17</sup>

### National-level COVID-19 context

Our study also suggests that the contextual factor of the country of residence is essential for understanding differences in individual mental reactions. For example, a previous study using SHARE data demonstrated that older people living in countries with higher death rates and those having family or friends who recently had COVID-19 are prone to negative mental health consequences.<sup>19</sup> We obtained similar results of individual mental health declines when using the national-level aspect of the proportion of respondents having someone familiar with COVID-19 (table 2). However, residual cross-country variation reflected by a remaining random effect after the inclusion of the national-level component indicates unobserved heterogeneity at the national level that has yet to be revealed.

### Background health conditions

Individual *clinical characteristics* were explored. In agreement with the literature, we demonstrated that a higher vulnerability score (age and comorbidities) for adverse COVID-19 outcomes risks mental health.<sup>14 17</sup> Regardless of COVID-19, chronic illnesses and their accompanying disability increase with age and are associated with mental health declines.<sup>51</sup> COVID-19 exacerbates this relationship.<sup>52</sup> History of mental disorders predicts mental health exacerbation in our study and the literature.<sup>14 16</sup> People with pre-existing mental health problems are prone to

worsening symptoms in response to pandemic-related information, social distancing isolation and disruptions to mental healthcare services.<sup>17 21</sup>

### Strengths

To the best of our knowledge, this study is the first to focus on work environment COVID-19 risks and safety perceptions among ageing workers, being performed in the relevant context of an ageing continent challenged by an ageing workforce. Additional strengths are extensive panel data that applied identical, comparable study designs, data collection and measures across European countries. Reliance on an overall large sample encompassing many different countries (n=27) and industry sectors (n=14) draws a comprehensive assessment of potential correlates, including modifiable factors related to mental health declines. Obtaining background clinical, sociodemographic and occupational data from prepandemic waves allowed us to infer causality on mental health status during the pandemic and map out effectors from several domains. Multilevel statistical modelling with random intercepts enabled us to integrate individual-level and country-level factors and analyse differences among countries regarding the prevalence of reported decrease in mental health status.

### Limitations

Several limitations must be acknowledged. First, many variables were based on self-reported data, thus prone to potential reporting bias, non-responding or inaccuracy. Therefore, we incorporated additional data such as consumption of specific medications, validated symptom scales (Euro-D) and data follow-up from several waves to obtain a more objective baseline picture. Further studies should integrate more 'objective' measures. However, the perceived mental health declines were not meant to stand for the consequentially clinical mental illness.

Second, our use of the SHARE study for secondary analyses challenged us with data limitations emanating from: the scope of the questionnaire that lacks aspects that may influence mental health—within and outside the workplace; each country contributed a relatively small unbalanced target population of workers aged 50–70 attending their workplace during the COVID-19, hence limiting generalisation; routing design of the questionnaire leading to missing data and exclusion of participants, thereby reducing our sample size, though rather homogeneously; and crude 14 industry sectors classification, which could lead to misclassification of occupational risk stratification, and attenuate differences across industry sectors. Despite these unmeasurable variables, from our clinical experience, we assume that they do not constitute a confounder that would explain away the analysis effect. However, a reduction in estimates cannot be ruled out. Further research is needed to account for the country's distribution of the target population of ageing workers.

Third, we used the COVID-19 questionnaire taken during the post-first wave relaxation in Europe; therefore,

we limited the analyses of COVID-19-related variables to a cross-sectional manner and did not follow the mental health change trends of the individual along with the pandemic. However, evidence confirmed the stability of mental health estimates and perceived safety in the workplace between subsequent time points during the pandemic across populations.<sup>18 53</sup> Moreover, obtaining prepandemic baseline panel data and mediation analyses assisted in causality interpretation challenges. Future assessment of long-term change in mental health using follow-up COVID-19 questionnaires can provide an important complement to the evidence emerging from our study.

### CONCLUSION AND IMPLICATIONS

The pandemic has taken a global toll on the mental health of ageing workers. Workplace environment and individual-level factors can modify the effects of COVID-19 on their mental health. Therefore, it is imperative to identify workplace conditions and screen subgroups of ageing workers vulnerable to mental health decline to reduce psychological distress and elevate their safety perception. Workplace measures improvement with tailored individual preventive approaches through the employers' occupational health services will benefit in preventing productivity loss accompanying mental health declines.

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