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Original Study

# The Effect of COVID-19 Endemicity on the Mental Health of Health Workers



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## ABSTRACT

### Keywords:

Burnout  
 COVID-19  
 health care workers  
 mental well-being  
 depression  
 anxiety

**Objectives:** A major surge in COVID-19 cases despite Singapore's high vaccination has strained the health care system in October 2021. Our aim was to assess and compare Healthcare Worker (HCW) mental well-being in 2021 against a previously published cohort in 2020.

**Design:** Cross-sectional survey study.

**Setting and Participants:** HCWs from 4 public hospitals and a primary health care system over a 4-week duration in 2021 coinciding with a major surge compared with a similar period in 2020.

**Methods:** A survey comprising of the Oldenburg Burnout Inventory (OLBI), Hospital Anxiety and Depression Scale (HADS), and Safety Attitudes Questionnaire (SAQ) was distributed via email. Primary endpoints were the proportion meeting OLBI thresholds for both disengagement and exhaustion and being at risk for both Anxiety and Depression using HADS. Multivariate analysis identified significant predictors among demographic, workplace, and SAQ data. Subgroup analysis of overseas HCWs was performed.

**Results:** We surveyed 1475 HCWs. Significantly more HCWs met primary outcomes using OLBI and HADS than in 2020 (84.1% and 39.6% vs 68.2% and 23.3%, respectively;  $P < .001$ ). Burnout levels were uniformly high. A HADS score  $\geq 8$  in either subscale was significantly associated with meeting burnout thresholds ( $P < .001$ ). Overseas HCWs ( $P = .002$ ), South Asian ethnicity ( $P = .004$ ), preuniversity educational qualifications ( $P = .026$ ), and longer shift workhours of 8 to  $< 12$  ( $P = .015$ ) and  $\geq 12$  ( $P = .001$ ) were significantly associated with meeting HADS thresholds. Among overseas HCWs ( $n = 407$ ), seeing family more than a year ago was significantly associated with worse OLBI disengagement scores and a greater proportion meeting HADS thresholds vs seeing them within a year or being local HCWs (47.2% vs 37.2% and 35.6%, respectively;  $P = .001$ ).

**Conclusions and Implications:** HCW mental health has objectively worsened between 2020 and 2021 in the pandemic's second year. Avoiding prolonged shifts, adopting preventive mental health strategies, improving patient safety, and attention to HCWs of minority ethnicity, from overseas, and with preuniversity education may help.

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Numerous studies and media have reported high levels of burnout<sup>1–3</sup> and reduced well-being<sup>4,5</sup> among health care workers (HCWs) during the COVID-19 pandemic. In 2020, the pandemic was characterized by uncertainty about the disease, high patient loads,<sup>6,7</sup> redeployment to unfamiliar and high-risk areas,<sup>8</sup> inadequate personal protective equipment (PPE)<sup>9,10</sup> and a lack of robust treatment or preventive options. Reduced physical interaction due to social distancing policies further compounded this by removing the supportive effects of peers and family.<sup>11</sup> This was especially difficult for overseas HCWs, who comprise a large proportion of several countries' health care workforces and are hindered by travel restrictions.<sup>12,13</sup> Nevertheless, few studies assessing HCW burnout during this pandemic, as characterized by excessive exhaustion and detachment from one's job,<sup>14</sup> did not have objective local prepandemic baseline data<sup>15</sup> to definitively conclude causality given that HCWs suffer a high preexisting prevalence of burnout.<sup>16–18</sup> Indeed, mitigating factors, such as altruism, have emerged as themes during this pandemic, although opinions regarding the extent of their protective effects have been conflicting.<sup>1,19,20</sup>

Although the second year of the pandemic has been characterized by a better understanding of COVID-19, the production of effective vaccines,<sup>21</sup> a larger armamentarium of treatment options,<sup>22,23</sup> and better PPE availability, it has also seen the emergence of more transmissible variants of concern such as the delta<sup>24,25</sup> and omicron variants,<sup>26,27</sup> which has increased uncertainty. Several countries, such as Singapore, are increasingly transiting from a zero-COVID policy to one that accepts COVID-19 endemicity. Despite our high vaccination rates (>85% of Singapore's population<sup>28</sup>), several factors such as the emergence of variants of concern,<sup>29,30</sup> opening of travel lanes,<sup>31</sup> and outbreaks among vaccinated populations<sup>25,32–34</sup> have contributed to a paradoxical surge in cases since the start of the pandemic from less than 0.7 daily cases per 100,000 population (April to August 2020) to a record high of 58.1 (October 2021) (Figure 1). Although about 98% are asymptomatic or mild,<sup>28</sup> serious cases have risen exponentially from less than 0.04 daily deaths per 1,000,000 population to 1.83 and a previous high of 31 critical care cases to a current peak of 67 over the same time frame.<sup>35</sup>

At present, Singapore's health care system is strained by a high volume of COVID-19 cases comprising individuals who are unvaccinated or have poor response despite home-based recovery being proposed as the standard of care.<sup>36</sup> This additionally coincides with a return to prepandemic non-COVID-19 caseloads,<sup>37,38</sup> which declined in 2020.<sup>7</sup> The chronic, unrelenting volume of cases since the start of the pandemic combined with the continuation of restrictions have likely contributed to an exodus of health care workers from our workforce.<sup>38,39</sup>

As more countries embark on this transition, it will be important to identify contributing factors to HCW mental health, well-being, and burnout in anticipation of possible strains on health care systems. In this follow-up study, we aim to compare the current prevalence of burnout and adverse mental health outcomes in HCWs with that derived from our previous study conducted in 2020 early in Singapore's COVID-19 experience.<sup>2</sup> Additionally, we aim to understand the effects on our HCWs from overseas.

## Methods

We conducted a multicenter, cross-sectional study and disseminated a survey to all HCWs across 4 public hospitals and a network of primary health care centers (polyclinics) between September 19 and October 19, 2021 (Supplementary Table 1). This time frame coincided with the start of a surge in cases despite reaching milestone community vaccination levels. Health care workers surveyed comprised doctors, nurses, allied health care professionals (AHPs), administrative or managerial staff, and support staff. Support staff referred to

