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Original Study

Burnout and Associated Factors Among Health Care Workers in Singapore During the COVID-19 Pandemic

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ABSTRACT

Objectives: The strain on health care systems due to the COVID-19 pandemic has led to increased psychological distress among health care workers (HCWs). As this global crisis continues with little signs of abatement, we examine burnout and associated factors among HCWs.
Design: Cross-sectional survey study.
Setting and Participants: Doctors, nurses, allied health professionals, administrative, and support staff in 4 public hospitals and 1 primary care service in Singapore 3 months after COVID-19 was declared a global pandemic.
Methods: Study questionnaire captured demographic and workplace environment information and comprised 3 validated instruments, namely the Oldenburg Burnout Inventory (OLBI), Safety Attitudes Questionnaire (SAQ), and Hospital Anxiety and Depression Scale (HADS). Multivariate mixed model regression analyses were used to evaluate independent associations of mean OLBI-Disengagement and -Exhaustion scores. Further subgroup analysis was performed among redeployed HCWs.
Results: Among 11,286 invited HCWs, 3075 valid responses were received, giving an overall response rate of 27.2%. Mean OLBI scores were 2.38 and 2.50 for Disengagement and Exhaustion, respectively. Burnout thresholds in Disengagement and Exhaustion were met by 79.7% and 75.3% of respondents, respectively. On multivariate regression analysis, Chinese or Malay ethnicity, HADS anxiety or depression scores ≥ 8, shifts lasting ≥ 8 hours, and being redeployed were significantly associated with higher OLBI mean scores, whereas high SAQ scores were significantly associated with lower scores. Among redeployed HCWs, those redeployed to high-risk areas in a different facility (offsite) had lower burnout scores than those redeployed within their own work facility (onsite). A higher proportion of HCWs redeployed offsite assessed their training to be good or better compared with those redeployed onsite.
Conclusions and Implications: Every level of the health care workforce is susceptible to high levels of burnout during this pandemic. Modifiable workplace factors include adequate training, avoiding

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The authors declare no conflicts of interest.
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prolonged shifts ≥8 hours, and promoting safe working environments. Mitigating strategies should target every level of the health care workforce, including frontline and nonfrontline staff. Addressing and ameliorating burnout among HCWs should be a key priority for the sustainment of efforts to care for patients in the face of a prolonged pandemic.

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The first COVID-19 case was reported in Singapore on January 23, 2020, and by April 3, 2020, stay-at-home orders, locally termed "circuit breaker" measures, were instituted whereby work-from-home arrangements were encouraged and schools and nonessential services such as dining, retail, and entertainment establishments were closed for approximately 2 months. Nonurgent medical care was reduced wherever possible to redeploy health care resource towards surge capacity and frontline units such as the emergency department, inpatient pandemic, and intensive care units.[1]

Although "circuit breaker" measures sharply curbed community spread, major outbreaks emerged within migrant worker accommodations.[2] Work permit holders in Singapore constitute approximately 1 million of a total population of 5.7 million residents.[2,3] Most semi-skilled workers involved in the construction, shipbuilding, and manufacturing industries are housed in dormitory-style accommodations regulated by the government,[4] which house between 3000 and 25,000 residents and feature communal living and various shared facilities, including laundry, recreation, eating, and groceries. In spite of our migrant workers comprising only 5% of Singapore's resident population, outbreaks among dormitory residents have contributed toward 95% of Singapore's total number of cases.[5] Possible reasons include the usage of shared facilities, which make social distancing and isolation challenging.[2] Forward Assurance and Support Teams (FAST) were deployed at each of the 43 purpose-built dormitories and several other similar housing facilities.[6] These included onsite medical facilities[7] staffed by health care workers (HCWs) redeployed from public health care institutions and supplemented by private health care groups and volunteers. Other sites of HCW redeployment were Community Care and Swab Isolation facilities which were set up to isolate and care for clinically-well cases (potential- or proven-COID-19 positivity) who do not require inpatient care.[8]

Pandemics impose immense psychological burden on health care staff due to a mix of workplace stressors and personal fears. A meta-analysis[9] showed that when comparing high- versus low-risk exposure groups, the odds ratio for acute or posttraumatic stress (PTS) and psychological distress was 1.71 and 9.94, respectively. Similar findings were seen in the SARS outbreak of 2003[10–13] when emotional distress, depression, and anxiety occurred more frequently among frontline HCWs. Burnout is a syndrome caused by chronic workplace stress and, according to Maslach and Jackson,[14] consists of 3 dimensions: emotional exhaustion, depersonalization, and feelings of reduced personal accomplishment. Burnout in HCWs has consistently shown a dose-response relationship with poorer patient safety outcomes.[15,16] It has been associated with anxiety, depression, marital stress, early retirement, substance abuse, and suicide among HCWs.[17–19] Of note, burnout among HCWs during a pandemic is not fully understood, especially with regard to different facets of the work environment and concomitant psychological responses, such as anxiety and depression.

