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Impacts and interactions of COVID-19 response involvement, health-related behaviours, health literacy on anxiety, depression and health-related quality of life among healthcare workers: a cross-sectional study

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ABSTRACT

Objectives We examined impacts and interactions of COVID-19 response involvement, health-related behaviours and health literacy (HL) on anxiety, depression, and health-related quality of life (HRQoL) among healthcare workers (HCWs).

Design A cross-sectional study was conducted. Data were collected 6 April to 19 April 2020 using online-based, self-administered questionnaires.

Setting 19 hospitals and health centres in Vietnam.

Participants 7 124 HCWs aged 21–60 years.

Results The COVID-19 response-involved HCWs had higher anxiety likelihood (OR (95% CI)=4.41 (3.53 to 5.51)), higher depression likelihood (OR(95% CI)=3.31 (2.71 to 4.05)) and lower HRQoL score (coefficient, b(95% CI)=−2.14 (−2.89 to −1.38)), compared with uninvolved HCWs. Overall, HCWs who smoked or drank at unchanged/increased levels had higher likelihood of anxiety, depression and lower HRQoL scores; those with unchanged/healthier eating, unchanged/more physical activity and higher HL scores had lower likelihood of anxiety, depression and higher HRQoL scores. In comparison to uninvolved HCWs who smoked or drank at never/stopped/reduced levels, involved HCWs with unchanged/increased smoking or drinking had lower anxiety likelihood (OR(95% CI)=0.34 (0.14 to 0.83)) or (OR(95% CI)=0.26 (0.11 to 0.60)), and lower depression likelihood (OR(95% CI)=0.33 (0.15 to 0.74)) or (OR(95% CI)=0.24 (0.11 to 0.53)), respectively. In comparison with uninvolved HCWs who exercised at never/stopped/reduced levels, or with those in the lowest HL quartile, involved HCWs with unchanged/increased exercise or with one-quartile HL increment reported lower anxiety likelihood (OR(95% CI)=0.50 (0.31 to 0.81)) or (OR(95% CI)=0.57 (0.45 to 0.71)), lower

depression likelihood (OR(95% CI)=0.40 (0.27 to 0.61)) or (OR(95% CI)=0.63 (0.52 to 0.76)), and higher HRQoL scores (b(95% CI)=2.08 (0.58 to 3.58)), or (b(95% CI)=1.10 (0.42 to 1.78)), respectively.

Conclusions Physical activity and higher HL were found to protect against anxiety and depression and were associated with higher HRQoL. Unexpectedly, smoking and drinking were also found to be coping behaviours. It is important to have strategic approaches that protect HCWs' mental health and HRQoL.

Strengths and limitations of this study

► Both research assistants and studied healthcare workers were vulnerable to COVID-19 infection.
► Hospitals, health centres, researchers and assistants were required to strictly follow the safety guidelines during data collection.
► Causality cannot be drawn from a cross-sectional design.
► Findings from a large studied sample can be generated to healthcare workers.
► Findings can be helpful for future studies and strategic interventions to contain the pandemic.

INTRODUCTION

The COVID-19 disease caused by the SARS-CoV-2 virus has been recognised as a global public health concern.[1–3] The pandemic posts a huge burden to all governments and healthcare systems worldwide.[4 5] It influences people's mental health and health-related quality of life (HRQoL)[6] and delays

access to the provision of care.[7] There is currently no specific antiviral treatment for COVID-19 and no available vaccine.[8] Therefore, prevention and supportive care are highly recommended.[9–14]

All nations' medical and public health workforces and response capacities have been mobilised to prevent COVID-19 from spreading.[15] High demand for healthcare facilities outstrips supply dilemmas,[16–20] especially in low-income and middle-income countries.[21] Affected countries have mobilised and reallocated resources to respond to the COVID-19 pandemic.[22–24] In addition, increases in healthcare professionals' absenteeism and malpractice due to the epidemic have been reported,[25] as have reassignment of healthcare personnel, and involvement of students in healthcare delivery during the pandemic.[22 23 26] This situation will not improve if medical facilities are not sufficiently equipped and workforces are not well prepared.[27]

Public health response measures including the social distancing and lockdown have been implemented to contain the COVID-19 pandemic. These measures have adverse psychological consequences such as fear, anxiety, depression.[28 29] As unfavourable mental health, outcomes may affect people's HRQoL. Therefore, these issues should be addressed as part of any pandemic response.[30–32]