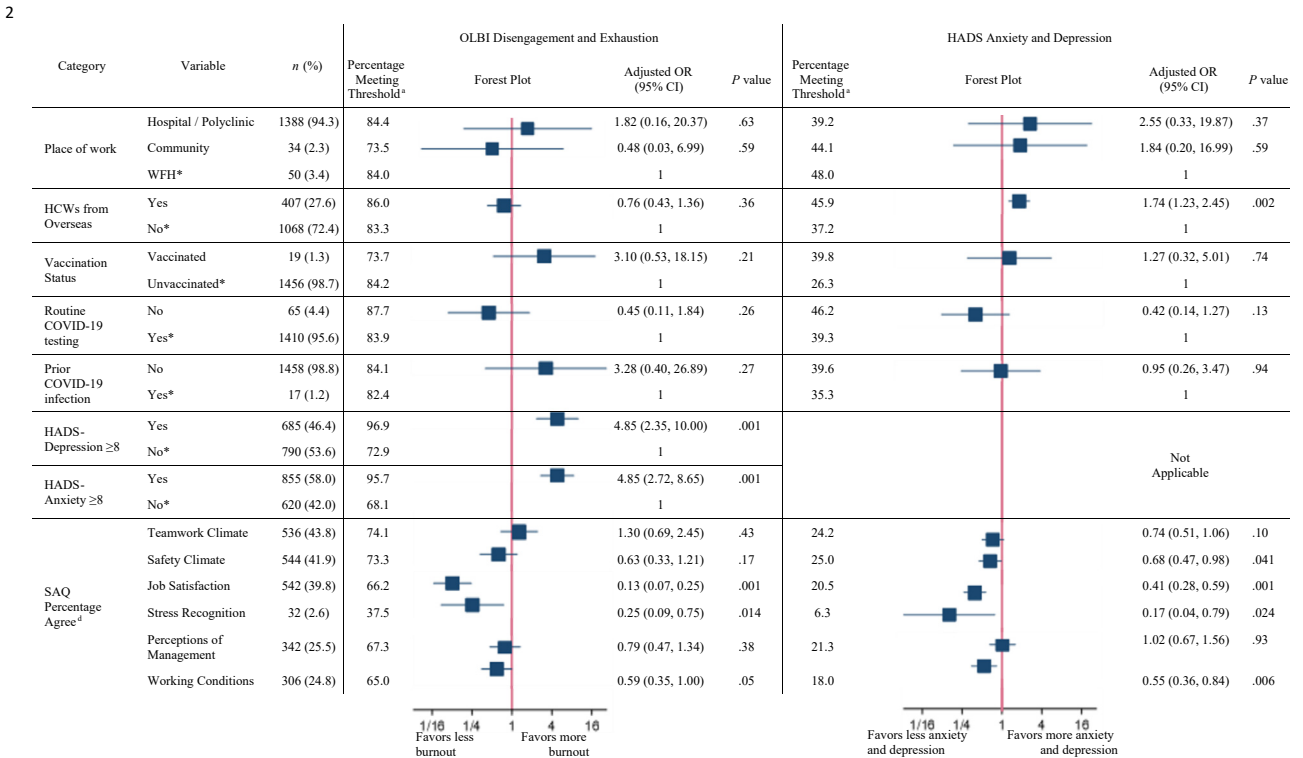
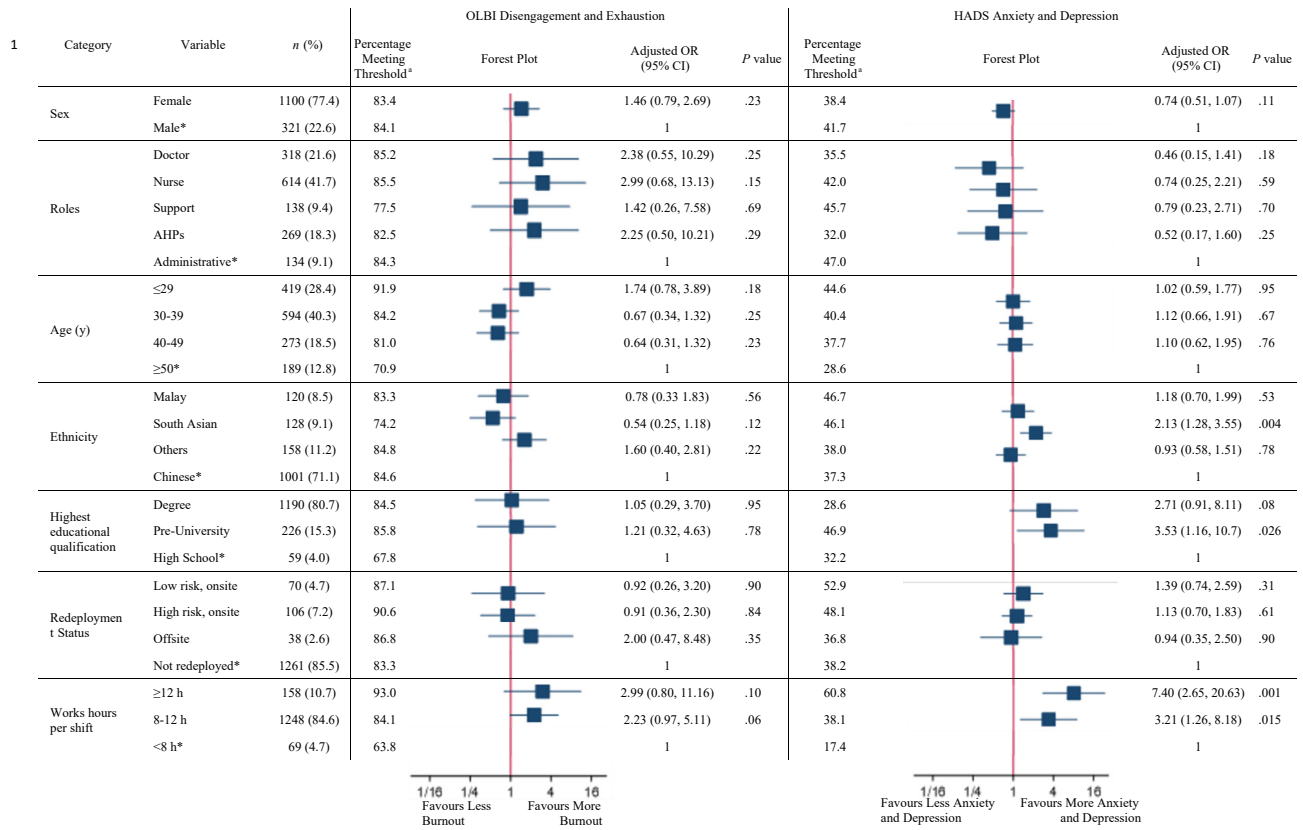
nonclinical employees involved in hospital operations (eg, porters, housekeeping, and security staff). As cross-sectional studies are unable to assess temporal relationships between exposure and outcome, we sought to mitigate this by comparing results in an earlier study<sup>2</sup> collected over a similar duration from May 29 to June 24, 2020, which coincided with the tail end of the first major surge. The survey was distributed to HCWs in the same health care institutions and via the same methods as the earlier study, that is, through a link to a questionnaire platform (FormSG; GovTech, Singapore) which was disseminated via corporate email and snowball sampling by word of mouth. An email reminder was disseminated twice at the middle and toward the end of each study period. This questionnaire was worded in English, which is Singapore's lingua franca. The first page declared the questionnaire's aim, its voluntary and anonymous nature, and that implied consent was associated with proceeding with the survey.

We collected basic demographic and workplace environment information data and organized respondents by categories such as (1) HCW roles, (2) gender, (3) ethnicity, (4) redeployment outside primary roles, (5) being tested for COVID-19, (6) primary site of work, (7) if work-from-home or working in offsite facilities was part of their job scope, (8) highest educational qualification, (9) number of workdays and average duration of shifts, (10) vaccination status, and (11) if they were HCWs from overseas. For redeployed HCWs, we further categorized them into (1) redeployed onsite (low risk), that is, not in direct contact with known COVID-19 cases; (2) redeployed onsite (high risk), that is, highly likely to be in direct contact with known COVID-19 cases (eg, emergency department, critical care unit); and (3) redeployed offsite to high-risk areas (eg, foreign work dormitory, community care facility, swab isolation facility).

Responses to three validated questionnaires, that is, Oldenburg Burnout Inventory (OLBI), Safety Attitudes Questionnaire (SAQ), and Hospital Anxiety and Depression Scale (HADS) were collated. These tools have been described in our prior study.<sup>2</sup> The OLBI<sup>40</sup> comprises 16 positively and negatively framed questions rated on a 4-point Likert-type scale that are equally divided into 2 dimensions—exhaustion (which refers to feelings of emptiness, overwork, physical exhaustion, and a strong need for rest) and disengagement (which refers to distancing from the objects and content of one's work) (Supplementary Table 2). An HCW was deemed to be burnt out if the mean score of both domains exceeded thresholds of  $\geq 2.25$  for exhaustion and  $\geq 2.10$  for disengagement, which have been correlated with physical symptoms.<sup>40,41</sup> The HADS<sup>42</sup> is a widely validated,<sup>43,44</sup> self-reported questionnaire evaluating Depression and Anxiety with 7 items for each domain (Supplementary Table 3) rated on a 4-point Likert scale scored as 0, 1, 2, and 3. A score of  $\leq 7$  is normal, 8–10 is borderline abnormal, and  $\geq 11$  is abnormal. An HCW with a score  $\geq 8$  in both domains is deemed to be at risk of both depression and anxiety. The SAQ<sup>45</sup> (Supplementary Table 4) covers 6 patient safety domains (ie, teamwork climate, safety climate, perceptions of management, job satisfaction, working conditions, and stress recognition) rated on a 5-point Likert-type scale comprising 30 core questions common to all versions of the SAQ and some additional relevant questions from the full SAQ bank. Nonclinical HCWs had the option to omit domains that were not relevant. A Safety Culture Score<sup>45,46</sup> for each domain was calculated by the formula (Mean value of item scores within a domain  $- 1) \times 25$ .

A score of 1 is transformed to 0, 2 to 25, 3 to 50, 4 to 75, and 5 to 100. A score of  $\geq 75$  is a percentage "agree" for that domain, and a percentage agree rate (PAR) is the proportion of respondents with a percentage agree.