Pandemics require HCWs to sustain a period of heightened workload under stressful conditions, rapidly changing guidelines and redeployment to unfamiliar, high-risk settings[20] while evoking fears of passing infection to loved ones.[13] Although Singapore has reported only 27 COVID-19 mortalities at the time of writing this article,[5] high per capita case load has necessitated a rapid redeployment of HCWs to FAST teams to staff medical posts under physically demanding conditions, such as under tentage in full personal protective equipment (PPE) amid Singapore's hot and humid climate with daytime temperatures reaching 35°C. At 6 months into this pandemic and no clear end in sight, we hypothesize that there would be a high level of burnout among HCWs that may be associated with changes in working environment including redeployment and workplace safety as well as anxiety and depression.

Methods

We conducted a multicenter, cross-sectional survey study whereby a questionnaire was distributed to doctors, nurses, allied health care professionals (AHPs), administrative or managerial staff, and support staff across 4 public hospitals involved in the care of COVID-19 cases (bed capacities of approximately 300, 700, 1200, and 2000 beds, respectively) and a public primary health care service from May 29 to June 24, 2020 (Supplementary Table 1). This was approximately 4 months from Singapore's first case and 2 months since the institution of national stay-at-home measures to curb COVID-19 spread. Support staff comprised nonclinical employees who were involved in the operations of the hospital such as porters, cleaners, laboratory technicians, and security staff. This questionnaire was voluntary, anonymous, worded in English, and distributed via corporate e-mail accounts using a secure, online questionnaire platform FormSG (GovTech, Singapore). As English is the standard operating language in Singapore, no literacy issues were encountered. The questionnaire captured basic demographic and workplace environment information and responses to 3 validated questionnaires: The Safety Attitudes Questionnaire (SAQ), Oldenburg Burnout Inventory (OLBI), and Hospital Anxiety and Depression Scale (HADS). We grouped respondents by categories such as (1) HCW roles, (2) Sex, (3) Ethnicity, (4) Redeployment outside primary roles, (5) Being tested for COVID-19, (6) Primary site of work, (7) Educational status, and (8) Average duration of shift during the pandemic (compared with routine 8- to 10-hour shifts during nonpandemic periods).

As redeployed HCWs constituted a large proportion of our health care workforce, we performed a subgroup analysis whereby this group was further divided 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).

Oldenburg Burnout Inventory

The OLBI is a 16-item validated tool to assess burnout[21] (Supplementary Table 2) covering 2 dimensions: Exhaustion and Disengagement. Disengagement refers to distancing oneself from the objects and content of one's work while exhaustion refers to feelings of emptiness, overwork, a strong need for rest, and physical exhaustion. Each dimension consists of 8 items rated on a 4-point Likert scale with options including "Strongly disagree," "Disagree," "Agree," and "Strongly agree" with 4 points for the highest burnout response and 1 point for the lowest. The means and SDs were calculated for each domain and compared across baseline respondent characteristics. Burnout was determined with a cutoff of ≥2.25 for Exhaustion and

≥2.10 for Disengagement, which correlates with physical symptoms[22] and has been used in recent studies[23,24] to determine the extent of burnout. The OLBI offers advantages over the commonly used Maslach Burnout Inventory, as it uses both positively and negatively framed questions for each domain, which reduces the risk of artefactual relationships[25] and acquiescence response biases,[26] thus making it a superior psychometric scale.[21,27] The OLBI has been validated for use in a variety of populations and settings.[28–30]

The Safety Attitudes Questionnaire

The SAQ[31] (Supplementary Table 3) has been validated for different languages, HCW roles, and health care settings,[32,33] and consists of questions covering 6 patient safety domains of teamwork climate, safety climate, perceptions of management, job satisfaction, working conditions, and stress recognition. These items are scored on a 5-point Likert scale with options including "Strongly Disagree," "Disagree," "Neutral," "Agree," and "Strongly Agree." A higher score reflects better safety attitudes. Although the full SAQ comprises 60 questions, each validated version includes the same 30 core questions with additional relevant questions. As this survey was disseminated to HCWs in both clinical and nonclinical roles, respondents had the option to omit domains that were not applicable to them, as some of these domains only applied to clinical situations. A Safety Culture Score was calculated for each domain[31,34]:

(Mean value of item scores within a domain − 1) × 25

Thus, a score of "1" is transformed to "0," "2" to "25," "3" to "50," "4" to "75," and "5" to "100." A score of ≥75 is a "Percentage Agree" for that domain and a "Percentage Agree Rate" is the proportion of respondents with a "Percentage Agree." Conversely, a score of ≤50 represented "Percentage Disagree."

The Hospital Anxiety and Depression Scale

The HADS[35] is a self-reported questionnaire evaluating Depression and Anxiety with 7 items each (Supplementary Table 4). Each item is rated on a 4-point Likert scale scored as 0, 1, 2, and 3. A score of ≤7 is normal, 8 to 10 is borderline abnormal, and ≥11 is abnormal. We deemed a score of ≥8 or more to signify risk of depression and/or anxiety.

Outcomes

Our primary outcome measure was OLBI mean scores. Secondary outcomes measured included burnout rates based on OLBI-D ≥2.10 and OLBI-E ≥2.25, SAQ Percentage Agree Rates overall and for each domain and proportion of HCWs with a score of ≥8 for HADS-Anxiety and -Depression.

Statistics

Analyses were performed using SPSS 26.0 (IBM Corp, Armonk, NY) with statistical significance set as $P < .05$.