While healthcare workers (HCWs) are at high risk of developing anxiety, depression, insomnia and distress, these risks are higher among HCWs in frontline settings and those exposed to COVID-19.[33 34] During the social distancing recommendations, the general public is urged to work and study remotely if possible. But because HCWs still have to commute to work and continue providing care, they are more likely to have psychological health problems.[35–38] HCWs need to stay calm, reassure the public and save lives.[39 40] They play an important role in monitoring and supporting patients' and families' psychological health.[38]

Early detection of mental health issues and interventions can help minimise COVID-19 infections and adverse psychological outcomes.[41–44] In order to develop strategies, it is critical to understand the status, sources and protective factors of anxiety, depression and HRQoL in healthcare professionals,[45] especially those involved in the COVID-19 response.[46] We thus examined the impacts and interactions of COVID-19 response involvement with lifestyles and health literacy (HL) on anxiety, depression and HRQoL among HCWs.

METHODS
Study design and settings
A cross-sectional study was conducted on HCWs. Data were collected 6 April to 19 April 2020 using online-based and self-administered questionnaires. The study participants were recruited from 15 hospitals and 4 health centres across Vietnam, including 11 hospitals and 1 health centre in the nation's northern provinces; 1 hospital and 1 health centre in the central Vietnam and 3 hospitals and 2 health centres in the southern provinces.

Study sample
We intentionally invited 19 hospitals and health centres to participate in our study. All HCWs received the announcement about the survey. All were invited to participate. A total sample of 7124 HCWs (out of 11 517 possible participants) aged 21–60 years completed the survey. table 1 lists numbers of studied and possible participants from each hospital and health centre.

Research instruments and assessments
Social demographics and clinical indicators
HCWs' information included age (years), gender (women vs men), marital status (never married vs ever married), ability to pay for medication (very difficult to very easy), body height (cm), weight (kg). Body mass index (kg/m^2) also was calculated. Social status (low, middle, high) was assessed by HCWs themselves based on education, career and salary. The high level when people have the most money, most education and most respected jobs, whereas the low level when people have the least money, least education, and least respected jobs or no job.

HCWs were asked whether they have been involved in healthcare interactions with other departments or facilities responding to the COVID-19 pandemic. In addition, HCWs' information includes type of healthcare personnel—job category (doctors, nurses or others) and type of care facility (non-frontline vs frontline), with frontline positions defined as those in outpatient departments, emergency departments, quarantine, isolation areas, medical imaging and laboratory diagnosis departments, patient administration areas. Respondents were also asked whether they had previous experience with epidemic containment (no vs yes).

HCWs also were asked to report suspected health problems similar to symptoms of COVID-19, named as suspected COVID-19 symptoms (S-COVID-19-S)[47]: common symptoms (fever, cough, dyspnoea), along with less common symptoms (myalgia, fatigue, sputum production, confusion, headache, sore throat, rhinorrhea, chest pain, haemoptysis, diarrhoea and nausea/vomiting). HCWs with any of those symptoms were classified as having S-COVID-19-S. The comorbidity was assessed using the items of the Charlson comorbidity index.[48 49] Finally, HCWs were asked about the pregnancy status, with men also asked whether their wives were pregnant.

Health-related behaviours
HCWs rated their current health-related behaviours compared with before the pandemic. Participants ranked their smoking, drinking and physical activity on a scale ranging from never to stopped, less, unchanged and more. Participants also rated their eating behaviour as less healthy, unchanged and healthier. We then categorised responses into two groups for analysis, for example, never/stopped/less versus unchanged/more for