Subgroup analysis was performed on HCWs from overseas as these comprised about 20% of the health care workforce in Singapore.<sup>47</sup> As overseas travel would mandate prolonged quarantining on return, this was disallowed unless special permission was given to preserve manpower for surge capacity, expansion of COVID treatment facilities,



AHPs, allied health professionals; HADS, Hospital Anxiety and Depression Scale; OLBI, Oldenburg Burnout Inventory; OR, odds ratio; SAQ, Safety Attitudes Questionnaire; WFH, work from home. Generalized Linear Mixed Model analysis with Institution as random effect.

\*Reference group.

<sup>a</sup>Percentage was calculated as a percentage of valid responses for that covariate.

<sup>b</sup>In-community refers to foreign worker dormitories, Community Care Facilities, or Swab Isolation Facilities.

<sup>c</sup>Preuniversity refers to associate degrees, A levels, and technical college qualifications.

<sup>d</sup>The reference group for each domain of the SAQ were respondents with percentage disagree.

**Fig. 1.** Multivariate analysis for predictors of meeting thresholds for (1) OLBI disengagement and exhaustion and (2) HADS anxiety and depression.

and higher operational tempo. We hypothesized that prolonged separation from family would have adverse mental health effects in this subgroup. We stratified HCWs from overseas based on whether they had seen their families within the last 1 year.

### Outcomes

Our primary outcome measures were the proportions of HCWs meeting thresholds for both OLBI exhaustion and disengagement as well as HADS Anxiety and Depression. This recognizes that HCWs meeting thresholds for both domains in each scale likely demonstrated the highest burnout and adverse mental health risks. Secondary outcomes measured included mean HADS and OLBI scores for each domain as well as SAQ PARs overall and for each domain.

### Statistics

All analyses were performed using Stata, version 17.0 (StataCorp LLC) with statistical significance set as 2-sided  $P < .05$ . Cronbach alphas and confirmatory factor analysis (utilizing root mean square error of approximation, comparative fit indices, and standardized root mean square residual<sup>48</sup>) demonstrated very good reliability and good model fit for most subscales (Supplementary Table 5).

Multivariate logistic regressions and generalized linear models were used to evaluate for differences in binary and numerical outcomes, respectively, between the 2021 and 2020 cohorts.

Predictors (demographic, workplace characteristics, and SAQ domain scores) for meeting thresholds for both OLBI exhaustion and disengagement domains as well as both HADS anxiety and depression were investigated using generalized linear mixed model with institution as a random effect and presented as adjusted odds ratios (ORs) with 95% CIs. As respondents comprised random samples from each institution, "Institution" was considered as a random factor (clustering effect) to account for the interinstitutional variance contribution and its impact on the  $P$  values. Forest plots are shown for the multivariate analyses (Figure 1). A subgroup analysis on HCWs from overseas has been performed (Table 1).

### Ethics

Ethics approval with waiver of individual participant consent was obtained from the National Healthcare Group's Domain Specific Review Board (reference number 2020/00598).

## Results

### Survey Responses

We had 1475 respondents (response rate 14.5%) (Table 2), with an average age of 36.4 years. Among these, 74.6% were female (1.91% were pregnant) and 67.9% were of Chinese ethnicity (the remainder were of Malay, South Asian, and Other ethnicities in roughly equal proportions). Doctors, nurses, AHPs, support staff, and administrative staff comprised 21.6%, 41.6%, 18.2%, 9.4%, and 9.1% of respondents, respectively. Further, 89.4% worked in a hospital, with the remainder working in a primary care setting. Redeployed HCWs accounted for 14.8% of respondents whereas HCWs from overseas comprised 27.6% of respondents. For highest educational qualification, degree holders and above, preuniversity (ie, associate degrees, diploma, A levels, technical college), and high school and below comprised 80.7%, 15.3%, and 4.0%, respectively. We received valid OLBI and HADS scores for all 1475 respondents, whereas 979 (66.3%) HCWs completed all 6 domains of the SAQ.

### Comparison Between 2021 and 2020 Cohorts

Compared to the previous study in 2020 (3075 respondents, response rate 27.2%) (Table 2), there was no significant difference in age (mean age 36.37 vs 36.94,  $P = .29$ ). However, the 2021 cohort had a slightly higher proportion of females (74.6% vs 71.5%,  $P = .004$ ). Additionally, there were significant differences observed in ethnic composition, primary place of work, HCW role, highest education qualification, redeployment status, latest COVID-19 testing status, recently treating a COVID-19 patient and shift duration (all  $P < .001$ ).

In the current 2021 study, the average OLBI disengagement and exhaustion scores were 2.65 and 2.78, respectively, with 90.2% and 88.9% reaching threshold in each domain and 84.1% reaching thresholds in both domains. This was significantly higher than in the 2020 cohort, where 68.2% met burnout threshold in both domains ( $P < .001$ ). The HADS scores also showed a significantly higher proportion of respondents at risk of mental health issues in 2021, with 39.6% meeting thresholds for risks of both anxiety and depression vs 23.3% in 2020 ( $P < .001$ ). Finally, SAQ scores also showed a significantly poorer PAR in each domain in 2021, with only 16.9% reaching PAR for the total score compared with 25.9% in 2020 ( $P < .001$ ).

### Multivariate Analysis

In the multivariate analysis (Figure 1), we identified having a HADS score of 8 or more for either the anxiety (OR 4.85, 95% CI 2.72–8.65;  $P = .001$ ) or depression domains (OR 4.85, 95% CI 2.35–10.0;  $P < .001$ ) to be independently associated with meeting the thresholds for both OLBI disengagement and exhaustion. Furthermore, reaching a percentage agree in the SAQ domains for job satisfaction (OR 0.13, 95% CI 0.07–0.25;  $P < .001$ ) and stress recognition (OR 0.25, 95% CI 0.09–0.75;  $P = .014$ ) was negatively associated with meeting burnout thresholds.

For being at risk of both anxiety and depression, independent predictors included being HCWs of South Asian ethnicity (OR 2.13, 95% CI 1.28–3.55;  $P = .004$ ), having a preuniversity educational certificate as the highest qualification (eg, diploma, A levels, technical college) (OR 3.53, 95% CI 1.16–10.7;  $P = .026$ ), being an HCW from overseas (OR 1.74, 95% CI 1.23–2.45;  $P = .002$ ), and working longer workhours per shift (8 to <12 hours: OR 3.21, 95% CI 1.26–8.18;  $P = .015$ ; and  $\geq 12$  hours: OR 7.40, 95% CI 2.65–20.63;  $P = .001$ ). In the SAQ, having a percentage agree for safety climate (OR 0.68, 95% CI 0.47–0.98;  $P = .041$ ), job satisfaction (OR 0.41, 95% CI 0.28–0.59;  $P < .001$ ), stress recognition (OR 0.17, 95% CI 0.04–0.79;  $P = .024$ ), and working conditions (OR 0.55, 95% CI 0.36–0.84;  $P = .006$ ) were negatively associated.

### Health Care Workers From Overseas

Among 407 HCWs from overseas (Table 1), 362 (88.9%) had last seen their families more than a year ago. OLBI disengagement scores for this group were significantly higher (2.70) compared with local HCWs and HCWs from overseas who had seen their families within a year ago (2.64 and 2.50, respectively) ( $P = .023$ ), whereas the percentage meeting thresholds for being at risk of depression and anxiety was higher at 47.2% vs 37.2% and 35.6%, respectively ( $P = .0013$ ). There was no significant difference, however, in SAQ PARs, mean HADS scores, or the proportion meeting OLBI thresholds for both domains.