Cronbach's alpha was presented to show the internal consistency of each questionnaire where an α > 0.7 suggested good reliability. Confirmatory factor analysis was also performed to assess the goodness of fit of the data on the instruments used. Root mean square error of approximation (RMSEA < 0.06), Comparative Fit Indices (CFI ≥0.90) and Standardized Root Mean Square Residual (SRMSR < 0.08) were presented.[36]

OLBI scores in each of the subscales, that is, disengagement and exhaustion, were used as continuous variables and described using the mean and SD. Crude and adjusted predictors (demographic and workplace characteristics as well as HADS and SAQ domain scores) for

the OLBI scores were performed using mixed linear models with institution as a random effect.

Ethics

Funding

Results

Survey Responses

Among 11,286 invited HCWs, we received 3075 valid responses, which constituted complete demographic and workplace information, OLBI scores, and HADS scores, giving an overall response rate of 27.2%. Although respondents could omit SAQ domain questions that were not appropriate to their work, 94.3% completed at least 1 SAQ domain and 62.7% completed all 6 domains. Table 1 shows the demographic characteristics. Women comprised 71.5% and HCWs of Chinese ethnicity comprised 53.3% with the remainder being of Malay, Indian, and Other ethnicities in roughly equal proportions. Doctors, nurses, AHPs, support staff, and administrative staff comprised 14.9%, 45.3%, 15.7%, 16.0%, and 8.0% of respondents, respectively, with response rates within each HCW role of 38.6%, 31.1%, 23.1%, 23.4%, and 17.5%, respectively.

Internal Consistency and Internal Construct Validity

In our study, the Cronbach's alpha for each subscale was good to excellent: OLBI-Exhaustion (α = 0.80) and Disengagement (α = 0.83), HADS Depression (α = 0.80) and Anxiety (α = 0.84), and SAQ Teamwork (α = 0.86), Safety Culture (α = 0.83), Job Satisfaction (α = 0.91), Perceptions of Management (α = 0.83), Stress Recognition (α = 0.83), and Working Conditions (α = 0.83). Goodness of fit indices for most subscales demonstrated a good model fit (Supplementary Table 5).

Scale Scores

In our study population, the scores for each scale are seen in Table 1. The average OLBI scores were 2.38 and 2.50 for Disengagement and Exhaustion, respectively. Burnout thresholds were met by 79.7% and 75.3% of respondents for Disengagement and Exhaustion, respectively, with 86.8% meeting thresholds for either and 68.2% for both. The mean Disengagement scores were highest for administrative staff (2.46) and lowest for support staff (2.32), whereas mean Exhaustion scores were highest for nurses (2.52) and lowest for support staff (2.44), although there was no significant difference in scores among HCW roles (see Table 2 and Figure 1). Mean HADS Depression and Anxiety scores were 5.7 and 6.9, respectively. Average Total SAQ Percentage Agree Rate was 25.9% with the lowest domain being Stress Recognition (8.2%) and highest, Teamwork (55.9%).

Multivariate Mixed Model Regression Analysis

On mixed model regression analysis with institution as random effects (Table 2), gender, site of work, and being tested for COVID-19 did not have significant differences in OLBI scores, although female

Table 1
Respondent Demographics, Work Environment Characteristics, and Baseline Measures of Emotional Well-Being (n = 3075)

Age, y, Mean (SD)	36.84 ± 9.95
	n (%)
Total	3075
Sex	
Female	2199 (71.5)
Male	794 (25.8)
Not stated	82 (2.7)
Ethnicity	
Chinese	1608 (53.3)
Malay	401 (13.0)
Indian	410 (13.3)
Others: Filipino, Burmese, Eurasian, white, Vietnamese	506 (16.5)
Not stated	150 (4.9)
Role	
Doctor	458 (14.9)
Nurse	1394 (45.3)
Allied health professional	483 (15.7)
Support staff: cleaners, porters, technicians, security	491 (16.0)
Administrative and managerial	247 (8.0)
Not stated	2 (0.1)
Education level*	
College degree and above	2132 (69.3)
Pre-university (ie, associate degrees, 'A' levels, technical colleges)	699 (22.7)
Secondary or below	241 (7.9)
Not specified	3 (0.1)
Redeployed	558 (18.1)
Not redeployed	2534 (82.4)
Within hospital, low risk	140 (25.1)
Within hospital, high risk	245 (43.9)
Outside of hospital	156 (28.0)
Current primary place of work	
Healthcare facility with COVID-19 cases	2442 (79.5)
Healthcare facility without COVID-19 case	329 (10.7)
Migrant worker dormitory or community care	90 (2.9)
Work from home	201 (6.5)
Tested for COVID-19	
Yes	527 (17.2)
No	
Average duration of your shift or daily work hours?	
Less than 8 hours	299 (9.7)
8−12 hours	2462 (80.1)
12 hours or more	314 (10.2)

Scales	Mean (SD)	Meeting Threshold, n (%)
Oldenburg Burnout Inventory (OLBI) (n = 3075)*		
Disengagement	2.38 (0.46)	2452 (79.7)
Exhaustion	2.50 (0.47)	2315 (75.3)
Meeting threshold for either Disengagement or Exhaustion		2670 (86.8)
Meeting threshold for both Disengagement and Exhaustion		2097 (68.2)
Hospital Anxiety and Depression Scale (HADS) (n = 3075)†		
Depression	5.7 (3.9)	979 (31.8)
Anxiety	6.9 (4.0)	1253 (40.7)
Meeting threshold for both Depression and Anxiety		716 (23.3)
Safety Attitudes Questionnaire (SAQ)		Percentage Agree Rate,‡ n (%)
Total mean (n = 1931)	64.0 (15.3)	501 (25.9)
Teamwork (n = 2479)	74.4 (18.8)	1386 (55.9)
Safety climate (n = 2525)	72.3 (18.1)	1329 (52.7)
Stress recognition (n = 2501)	31.5 (25.7)	205 (8.2)
Job satisfaction (n = 2725)	74.6 (22.3)	1613 (59.2)
Perceptions of Management (n = 2633)	64.1 (20.0)	932 (35.4)
Working conditions (n = 2428)	66.2 (20.8)	1030 (42.4)

*Thresholds for deeming burnout for (1) OLBI-Disengagement ≥ 2.10 and (2) OLBI-Exhaustion ≥ 2.25.

†Thresholds for deeming risk of anxiety or depression for HADS was ≥8 in either subscale.

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

gender approached significance for Exhaustion ($P = .051$). HCWs of Malay and Chinese ethnicities had significantly higher OLBI scores compared with HCWs of Indian ethnicity. Degree holders had significantly higher OLBI scores than HCWs with secondary or lower educational qualifications. Shifts lasting ≥8 hours were associated with significantly higher Exhaustion scores. HADS scores ≥8 for either depression or anxiety were strongly associated ($P ≤ .001$) with significantly higher OLBI scores. Respondents with a Percentage Agree for any of the SAQ domains had significantly lower Disengagement score. For Exhaustion, this relationship was seen with all SAQ domains except Teamwork and Safety Climate. Redeployment was also associated with significantly higher Exhaustion and Disengagement scores and underwent further subgroup analysis.

Redeployed Subgroup Analysis

A total of 486 (15.8%) HCWs in clinical roles (ie, doctors, nurses, and AHPs) were redeployed. Among redeployed HCWs, the mean Disengagement and Exhaustion scores were 2.45 and 2.55, respectively, both being significantly higher than in non-redeployed HCWs at 2.37 and 2.50 (Table 3), respectively. Among the 3 redeployment groups, that is, (1) Onsite (low risk), (2) Onsite (high risk), and (3) Offsite, a paradoxical but statistically significant relationship was demonstrated in which HCWs redeployed offsite had the lowest Disengagement and Exhaustion scores (2.31 and 2.44) followed by non-redeployed (2.37 and 2.48) and redeployed onsite (low risk 2.49 and 2.62, high risk 2.51 and 2.61). In addition, SAQ Percentage Agree Rates for each domain were highest among HCWs redeployed offsite with significantly higher rates seen for Job Satisfaction and Perceptions of Management. On multivariate analysis, factors that were strongly correlated with high OLBI scores included redeployment onsite (especially high risk), training assessed to be neutral or worse, shift duration ≥8 hours (Table 4).

Discussion

The few studies conducted on burnout among HCWs in Singapore have mostly used the Maslach Burnout Inventory and note burnout rates ranging from 40% to 60%.[37−40] The only pre-pandemic study in Singapore using OLBI involved 37 mental health HCWs and showed mean Exhaustion and Disengagement scores of 2.38 and 2.25,[41] respectively, which is lower than this study's 2.50 and 2.38. Our study is unique in comparing burnout against SAQ as a surrogate for workplace safety environment during a pandemic among other variables and did so at a timely juncture of 4 months after Singapore's first case and 2 months after instituting major changes to the public health system to combat COVID-19.

Demographic factors that were significantly associated with burnout included ethnicity and educational level. HCWs of Malay and Chinese ethnicities had higher burnout scores than those of Indian or other ethnicities. This has been noted in other studies in Malaysia[42] and Singapore[38] where Chinese and Malays constitute the 2 largest ethnic groups. This may be influenced by religio-cultural factors in ways that are not yet fully understood. Higher educational status was associated with higher burnout, as it is likely associated with seniority in health care and thus greater responsibilities. In our study, women had higher Exhaustion scores, which is consistent with other studies[43,44] and may be due to greater susceptibility to work-family role conflict[45] that interacted with other factors, such as longer work hours, fears of infecting loved ones,[13] and significant travel restrictions limiting female migrant HCWs' return to their families.[46,47] In our study, female-dominated HCW roles included nurses (88.4%), AHPs (73.7%), and administrative (71.1%), whereas doctors and support staff had a roughly equal divide (48.5% and 55.4%, respectively). Nevertheless, after adjusting for factors such as gender, multivariate

Table 2
Multivariate Analysis for Total Study Population (n = 3075) Using OLBI-Disengagement and -Exhaustion Scores as Dependent variables