## Discussion

Our study uniquely addresses the longitudinal impacts of a prolonged pandemic posture on HCW mental well-being by comparing outcomes in 2020 and 2021, in the face of a spike of new cases despite high population vaccination rates. We demonstrated that OLBI and HADS mean scores and proportion of HCWs meeting thresholds for

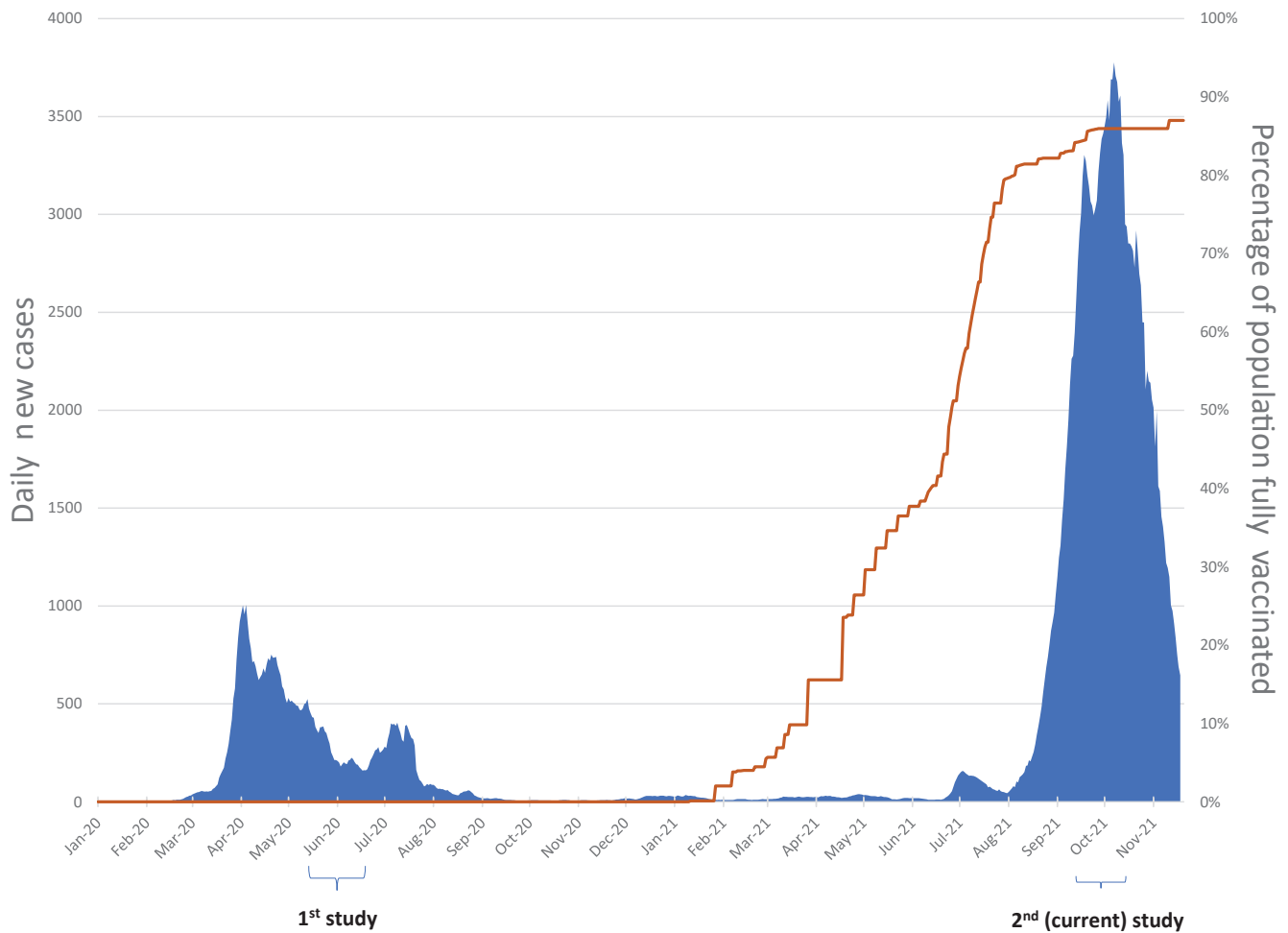


Fig. 2. Daily new cases and percentage of population fully vaccinated in Singapore.

burnout and being at risk of both anxiety and depression has increased significantly between 2020 and 2021. The absolute percentage of HCWs meeting these thresholds in 2021 is at a worrying level of 84.1% and 39.6% respectively as opposed to 68.2% and 23.3% in 2020. Additionally, attitudes toward patient safety have also deteriorated, with a significantly lower PAR for the total score (16.9% vs 25.9% in 2020). This is despite increased awareness and the institution of several protective policies<sup>3,49–53</sup> over the last 2 years.

When comparing independent predictors for burnout between our 2020 and 2021 cohort, only reaching threshold HADS scores for being at risk of depression and/or anxiety was common. Other predictors identified in 2020, such as being redeployed, and longer working hours per shift were no longer seen as independent predictors in our present cohort although this is likely due to uniformly high levels of burnout among different subgroups of our study population, limiting the power to detect significant differences.

Regarding adverse mental health outcomes, South Asian ethnicity (a minority ethnic group in Singapore), longer workhours per shift, holding a preuniversity certificate as the highest education qualification, and being an HCW from overseas were independently associated with risk of anxiety and depression. Although some studies have identified people of minority ethnicity as being at risk for mental health issues,<sup>54,55</sup> there is conflicting evidence<sup>56</sup> owing to poorly understood religio-cultural aspects, the role of community support, varied minority experiences in different countries, and significant intraethnic heterogeneity. Indeed, in Singapore's multiethnic context,

minorities in non-HCW populations have frequently demonstrated better self-reported mental health.<sup>57,58</sup> This has been postulated to be due to stronger family, religious, and community networks<sup>57</sup> and contrasts against collectivist cultures with Confucian roots among those of Chinese ethnicity that prioritize social and familial harmony over open displays of emotions.<sup>58</sup> This reversal of trends may be due to negative impacts of the pandemic on important supportive community, religious, familial, and social networks. This is an area that warrants further study.

Achieving a percentage agree in several SAQ domains had a statistically significant negative association with the primary outcomes. Although the causal relationship between perceptions of patient safety and burnout, depression, or anxiety is unclear, institutional focus on improving patient safety in deficient domains of the SAQ may be protective.<sup>59</sup> The relationship between long working hours and adverse mental health outcomes is well understood.<sup>60–62</sup> Like our previous study, shifts lasting less than 8 hours may be protective against burnout, highlighting the importance of proper work-rest cycles and prevention of prolonged shift lengths as a potential way to prevent burnout.

Subgroup analysis of HCWs from overseas demonstrated a significant association between prolonged separation from families for longer than a year and higher HADS anxiety and depression mean scores. This supplements the scarce data pertaining to this important and vulnerable group that comprises a significant component of several countries' HCW workforces.<sup>12,39,54</sup> Finding ways to allow

**Table 1**  
Comparison of OLBI, HADS, and SAQ Among Overseas HCWs

	Local HCWs (n = 1068)		Overseas HCWs			
	Meeting Threshold (%)	Mean (SD)	Last Seen Family Within Last Year (n = 45; 11.1%)		Last Seen Family Beyond a Year Ago (n = 362; 88.9%)	
Meeting Threshold (%)			Mean (SD)	Meeting Threshold (%)	Mean (SD)	Meeting Threshold (%)
OLBI Score						
Disengagement	89.9	2.64 (0.51)*	82.2	2.50 (0.46)*	92.3	2.70 (0.50)*
Exhaustion	88.0	2.77 (0.49)	91.1	2.71 (0.43)	91.2	2.83 (0.48)
Disengagement and exhaustion	83.3		80.0		86.7	
HADS						
Depression	44.3*	7.06 (4.23)	46.7*	7.00 (3.58)	52.8*	7.65 (3.72)
Anxiety	54.9†	8.50 (4.43)	64.4†	8.58 (3.35)	66.3†	9.11 (3.98)
Depression and anxiety	37.2*		35.6*		47.2*	
SAQ		Percentage Agree Rate (%)				
Teamwork climate		43.7		39.5		44.6
Safety climate		40.2		36.6		46.9
Stress recognition		2.2		0.0		3.9
Job satisfaction		39.0		46.5		41.0
Perceptions of management		27.1		21.4		21.5
Working conditions		24.0		27.5		26.6
Total		15.1		17.6		20.6

\* $P < .05$ .

† $P < .001$ .

HCWs from overseas to travel by facilitating and prioritizing leave to return home, enabling more efficient quarantining processes (if required), ensuring completion of vaccination, and expanding psychological support may be beneficial.

A very large proportion of our sample was fully vaccinated (98.7%) or undergoing regular SARS-CoV-2 testing (95.5%). This may be attributed to both of these being mandatory workplace requirements in the absence of valid contraindications,<sup>63</sup> high levels of vaccine acceptance in Singapore,<sup>64</sup> as well as a precedent for mandatory hepatitis B vaccinations<sup>65</sup> and opt-out semiannual influenza vaccination exercises<sup>66</sup> among HCWs. Nevertheless, this reduced the power of our study to determine the effects of these variables on our primary outcomes. The effects of these potentially protective factors should be further evaluated in settings with less HCW vaccination coverage or testing uptake either due to a lack of availability or personal preferences.

Despite an abundance of recommendations on how to combat burnout and adverse mental health outcomes among HCWs, there is limited evidence on their efficacy in this pandemic.<sup>49,53</sup> The objective worsening of these outcomes highlights the need for renewed efforts to combat this. This may be through the formal creation of well-resourced internal mental well-being departments dedicated to HCWs at an institutional level with appointed welfare champions spread across departments and health care roles. Our study identified HCWs from overseas and of minority ethnicity as groups vulnerable to adverse mental health outcomes, which we postulate may be due to effects of the pandemic on community support structures. As poorer HADS scores was significantly associated with higher risks of burnout, ensuring good HCW mental health may be protective<sup>15</sup> and this can be done by increasing access to trained counseling services, encouraging regular mental well-being breaks, disseminating reminders about self-care with emphasis on adequate rest, sleep, recreation, and maintaining connections with loved ones amid hectic schedules.<sup>67,68</sup> Policies should be enacted or reinforced at the institutional, state, and national level to guarantee the protection of rest cycles, leave taking, child and family care aspects, and manpower allocations. Factors contributory or indicative of work stress such as shift durations, patient numbers, leave taken, days off, and sick leaves should be tabulated with regular mental health surveys. Redline thresholds for

escalation to senior management should be assigned. Finally, targeting deficient patient safety domains as guided by SAQ may complement the above recommendations.

#### Limitations and Strengths

Although the 2021 study adopted the same methodology and recruitment strategy as the 2020 study over a similar study duration, we unexpectedly had fewer respondents (1475 vs 3075). This may have led to a sampling bias with some differences in baseline characteristics of the respondents. Nonetheless, the distribution of respondents' age was similar, and these differences were adjusted for when performing multivariate analysis to study the primary outcomes. Furthermore, we sampled the same population that would have faced similar changes in workplace conditions and policies between the 2 study periods. Thus, although a similar response rate with equivalent demographic factors would have been ideal, we feel that our findings remain valid. Various factors may have contributed to our reduced response rate. We postulate that HCWs had reduced ability to respond to survey invitation as workloads in 2021 were significantly higher because of a large surge in COVID-19 cases coupled with a return to prepandemic levels of non-COVID cases.<sup>69,70</sup> Significantly more HCWs treated COVID-19-positive patients in our present study (22.5% vs 15.0%). Additionally, because of difficulties with predicting case trajectories, the 2020 study coincided with the tail end of the initial surge whereas the 2021 one coincided with the peak of a much larger one (Figure 2).

The majority of studies in the current literature that evaluate mental health outcomes in HCWs during the COVID-19 pandemic are cross-sectional in nature, hence limiting their interpretation of causality. We believe a significant strength in our study is that we attempted to mitigate this by comparing the outcomes with our 2020 cohort. Nevertheless, longitudinal follow-up with individual subjects as part of a prospective cohort study design would have improved our understanding of how this relationship has changed with time. Additionally, mixed methods analysis can be employed to qualitatively understand other relevant factors contributing to these worrying trends.

**Table 2**  
Respondent Demographic, Work Environment Characteristics, and Baseline Measures of Emotional Well-Being

	2021, n (%)	2020, n (%)	P				
Total	1475	3075					
Age, y, mean (SD)	36.37 (10.04)	36.94 (9.95)	.29				
Gender			.004				
Male	321 (21.8)	794 (25.8)					
Female	1100 (74.6)	2199 (71.5)					
Not stated	54 (3.7)	82 (2.7)					
Ethnicity			<.001				
Chinese	1001 (67.9)	1608 (52.3)					
Malay	120 (8.1)	401 (13.0)					
South Asian	128 (8.7)	410 (13.3)					
Others, eg, Filipino, Burmese or from Myanmar, Eurasian, Caucasian, Vietnamese	158 (10.7)	506 (16.5)					
Not stated	68 (4.6)	159 (4.9)					
Current primary place of work			<.001				
Hospital	1318 (89.4)	2841 (92.4)					
Polyclinic or general practice	157 (10.6)	228 (7.41)					
Not stated	0 (0)	6 (0.20)					
Role			<.001				
Doctor	318 (21.6)	458 (14.9)					
Nurse	614 (41.6)	1394 (45.3)					
Allied health professional	269 (18.2)	483 (15.7)					
Support staff, ie, cleaners, porters, technicians, security	138 (9.4)	491 (16.0)					
Administrative and managerial	134 (9.1)	247 (8.0)					
Not stated	2 (0.1)	2 (0.1)					
Highest education qualification			<.001				
Degree and above	1190 (80.7)	2132 (69.3)					
Preuniversity (ie, associate degrees, diploma, A levels, technical college)	226 (15.3)	699 (22.7)					
High school or below	59 (4.0)	244 (8.0)					
Redeployment to other areas			<.001				
Not redeployed	1257 (85.2)	2534 (82.4)					
Redeployed	218 (14.8)	541 (17.6)					
Within hospital, low risk	81 (37.2)	140 (25.9)					
Within hospital, high risk	78 (35.8)	245 (45.3)					
Outside of hospital	43 (19.7)	156 (28.8)					
Not specified	2 (0.92)	0 (0)					
Have you ever been infected with COVID-19?			N/A				
Yes	17 (1.2)	Not Surveyed					
No	1458 (98.8)						
COVID-19 status in the last 1 wk			<.001				
Negative	1400 (94.9)	506 (16.5)					
Positive	9 (0.6)	21 (0.7)					
Do not know or not tested	66 (4.5)	254 (82.9)					
Vaccination status		Not Applicable	N/A				
Completed 2 doses at least	1456 (98.7)						
Completed only 1 dose	9 (0.61)						
Not vaccinated	10 (0.68)						
Have you treated a COVID-19–positive patient in the past week?			<.001				
Yes	332 (22.5)	462 (15.0)					
No	1059 (71.8)	2449 (79.6)					
Don't know	84 (5.7)	164 (5.3)					
Average duration of your shift or daily work hours?			<.001				
<8 h	69 (4.7)	299 (9.7)					
8–12 h	1248 (84.6)	2462 (80.1)					
≥12 h	158 (10.7)	314 (10.2)					
<b>Scales</b>	<b>Mean (SD)</b>	<b>Meeting Threshold, n (%)</b>	<b>Mean (SD)</b>	<b>Meeting Threshold, n (%)</b>			
<b>OLBI (n = 1475)*</b>							
Disengagement	2.65 (0.51)	1331 (90.2)	2.38 (0.46)	2452 (79.7)	<.001		
Exhaustion	2.78 (0.46)	1311 (88.9)	2.50	2315 (75.3)	<.001		
Meeting threshold for both disengagement and exhaustion		1240 (84.1)		2097 (68.2)	<.001		
<b>HADS (n = 1475)†</b>							
Depression	7.2 (4.1)	685 (46.4)	5.7 (3.9)	979 (31.9)	<.001		
Anxiety	6.7 (3.2)	855 (57.9)	6.9 (4.0)	1253 (40.7)	<.001		
Meeting threshold for both depression and anxiety		584 (39.6)		716 (23.3)	<.001		
<b>SAQ‡</b>	<b>n</b>	<b>Mean (SD)</b>	<b>PAR‡, n (%)</b>	<b>n</b>	<b>Mean (SD)</b>	<b>PAR‡, n (%)</b>	
Total mean (n=979)	979	58.6 (15.8)	165 (16.9)	1931	64.0 (15.3)	501 (25.9)	<.001
Teamwork climate (n=1224)	1224	67.8 (20.6)	536 (36.3)	2479	74.4 (18.8)	1386 (55.9)	<.001
Safety climate (n=1299)	1299	67.5 (19.1)	544 (36.9)	2525	72.3 (18.1)	1329 (52.7)	<.001
Stress recognition (n=1238)	1238	20.2 (20.9)	32 (2.2)	2501	31.5 (25.7)	205 (8.2)	<.001
Job satisfaction (n=1363)	1363	64.1 (24.0)	542 (36.7)	2725	74.6 (22.3)	1613 (59.2)	<.001
Perceptions of management (n=1341)	1341	57.8 (21.0)	342 (23.2)	2633	64.1 (20.0)	932 (35.4)	<.001
Working conditions (n=1232)	1232	55.6 (21.3)	306 (20.7)	2428	66.2 (20.8)	1030 (42.4)	<.001

\*Thresholds for deeming burnout for (1) OLBI disengagement  $\geq 2.10$  and (2) OLBI exhaustion  $\geq 2.25$ .†Thresholds for deeming risk of anxiety or depression for HADS was  $\geq 8$  in either subscale.