Covariates	n (%)*	OLBI-Disengagement			OLBI-Exhaustion		
		Mean (SD)	Adjusted		Mean (SD)	Adjusted	
			b (95% CI)	P Value		b (95% CI)	P Value
Gender							
Female	2199 (73.4)	2.38 (0.44)	−0.02 (−0.05 to 0.05)	.383	2.51 (0.46)	0.03 (0.00 to 0.07)	.051
Male	794 (26.5)	2.34 (0.44)	ref		2.42 (0.49)	ref	
Ethnicity							
Overall				**<.001**			**<.001**
Chinese	1508 (53.4)	2.43 (0.47)	0.10 (0.06 to 0.14)	<.001	2.51 (0.48)	0.08 (0.04 to 0.12)	<.001
Malay	401 (14.2)	2.40 (0.46)	0.06 (0.01 to 0.11)	.026	2.54 (0.46)	0.08 (0.03 to 0.13)	.002
Indian	410 (14.5)	2.23 (0.42)	ref		2.36 (0.46)	ref	
Others	505 (17.9)	2.27 (0.38)	0.01 (−0.04 to 0.05)	.851	2.41 (0.42)	0.02 (−0.03 to 0.07)	.397
Role							
Overall				**.027**			.157
Doctor	458 (14.9)	2.33 (0.52)	−0.03 (−0.08 to 0.03)	.093	2.45 (0.52)	−0.02 (−0.07 to 0.04)	.625
Nurse	1394 (45.4)	2.39 (0.43)	0.01 (−0.03 to 0.06)	.570	2.52 (0.46)	0.05 (−0.04 to 0.05)	.849
Support	491 (16.0)	2.32 (0.43)	ref		2.44 (0.44)	ref	
Administrative	247 (8.04)	2.46 (0.50)	0.07 (−0.01 to 0.16)	.089	2.47 (0.48)	−0.05 (−0.13 to 0.04)	.306
Allied health	483 (15.7)	2.41 (0.48)	0.03 (−0.03 to 0.08)	.372	2.53 (0.49)	0.02 (−0.03 to 0.08)	.447
Education							
Overall				**.042**			**.009**
Degree	2132 (69.4)	2.38 (0.48)	0.08 (0.02 to 0.14)	.031	2.50 (0.47)	0.10 (0.04 to 0.16)	.001
Diploma	699 (22.8)	2.42 (0.47)	0.06 (−0.001 to 0.12)	.053	2.54 (0.48)	0.09 (0.03 to 0.16)	.003
Secondary	241 (7.85)	2.28 (0.35)	ref		2.37 (0.42)	ref	
Site of Work							
Overall				.156			.491
At hospital/polyclinic	2771 (90.2)	2.38 (0.46)	0.002 (−0.07 to 0.08)	.963	2.50 (0.47)	−0.02 (−0.10 to 0.05)	.551
In community†	100 (3.26)	2.28 (0.45)	ref		2.40 (0.47)	ref	
Work from home	201 (6.54)	2.40 (0.46)	−0.06 (−0.16 to 0.09)	.275	2.48 (0.50)	−0.07 (−0.17 to 0.03)	.194
Tested for COVID-19							
Yes	527 (17.1)	2.33 (0.43)	ref		2.47 (0.44)	ref	
No	2548 (82.9)	2.39 (0.46)	0.04 (−0.003 to 0.07)	.069	2.50 (0.48)	0.03 (−0.01 to 0.07)	.125
Duration of shift							
Overall, h				.169	2.33 (0.46)		**<.001**
< 8	299 (9.72)	2.29 (0.43)	ref		2.33 (0.46)	ref	
8 to < 12	2462 (80.1)	2.38 (0.45)	0.002 (−0.09 to 0.04)	.915	2.49 (0.46)	0.06 (0.01 to 0.10)	.015
≥ 12	314 (10.2)	2.49 (0.52)	0.04 (−0.002 to 0.09)	.059	2.69 (0.50)	0.16 (0.10 to 0.23)	<.001
Redeployed							
Yes	558 (18.1)	2.45 (0.46)	0.08 (0.04 to 0.11)	<.001	2.55 (0.48)	0.04 (0.01 to 0.08)	.020
No	2517 (81.9)	2.37 (0.45)	ref		2.48 (0.47)	ref	
Hospital Anxiety and Depression Scale							
Depression							
Yes: score ≥ 8	979 (31.8)	2.67 (0.48)	0.19 (0.15 to 0.22)	<.001	2.82 (0.44)	0.23 (0.19 to 0.62)	<.001
No: score <8	2095 (68.2)	2.25 (0.39)	ref		2.34 (0.41)	ref	
Anxiety							
Yes: score ≥ 8	1253 (40.7)	2.60 (0.45)	0.14 (0.11 to 0.17)	<.001	2.78 (0.42)	0.25 (0.22 to 0.28)	<.001
No: score <8	1822 (59.3)	2.23 (0.40)	ref		2.30 (0.40)	ref	
Safety Assessment Questionnaire							
Teamwork							
Percentage agree	1583 (56.7)	2.22 (0.40)	−0.05 (−0.08 to −0.01)	.013	2.36 (0.43)	−0.02 (−0.06 to 0.01)	.192
Percentage disagree	1208 (43.3)	2.58 (0.46)	ref		2.69 (0.46)	ref	
Safety climate							
Percentage agree	1512 (53.5)	2.20 (0.38)	−0.04 (−0.08 to −0.01)	.021	2.33 (0.43)	−0.03 (−0.07 to 0.01)	.120
Percentage disagree	1314 (46.5)	2.59 (0.46)	ref		2.70 (0.45)	ref	
Job satisfaction							
Percentage agree	1715 (53.4)	2.17 (0.35)	−0.28 (−0.31 to −0.24)	<.001	2.32 (0.41)	−0.17 (−0.21 to −0.13)	<.001
Percentage disagree	1173 (40.6)	2.69 (0.43)	ref		2.77 (0.44)	ref	
Stress recognition							
Percentage agree	228 (7.94)	1.99 (0.39)	−0.20 (−0.25 to −0.15)	<.001	2.05 (0.42)	−0.26 (−0.31 to −0.21)	<.001
Percentage disagree	2642 (92.1)	2.42 (0.45)	ref		2.54 (0.46)	ref	
Perception of management							
Percentage agree	1059 (36.8)	2.16 (0.39)	−0.07 (−0.11 to −0.04)	<.001	2.27 (0.41)	−0.08 (−0.11 to −0.04)	<.001
Percentage disagree	1819 (63.2)	2.51 (0.45)	ref		2.63 (0.46)	ref	
Working conditions							
Percentage agree	1232 (44.8)	2.17 (0.37)	−0.07 (−0.10 to −0.03)	<.001	2.29 (0.41)	−0.09 (−0.12 to −0.05)	<.001
Percentage disagree	1517 (55.2)	2.54 (0.46)	ref		2.66 (0.46)	ref	