‡PAR refers to the proportion of respondents who scored 75% or above for the Safety Culture Score in each domain.

## Conclusions and Implications

Singapore's paradoxical peak in COVID-19 cases despite high population vaccination rates is a cautionary message to all countries aiming to open their economies and accept COVID-19 endemicity. Furthermore, until global vaccine equality is achieved,<sup>71</sup> the risk of future SARS-CoV-2 variants, such as omicron, exists and guarantees that COVID-19 will remain a long-term public health concern.<sup>72,73</sup> Although HCW burnout and mental health issues have been a perennial problem, it has worsened over this pandemic despite increased awareness and support. Thus, as we transit to a state of COVID endemicity, we may face a second mental health epidemic among HCWs. We urge health care systems to comprehensively audit the state of mental health among their HCWs and to continually evaluate for contributory factors to guide formal steps toward protecting them and keeping health care delivery sustainable.

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## Supplementary Data

Supplementary data related to this article can be found online at <https://doi.org/10.1016/j.jamda.2022.01.059>.

## References

- Hu D, Kong Y, Li W, et al. Frontline nurses' burnout, anxiety, depression, and fear statuses and their associated factors during the COVID-19 outbreak in Wuhan, China: a large-scale cross-sectional study. *EClinicalMedicine* 2020;24:100424.
- Tan BYQ, Kanneganti A, Lim LKH, et al. Burnout and associated factors among health care workers in Singapore during the COVID-19 pandemic. *J Am Med Dir Assoc* 2020;21:1751–1758.e5.
- Nanda A. More doctors in Singapore face burnout, anxiety amid the pandemic. *Straits Times*. August 3, 2021. <https://www.straitstimes.com/life/more-doctors-in-singapore-face-burnout-anxiety-amid-the-pandemic>. Accessed October 19, 2021.
- Tan BYQ, Chew NWS, Lee GKH, et al. Psychological impact of the COVID-19 pandemic on health care workers in Singapore. *Ann Intern Med* 2020;173:317–320.
- Denning M, Goh ET, Scott A, et al. What has been the impact of Covid-19 on safety culture? A case study from a large metropolitan healthcare trust. *Int J Environ Res Public Health* 2020;17:7034.
- Carenzo L, Costantini E, Greco M, et al. Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. *Anaesthesia* 2020;75:928–934.
- Kadri SS, Sun J, Lawandi A, et al. Association between caseload surge and COVID-19 survival in 558 U.S. hospitals, March to August 2020. *Ann Intern Med* 2021;174:1240–1251.
- Shanker S, Chia DWJ, Ganti S. Difficulties faced by a medical team based at a COVID-19 quarantine facility. *Singapore Med J*. Published online. July 30, 2020. <https://doi.org/10.11622/smedj.2020115>.
- Burki T. Global shortage of personal protective equipment. *Lancet Infect Dis* 2020;20:785–786.
- Ranney ML, Griffith V, Jha AK. Critical supply shortages — the need for ventilators and personal protective equipment during the Covid-19 pandemic. *N Engl J Med* 2020;382:e41.
- Chan GMF, Kanneganti A, Yasin N, Ismail-Pratt I, Logan SJS. Well-being, obstetrics and gynaecology and COVID-19: leaving no trainee behind. *Aust N Z J Obstet Gynaecol* 2020;60:983–986.
- Sidhu K, Bamrah J, Akhtar I, John T, Sood U. Covid-19 has added strain on overseas doctors unable to see their families. *BMJ*. Updated January 15, 2021. <https://blogs.bmj.com/bmj/2021/01/15/covid-19-has-added-strain-on-migrant-doctors-unable-to-see-their-families/>. Accessed October 19, 2021.
- Chua N. TTSH worker has not gone back to Philippines to visit family for 2 years amid Covid-19. *The Straits Times*. Updated November 14, 2021. <https://www.straitstimes.com/singapore/health/ttsh-worker-has-not-gone-back-to-philippines-to-visit-family-for-2-years-amid-covid>. Accessed November 16, 2021.
- Maslach C, Leiter MP. Understanding the burnout experience: recent research and its implications for psychiatry. *World Psychiatry* 2016;15:103–111.
- Fari G, de Sire A, Giorgio V, et al. Impact of COVID-19 on the mental health in a cohort of Italian rehabilitation healthcare workers. *J Med Virol* 2022;94:110–118.
- See KC, Zhao MY, Nakataki E, et al. Professional burnout among physicians and nurses in Asian intensive care units: a multinational survey. *Intens Care Med* 2018;44:2079–2090.
- Peterson U, Bergström G, Demerouti E, Gustavsson P, Asberg M, Nygren A. Burnout levels and self-rated health prospectively predict future long-term sickness absence: a study among female health professionals. *J Occup Environ Med* 2011;53:788–793.
- Shanafelt TD, Balch CM, Bechamps G, et al. Burnout and medical errors among American surgeons. *Ann Surg* 2010;251:995–1000.
- Sumner RC, Kinsella EL. Grace under pressure: resilience, burnout, and well-being in frontline workers in the United Kingdom and Republic of Ireland during the SARS-CoV-2 pandemic. *Front Psychol* 2021;11:576229.
- Wu P, Fang Y, Guan Z, et al. The psychological impact of the SARS epidemic on hospital employees in China: exposure, risk perception, and altruistic acceptance of risk. *Can J Psychiatry* 2009;54:302–311.
- Pramanick A, Kanneganti A, Wong JJJ, et al. A reasoned approach towards administering COVID-19 vaccines to pregnant women. *Prenat Diagn* 2021;41:1018–1035.
- Shang L, Lye DC, Cao B. Contemporary narrative review of treatment options for COVID-19. *Respirology* 2021;26:745–767.
- Mahase E. Covid-19: Molnupiravir reduces risk of hospital admission or death by 50% in patients at risk, MSD reports. *BMJ* 2021;375:n2422.
- Mahase E. Delta variant: what is happening with transmission, hospital admissions, and restrictions? *BMJ* 2021;373:n1513.
- Chia PY, Xiang Ong SW, Chiew CJ, et al. Virological and serological kinetics of SARS-CoV-2 Delta variant vaccine-breakthrough infections: a multi-center cohort study. *Clin Microbiol Infect*; 2021.
- Torjesen I. Covid-19: Omicron may be more transmissible than other variants and partly resistant to existing vaccines, scientists fear. *BMJ* 2021;375:n2943.
- Karim SSA, Karim QA. Omicron SARS-CoV-2 variant: a new chapter in the COVID-19 pandemic. *Lancet* 2021;398:2126–2128.
- Ministry of Health (Government of Singapore). Update on local COVID-19 situation (18 Oct 2021). Ministry of Health, Government of Singapore. Updated October 18, 2021. [https://www.moh.gov.sg/news-highlights/details/update-on-local-covid-19-situation-\(18-oct-2021\)](https://www.moh.gov.sg/news-highlights/details/update-on-local-covid-19-situation-(18-oct-2021)). Accessed October 19, 2021.
- Walensky RP, Walke HT, Fauci AS. SARS-CoV-2 variants of concern in the United States—challenges and opportunities. *JAMA* 2021;325:1037–1038.
- Altmann DM, Boyton RJ, Beale R. Immunity to SARS-CoV-2 variants of concern. *Science* 2021;371:1103–1104.
- Leung K, Wu JT, Leung GM. Effects of adjusting public health, travel, and social measures during the roll-out of COVID-19 vaccination: a modelling study. *Lancet Public Health* 2021;6:e674–e682.
- Bergwerk M, Gonen T, Lustig Y, et al. Covid-19 breakthrough infections in vaccinated health care workers. *N Engl J Med* 2021;385:1474–1484.
- Shitrit P, Zuckerman NS, Mor O, Gottesman BS, Chowers M. Nosocomial outbreak caused by the SARS-CoV-2 Delta variant in a highly vaccinated population, Israel, July 2021. *Euro Surveill* 2021;26:2100822.
- Brown CM, Vostok J, Johnson H, et al. Outbreak of SARS-CoV-2 infections, including COVID-19 vaccine breakthrough infections, associated with large public gatherings—Barnstable County, Massachusetts, July 2021. *MMWR Morb Mortal Wkly Rep* 2021;70:1059.
- Hannah R, Edouard M, Rodés-Guirao L, et al. Coronavirus pandemic (COVID-19). <https://ourworldindata.org/coronavirus>. Accessed October 11, 2021.
- Bowles KH, McDonald M, Barrón Y, Kennedy E, O'Connor M, Mikkelsen M. Surviving COVID-19 after hospital discharge: symptom, functional, and adverse outcomes of home health recipients. *Ann Intern Med* 2021;174:316–325.
- Ng KG. Longer wait for admission with most public hospitals seeing more A&E patients, Covid-19 cases. *The Straits Times*. Updated September 20, 2021. <https://www.straitstimes.com/singapore/health/most-public-hospitals-saw-more-ae-patients-in-past-week-compared-with-past-month>. Accessed October 11, 2021.
- Lim V. 'I haven't seen the daylight in ages': Pressure on healthcare workers as COVID-19 cases spike. *Channel NewsAsia*. Updated October 14, 2021. <https://www.channelnewsasia.com/singapore/covid-19-healthcare-workers-coping-cases-nurses-doctors-2237801>. Accessed October 19, 2021.
- Cheryl T. More healthcare workers in S'pore quit amid growing fatigue as Covid-19 drags on. *The Straits Times*. Updated November 1, 2021. <https://www.straitstimes.com/singapore/politics/more-healthcare-workers-in-s-pore-resigning-amid-growing-fatigue-as-covid-19-drags>. Accessed November 1, 2021.
- Demerouti E, Bakker AB, Vardakou I, Kantas A. The convergent validity of two burnout instruments: a multitrait-multimethod analysis. *Eur J Psychol Assess* 2003;19:12–23.
- Aldrich B, Price J, Mueller C. Handbook of organizational measurement. *Teach Sociol* 1989;17:102.
- Zigmond AS, Snaith RP. The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scand* 1983;67:361–370.
- de Almeida Macêdo E, Appenzeller S, Lavras Costallat LT. Assessment of the Hospital Anxiety and Depression Scale (HADS) performance for the diagnosis of anxiety in patients with systemic lupus erythematosus. *Rheumatol Int* 2017;37:1999–2004.
- Driskell LD, Starosta AJ, Brenner LA. Clinical utility and measurement characteristics of the Hospital Anxiety and Depression Scale for individuals with traumatic brain injury. *Rehabil Psychol* 2016;61:112–113.