NOTE. Bold values are statistically significant ($P < .05$).
Mixed Model analysis with Institution as random effect. b = the linear regression estimate which reflects the difference in the OLBI Disengagement or Exhaustion score between groups.
  *Percentage was calculated as a percentage of valid responses for that covariate and placed in parentheses.
  †In community refers to Foreign worker dormitories, Community Care Facilities, or Swab Isolation Facilities.
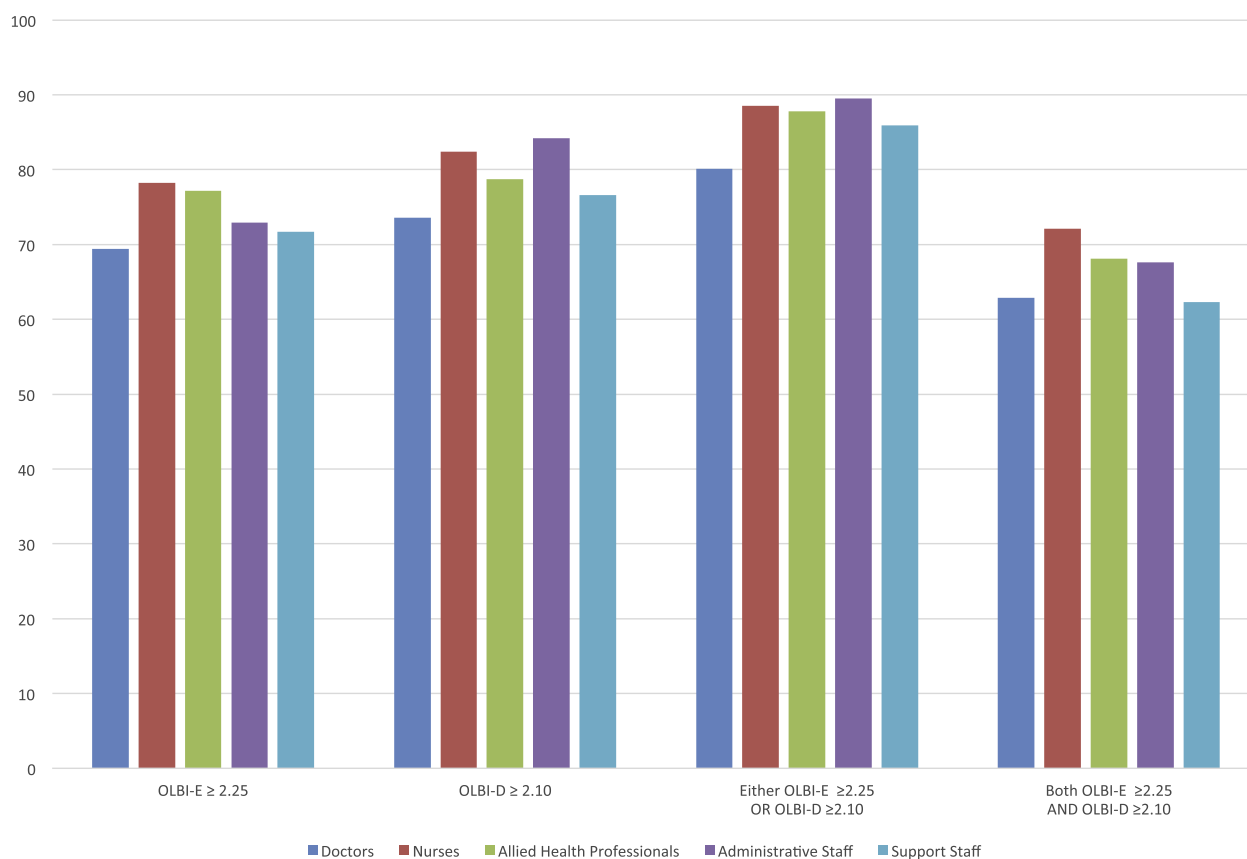
Fig. 1. Burnout rates based on OLBI-E and OLBI-D scores by HCW roles among the total study population (%).

analysis did not show significant difference in burnout between different HCW roles, although there was a nonsignificant trend toward higher exhaustion scores among nurses that has been observed in other studies.[48] Surprisingly, HCWs in administrative roles and those who work from home had relatively high disengagement scores, which may be linked to increased operational demands while switching to a different working environment at home. The observation that every strata of the health care workforce can be at risk of

increased psychological burden was also noted by Rossi et al.,[49] who found that nonfrontline HCWs had largely comparable psychological outcomes, such as anxiety, depression, insomnia, and perceived stress levels compared with frontline HCWs.

Various countries have had to redeploy HCWs during this pandemic,[20,50,51] but the effects of redeployment during a pandemic on HCW burnout have not been well studied. The paradoxically higher OLBI scores among HCWs redeployed onsite versus those redeployed

Table 3
Comparison of SAQ, OLBI, and Training Quality in Non-redeployed and Redeployed Clinical HCWs, That is, Doctors, Nurses, Allied Health Professionals

	Non-Redeployed n = 2534	Redeployed*			P Value
		Onsite (Low Risk) n = 122	Onsite (High Risk) n = 214	Offsite n = 123	
OLBI Score (Mean)					
Disengagement	2.37	2.49	2.51	2.31	<.001
Exhaustion	2.50	2.62	2.61	2.44	<.001
SAQ percentage agree rate (%)					
Teamwork	57.8	49.6	60.1	65.3	.081
Safety Culture	54.4	44.7	55.6	54.4	.201
Stress Recognition	7.9	3.2	7.6	6.4	.266
Job Satisfaction	58.6	46.4	56.1	72.8	<.001
Perceptions of Management	36.4	29.8	29.1	44.8	.012
Work Culture	42.6	31.5	42.6	45.6	.086
Total					
Individual assessment of training quality (%)					
Good or better		36.1	47.9	52.8	.002
Neutral or worse		38.5	41.9	32.0	
No training received		25.4	10.2	15.2	

*In our sample population, HCWs were redeployed to 1 of 3 areas: (1) within their own work facility with a low risk of COVID-19 contact, that is, Onsite (Low Risk), (2) within their own work facility with a high risk of COVID-19 contact, that is, Onsite (High Risk), or (3) different facility (foreign work dormitory, community care facility, swab isolation facility) with high risk of COVID-19 contact, that is, Offsite.

Table 4
Subgroup Analysis of Redeployed Clinical HCWs (n = 459), That Is, Doctors, Nurses, Allied Health Professionals Using Oldenburg Burnout Inventory (OLBI) Disengagement and Exhaustion Scores as Dependent Variables

	n	OLBI-Disengagement			OLBI-Exhaustion		
		Mean (SD)	b (95% CI)	*P* Value	Mean (SD)	b (95% CI)	*P* Value
Role				.772			.480
Doctor	114	2.43 (0.49)	ref		2.52 (0.56)	ref	
Nurse	308	2.45 (0.44)	0.02 (−0.09 to 0.11)	.846	2.59 (0.45)	0.07 (−0.05 to 0.16)	.268
Allied Health	48	2.48 (0.50)	0.05 (−0.10 to 0.21)	.480	2.58 (0.49)	0.06 (−0.09 to 0.24)	.349
Redeployed* to				**.001**			**.009**
Onsite (low risk)	125	2.49 (0.46)	0.18 (0.06 to 0.29)	.004	2.62 (0.47)	0.18 (0.05 to 0.29)	.007
Onsite (high risk)	221	2.51 (0.46)	0.20 (0.09 to 0.30)	<.001	2.61 (0.48)	0.17 (0.05 to 0.28)	.005
Offsite	124	2.31 (0.42)	ref		2.44 (0.48)	ref	
Individual assessment of training quality				**<.001**			**<.001**
Good or better	210	2.31 (0.41)	ref		2.44 (0.46)	ref	
Neutral or worse	177	2.59 (0.46)	0.28 (0.20 to 0.37)	<.001	2.69 (0.49)	0.25 (0.16 to 0.35)	<.001
No training received	72	2.56 (0.47)	0.25 (0.13 to 0.36)	<.001	2.68 (0.48)	0.24 (0.12 to 0.37)	<.001
Tested for COVID-19							
Yes	67	2.42 (0.53)	ref		2.57 (0.48)	ref	
No	403	2.46 (0.45)	0.04 (−0.10 to 0.16)	.477	2.59 (0.52)	0.02 (−0.16 to 0.10)	.633
Duration of shift, h				**.007**			**< .001**
< 8	53	2.27 (0.35)	ref		2.31 (0.43)	ref	
8 to < 12	358	2.46 (0.46)	0.19 (0.05 to 0.31)	.007	2.58 (0.47)	0.27 (0.13 to 0.40)	<.001
≥ 12	59	2.55 (0.47)	0.28 (0.09 to 0.43)	.002	2.70 (0.51)	0.39 (0.21 to 0.56)	<.001

NOTE. The bolded values have achieved pre-determined levels statistical significance amongst components of each subcategory.
Mixed model with Institution as random effects performed.
*In our sample population, HCWs were redeployed to 1 of 3 areas: (1) within their own work facility with a low risk of COVID-19 contact, that is, Onsite (Low Risk), (2) within their own work facility with a high risk of COVID-19 contact, that is, Onsite (High Risk), or (3) different facility (foreign work dormitory, community care facility, swab isolation facility) with high risk of COVID-19 contact, that is, Offsite.