45. Sexton JB, Helmreich RL, Neilands TB, et al. The Safety Attitudes Questionnaire: psychometric properties, benchmarking data, and emerging research. *BMC Health Serv Res* 2006;6:44.
46. Profit J, Sharek PJ, Ampsoker AB, et al. Burnout in the NICU setting and its relation to safety culture. *BMJ Qual Saf* 2014;23:806–813.
47. National Population and Talent Division; Prime Minister's Office (Government of Singapore). Projection of Foreign Manpower Demand for Healthcare Sector, Construction Workers and Foreign Domestic Workers. Prime Minister's Office, Government of Singapore. Updated November 1, 2012, <https://www.strategygroup.gov.sg/images/Press%20Release%20images/PDFs/occasional-paper-projection-of-foreign-manpower-demand-healthcare-construction-foreign-domestic-workers.pdf>. Accessed October 11, 2021.
48. Vandenberg RJ, Lance CE. A review and synthesis of the measurement invariance literature: suggestions, practices, and recommendations for organizational research. *Organ Res Methods* 2000;3:4–70.
49. Sharifi M, Asadi-Pooya AA, Mousavi-Roknabadi RS. Burnout among healthcare providers of COVID-19; a systematic review of epidemiology and recommendations. *Arch Acad Emerg Med* 2020;9:e7.
50. Fessell D, Cherniss C. Coronavirus Disease 2019 (COVID-19) and beyond: micropractices for burnout prevention and emotional wellness. *J Am Coll Radiol* 2020;17:746–748.
51. Blake H, Bermingham F, Johnson G, Tabner A. Mitigating the psychological impact of COVID-19 on healthcare workers: a digital learning package. *Int J Environ Res Public Health* 2020;17:2997.
52. Appelbom S, Bujacz A, Finnes A, et al. The rapid implementation of a psychological support model for frontline healthcare workers during the COVID-19 pandemic: a case study and process evaluation. *Front Psychiatry* 2021;12:713251.
53. Amanullah S, Ramesh Shankar R. The impact of COVID-19 on physician burnout globally: a review. *Healthcare* 2020;8:421.
54. Schilgen B, Nienhaus A, Handtke O, Schulz H, Mösko M. Health situation of migrant and minority nurses: A systematic review. *PLoS One* 2017;12:e0179183.
55. Gilleen J, Santaolalla A, Valdearenas L, Salice C, Fusté M. Impact of the COVID-19 pandemic on the mental health and well-being of UK healthcare workers. *BJPsych Open* 2021;7:e88.
56. Prasad K, McLoughlin C, Stillman M, et al. Prevalence and correlates of stress and burnout among U.S. healthcare workers during the COVID-19 pandemic: a national cross-sectional survey study. *EClinicalMedicine* 2021;35:100879.
57. Lim WY, Ma S, Heng D, Bhalla V, Chew SK. Gender, ethnicity, health behaviour & self-rated health in Singapore. *BMC Public Health* 2007;7:184.
58. Vaingankar JA, Subramaniam M, Abidin E, et al. Socio-demographic correlates of positive mental health and differences by depression and anxiety in an Asian community sample. *Ann Acad Med Singap* 2013;42:514–523.
59. de Sire A, Marotta N, Raimo S, et al. Psychological distress and work environment perception by physical therapists from southern Italy during COVID-19 pandemic: the C.A.L.A.B.R.I.A study. *Int J Environ Res Public Health* 2021;18:9676.
60. Spurgeon A, Harrington JM, Cooper CL. Health and safety problems associated with long working hours: a review of the current position. *Occup Environ Med* 1997;54:367–375.
61. Singh P, Aulak DS, Mangat SS, Aulak MS. Systematic review: factors contributing to burnout in dentistry. *Occup Med* 2016;66:27–31.
62. Patel RS, Bachu R, Adikey A, Malik M, Shah M. Factors related to physician burnout and its consequences: a review. *Behav Sci (Basel)* 2018;8:98.
63. Sokol D. Covid-19 vaccination should be mandatory for healthcare workers. *BMJ* 2021;375:n2670.
64. Lazarus JV, Ratzan SC, Palayew A, et al. A global survey of potential acceptance of a COVID-19 vaccine. *Nat Med* 2021;27:225–228.
65. Wise J. Covid-19: is the UK heading towards mandatory vaccination of healthcare workers? *BMJ* 2021;373:n1056.
66. Kyaw WM, Chow A, Hein AA, Lee LT, Leo YS, Ho HJ. Factors influencing seasonal influenza vaccination uptake among health care workers in an adult tertiary care hospital in Singapore: a cross-sectional survey. *Am J Infect Control* 2019;47:133–138.
67. Tng XJJ, Chew QH, Sim K. Psychological sequelae within different populations during the COVID-19 pandemic: a rapid review of extant evidence. *Singapore Med J*. Published online July 30, 2020. <https://doi.org/10.11622/smedj.2020111>.
68. Chew QH, Wei KC, Vasoo S, Sim K. Psychological and coping responses of health care workers toward emerging infectious disease outbreaks: a rapid review and practical implications for the COVID-19 pandemic. *J Clin Psychiatry* 2020;81:20r13450.
69. Iacobucci G. How is the pandemic affecting non-covid services? *BMJ* 2021;372:n215.
70. Birkmeyer JD, Barnato A, Birkmeyer N, Bessler R, Skinner J. The impact of the COVID-19 pandemic on hospital admissions in the United States. *Health Aff (Millwood)* 2020;39:2010–2017.
71. Smith A. Covid omicron variant linked to vaccine inequality, experts say. *NBC News*. Published November 30, 2021. <https://www.nbcnews.com/news/world/omicron-linked-global-vaccine-inequality-experts-rcna6916>. Accessed December 4, 2021.
72. Dyer O. Covid-19: Delta infections threaten herd immunity vaccine strategy. *BMJ* 2021;374:n1933.
73. Scientific Advisory Group for Emergencies (Government of UK). Long term evolution of SARS-CoV-2, 26 July 2021. <https://www.gov.uk/government/publications/long-term-evolution-of-sars-cov-2-26-july-2021/long-term-evolution-of-sars-cov-2-26-july-2021>. Accessed October 28, 2021.