offsite and non-redeployed, challenged our hypothesis that unfamiliar work environments under physically demanding conditions[52,53] would cause more burnout. Possibly, HCWs redeployed onsite worked with sicker patients compared with those being redeployed offsite within a community setting. Unfortunately, our study did not capture the details and complexities of care within each area of redeployment. A significantly greater proportion of HCWs redeployed offsite rated their training as good or better (52.8%) versus those redeployed onsite (36.1%–47.9%). This was strongly associated with lower OLBI scores and underscores the importance of effective pre-deployment preparation. Many of the HCWs redeployed offsite were volunteers, unlike HCWs who were redeployed onsite, often out of operational necessity or closure of nonessential services. This may contribute to the higher Job Satisfaction and Perceptions of Management Percentage Agree Rates among HCWs redeployed offsite. Altruism[12,54,55] and camaraderie that developed even under stressful conditions[56] may be protective. During the SARS outbreak, Tam et al.[11] noted that the odds ratio of having psychiatric morbidity (defined as "case" under General Health Questionnaire) was highest in unwilling HCWs followed by HCWs without objections and last willing HCWs. Hu et al.,[57] however, noted that although staff dispatched voluntarily from elsewhere to Wuhan had significantly lower emotional exhaustion scores, they had significantly higher depersonalization scores compared with those assigned there. Finally, the strong association between high SAQ Percentage Agree Rates and low OLBI scores highlight the importance of a supportive work safety environment in reducing burnout.[9–11,13]

Limitations to this study include the lack of a comparable pre-pandemic health care workforce burnout for direct comparison. Meaningful comparisons between different study populations can also be challenging due to adoption of different rating tools and burnout criteria in different studies and varying cultural acceptance of workplace factors. There also may be a sampling bias, as overworked HCWs may be too busy to respond to this questionnaire. However, we have attempted to mitigate this through 3 rounds of e-mails and managed to obtain a representative cross-section of the health care

workforce.[58,59] Finally, the citizenship status of HCWs was not captured. In the background of travel bans and quarantine requirements during the pandemic, prolonged time away from family and reduced domestic support may also be an independent risk factor for burnout.

Conclusions and Implications

Our study highlights that every level of the health care workforce is susceptible to burnout. Mitigating strategies should be deployed to both front- and second-line HCWs. Women and HCWs redeployed onsite, especially where involuntary or involving complex medical care, need special attention. This includes female-dominated HCW roles, such as nursing, AHPs, and administrative staff within our health care workforce. Modifiable workplace factors include adequate training, avoiding prolonged shifts ≥8 hours and promoting safe working environments. Future interpandemic strategies include codifying best practices in clinical care and human resource management in preparation for future pandemics as well as continual training and accreditation in infectious disease-relevant skills such as PPE usage. Coping strategies should be taught during and in-between pandemics to reduce the onset and effects of burnout as a continual priority in sustaining patient-care efforts.

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Supplementary Table 1
Health Care Institutions That Were Included in This Study

Health Institution	Address	Bed Capacity	COVID-19 Cases at Any 1 Time During Study Period	Number of Health Care Workers Invited
National University Hospital	5 Lower Kent Ridge Rd, Singapore 119074	1200 beds	50—100	4747
Ng Teng Fong General Hospital	1 Jurong East Street 21, Singapore 609606	700 beds	50—100	2452
Alexandra Hospital	378 Alexandra Rd, Singapore 159964	300 beds	50—100	815
Institute of Mental Health	10 Buangkok View, Buangkok Green Medical Park, Singapore 539747	2000 beds	1—25	2486
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			786

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
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 (ie, 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 (eg, 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 4
Hospital Anxiety and Depression Scale

	Question	Domain	Responses and Score			
1.	I feel tense or "wound up"	A	Most of the time **3**	A lot of the time **2**	From time to time, occasionally **1**	Not at all **0**
2.	I still enjoy the things I used to enjoy	D	Definitely as much **0**	Not quite so much **1**	Only a little **2**	Hardly at all **3**
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 and 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

A, Anxiety; D, Depression.
0—7: Normal, 8—10: Borderline abnormal, 11—21: Abnormal

Supplementary Table 5
Cronbach's Alpha and Goodness-of-Fit Confirmatory Factor Analysis

Subscale	Cronbach's Alpha (> 0.7)	Confirmatory Factor Analysis Model-Fit Indices		
		CFI (>0.9)	RMSEA (< 0.06)	SRMSR (< 0.08)
Hospital Anxiety and Depression Scale				
Depression	0.80	0.96	0.066	0.033
Anxiety	0.84	0.99	0.047	0.020
Oldenburg Burnout Inventory				
Disengagement	0.80	0.89	0.059	0.112
Exhaustion	0.83	0.91	0.106	0.061
Safety Attitudes Questionnaire				
Team work	0.86	0.99	0.055	0.020
Safety climate	0.83	0.98	0.068	0.024
Job satisfaction	0.91	0.99	0.064	0.014
Stress recognition	0.83	0.98	0.122	0.026
Perception of management	0.83	0.99	0.051	0.015
Working condition	0.83	1.00	0.015	0.005

CFI, Comparative Fit Indices; RMSEA, Root Mean Square Error of Approximation; SRMSR, Standardized Root Mean Square Residual.