**Supplementary Table 1**

## Health Care Institutions Included in This Study

Health Institution	Address	Bed Capacity	COVID Cases at Time of Study
National University Hospital	5 Lower Kent Ridge Rd, Singapore 119074 6779 5555	1239 beds	More than 100
Ng Teng Fong General Hospital	1 Jurong East Street 21, Singapore 609606 6716 2000	700 beds	More than 100
Alexandra Hospital	378 Alexandra Rd, Singapore 159964 6472 2000	300 beds	50-100
Institute of Mental health	10 Buangkok View, Buangkok Green Medical Park, Singapore 539747 6389 2000	2010 beds	24-49
National University Polyclinics	Bukit Batok Polyclinic 50 Bukit Batok West Avenue 3 Singapore 659164 Choa Chu Kang Polyclinic 2 Teck Whye Crescent Singapore 688846 Clementi Polyclinic Blk 451 Clementi Avenue 3 #02-307 Singapore 120451 Jurong Polyclinic 190 Jurong East Avenue 1 Singapore 609788 Pioneer Polyclinic 26 Jurong West Street 61 Singapore 648201 Queenstown Polyclinic 580 Stirling Road Singapore 148958		Outpatient services

**Supplementary Table 2**

## Oldenburg Burnout Inventory (4-Point Likert Scale)

	Question	Domain	Reversed Questions
1.	I always find new and interesting aspects of my work.	D	✓
2.	There are days when I feel tired before I arrive at work.	E	
3.	It happens more and more often that I talk about my work in a negative way.	D	
4.	After work, I tend to need more time than in the past in order to relax and feel better	E	
5.	I can tolerate the pressure of my work very well.	E	✓
6.	Lately, I tend to think less at work and do my job almost mechanically.	D	
7.	I find my work to be a positive challenge.	D	✓
8.	During my work, I often feel emotionally drained.	E	
9.	Over time, one can become disconnected from this type of work.	D	
10.	After working, I have enough energy for my leisure activities.	E	✓
11.	Sometimes I feel sickened by my work tasks.	D	
12.	After my work, I usually feel worn out and weary.	E	
13.	This is the only type of work that I can imagine myself doing.	D	✓
14.	Usually, I can manage the amount of my work well.	E	✓
15.	I feel more and more engaged in my work.	D	✓
16.	When I work, I usually feel energized.	E	✓

D, Disengagement; E, Exhaustion.

**Supplementary Table 3**

Hospital Anxiety and Depression Scale

Question	Domain	Responses & Score				
1. I feel tense or 'wound up'	A	Most of the time <b>3</b>	A lot of the time <b>2</b>	From time to time, occasionally <b>1</b>	Not at all <b>0</b>	
2. I still enjoy the things I used to enjoy	D	Definitely as much <b>0</b>	Not quite so much <b>1</b>	Only a little <b>2</b>	Hardly at all <b>3</b>	
3. I get a sort of frightened feeling as if something awful is about to happen	A	Very definitely and quite badly 3	Yes, but not too badly 2	A little, but it doesn't worry me 1	Not at all 0	
4. I can laugh and see the funny side of things	D	As much as I always could 0	Not quite so much now 1	Definitely not so much now 2	Not at all 3	
5. Worrying thoughts go through my mind	A	A great deal of the time 3	A lot of the time 2	From time to time, but not too often 1	Only occasionally 0	
6. I feel cheerful	D	Not at all 0	Not often 1	Sometimes 2	Most of the time 3	
7. I can sit at ease & feel relaxed	A	Definitely 0	Usually 1	Not often 2	Not at all 3	
8. I feel as if I am slowed down	D	Nearly all the time 3	Very often 2	Sometimes 1	Not at all 0	
9. I get a sort of frightened feeling like 'butterflies' in the stomach	A	Not at all 0	Occasionally 1	Quite often 2	Very often 3	
10. I have lost interest in my appearance	D	Definitely 3	I don't take as much care as I should 2	I may not take quite as much care 1	I take just as much care ever 0	
11. I feel restless as I have to be on the move	A	Very much indeed 3	Quite a lot 2	Not very much 1	Not at all 0	
12. I look forward with enjoyment to things	D	As much as I ever did 0	Rather less than I used to 1	Definitely less than I used to 2	Hardly at all 3	
13. I get sudden feelings of panic	A	Very often indeed 3	Quite often 2	Not very often 1	Not at all 0	
14. I can enjoy a good book or radio or TV program	D	Often 0	Sometimes 1	Not often 2	Very seldom 3	

D: Depression, A: Anxiety.

0-7: Normal, 8-10: Borderline abnormal, 11-21: Abnormal.

**Supplementary Table 4**

Safety Attitudes Questionnaire (5-Point Likert Scale)

Question	Domain	Reversed Questions
1. Nurse input is well received in this clinical area.	TW	
2. In this clinical area, it is difficult to speak up if I perceive a problem with patient care.		✓
3. Disagreements in this clinical area are resolved appropriately (i.e., not who is right, but what is best for the patient).		
4. I have the support I need from other personnel to care for patients.		
5. It is easy for personnel here to ask questions when there is something that they do not understand.		
6. The physicians and nurses here work together as a well-coordinated team.		
7. I would feel safe being treated here as a patient.	SC	
8. Medical errors are handled appropriately in this clinical area.		
9. I know the proper channels to direct questions regarding patient safety in this clinical area.		
10. I receive appropriate feedback about my performance.		
11. In this clinical area, it is difficult to discuss errors.		✓
12. I am encouraged by my colleagues to report any patient safety concerns I may have.		
13. The culture in this clinical area makes it easy to learn from the errors of others.		
14. I like my job.	JS	
15. Working here is like being part of a large family.		
16. This is a good place to work.		
17. I am proud to work in this clinical area.		
18. Morale in this clinical area is high.		
19. When my workload becomes excessive, my performance is impaired.	SR	✓
20. I am less effective at work when fatigued.		✓
21. I am more likely to make errors in tense or hostile situations.		✓
22. Fatigue impairs my performance during emergency situations (e.g. emergency resuscitation, seizure).		✓
23. Management supports my daily efforts.	PM	
24. Management doesn't knowingly compromise patient safety.		
25. Management is doing a good job.		
26. Problem personnel are dealt with constructively by our management.		
27. I get adequate, timely info about events that might affect my work, from management.		
28. The levels of staffing in this clinical area are sufficient to handle the number of patients.	WC	
29. This hospital does a good job of training new personnel.		
30. All the necessary information for diagnostic and therapeutic decisions is routinely available to me.		
31. Trainees in my discipline are adequately supervised.		
32. I experience good collaboration with nurses in this clinical area.	No domain	
33. I experience good collaboration with staff physicians in this clinical area.		
34. I experience good collaboration with pharmacists in this clinical area.		
35. Communication breakdowns that lead to delays in delivery of care are common.		✓
36. My suggestions about safety would be acted upon if I expressed them to management.		

JS, Job satisfaction; PM, Perceptions of management; SC, Safety culture; SR, Stress recognition; TW, Teamwork; WC, Working conditions.

**Supplementary Table 5**

Cronbach's Alpha and Goodness-of-Fit Confirmatory Factor Analysis

Subscale	Cronbach Alpha (>0.7)	Confirmatory Factor Analysis Model-Fit Indices		
		CFI (>0.9)	RMSEA (<0.06)	SRMSR (<0.08)
HADS				
Depression	0.830	0.976	0.061	0.029
Anxiety	0.865	0.982	0.059	0.024
OLBI				
Disengagement	0.825	0.906	0.111	0.055
Exhaustion	0.833	0.929	0.097	0.057
SAQ				
Teamwork	0.859	0.994	0.038	0.016
Safety climate	0.812	0.988	0.047	0.021
Job satisfaction	0.892	0.981	0.105	0.025
Stress recognition	0.843	0.976	0.139	0.028
Perception of management	0.801	0.995	0.043	0.015
Working condition	0.768	0.990	0.078	0.019

CFI, comparative fit indices; HADS, Hospital Anxiety and Depression Scale; OLBI, Oldenburg Burnout Inventory; RMSEA, root mean square error of approximation; SAQ, Safety Attitudes Questionnaire; SRMSR, standardized root mean square residual.