Table 1 Study participants in different hospitals and health centres

Geographic location	Hospital/health centre	Possible participants	Studied participants
North			
Ha Noi	1. Military Hospital 103	1660	951
	2. E Hospital	1125	335
	3. General Hospital of Agricultural	555	424
	4. Thien An Obstetrics and Gynecology Hospital	68	63
Thai Nguyen	5. Thai Nguyen National Hospital	1186	988
Bac Ninh	6. Bac Ninh Obstetrics and Pediatrics Hospital	391	364
Hai Phong	7. Hai Phong University of Medicine and Pharmacy Hospital	319	316
	8. Kien An Hospital	659	483
	9. Kien Thuy District Health Center	271	271
Quang Ninh	10. Quang Ninh General Hospital	922	683
	11. Bai Chay Hospital	819	476
	12. Quang Ninh Obstetrics and Pediatrics Hospital	478	290
Centre			
Quang Tri	13. Trieu Phong District Health Center	271	203
Da Nang	14. Da Nang Oncology Hospital	555	134
South			
Ho Chi Minh	15. Tan Phu District Hospital	530	241
	16. Hospital District 2	812	318
	17. District 9 Health Center	170	102
	18. Thu Duc District Health Center	302	291
Can Tho	19. Can Tho University Of Medicine and Pharmacy Hospital	424	191
Total		11517	7124

smoking, drinking and doing physical activity; less healthy versus unchanged/healthier for eating behaviour.

Health literacy

HL was assessed using a short-form health literacy questionnaire of 12 items that has been validated and used in Asian countries,[50] including Vietnam.[6 51 52] HCWs rated their perceived difficulty of each item based on 4-point Likert scales from 1=very difficult to 4=very easy. The HL index score was standardised to an unified metric from 0 to 50 with higher score representing better HL[53] using the formula:

$$Index = (Mean - 1) \times (50/3) \quad (1)$$

Where Index is the specific index calculated, Mean is the mean of all participating items for each individual, 1 is the minimal possible value of the mean (leading to a minimum value of the index of 0), 3 is the range of the mean and 50 is the chosen maximum value.

Mental health

Anxiety was assessed using the Generalised Anxiety Disorder (GAD-7),[54] an efficient screening and assessment tool that has been validated in Vietnam.[55] HCWs were asked how often they had seven core symptoms in the previous 2 weeks, with 0='not at all', 1='several days', 2='more than half the days' and 3='nearly everyday'. As total GAD-7 scores range from 0 to 21, a GAD-7 score of ≥8 is considered as the optimal cut-off point for identifying anxiety disorder.[56 57]

Depression was assessed using a patient health questionnaire (PHQ)-9,[58] that has been validated and used in Vietnam.[6 59 60] HCWs were asked how often they had been bothered by nine symptoms during the previous 2 weeks on the same as anxiety above; with total PHQ-9 scores ranging from 0 to 27, a score of ≥10 is classified as depression.[58 61 62]

Health-related quality of life

The 36-Item Short Form Survey developed at Research and Development Corporation (RAND) as part of the Medical Outcomes Study was used to assess HRQoL.[63] This also has been used in previous Vietnamese studies.[6 64] The HRQoL score was calculated following the user manual.[65 66] The possible calculated scores range from 0 to a maximum of 100.

Data collection procedure

Research assistants (doctors, nurses and medical students) received a 4-hour training session on data collection by senior researchers at each hospital or health centre. The infection control training was also provided, for example, using masks, washing hands, positioning according to guidelines of the Centers for Disease Control and Prevention,[67] WHO[68] and Vietnam Ministry of Health.[10]

The online survey links were sent via text messages or emails to HCWs at most of the hospitals and health centres. Printed questionnaires were sent to HCWs for self-administration at the following institutions: 774 were returned from Military

Hospital 103; 56 from Thien An Obstetrics and Gynecology Hospital in Ha Noi; 316 from Hai Phong University of Medicine and Pharmacy Hospital, 483 from Kien An Hospital, 271 from Kien Thuy District Health Center in Hai Phong city; and 8 from Quang Ninh General Hospital in Quang Ninh Province. All available HCWs were invited to participate in the survey. Most respondents took 15–20 min to complete the questionnaires. Because all questions were marked as mandatory fields on the online survey, and printed questionnaires were double-checked by research assistants to make sure all questions were answered, there are no missing data. Responses were coded, cleaned and analysed by researchers confidentially.

Data analysis

Different variables' distribution was first explored using descriptive analysis. The distribution of HRQoL scores was checked for normality using a visual inspection of its histogram, normal Q-Q plot.[69] Second, the univariable and multivariable analyses were used to examine the determinants of anxiety, depression and HRQoL. Finally, we conducted the interaction analysis (using the interaction terms) to examine the effect modification of lifestyles and HL on the association of COVID-19 response involvement with anxiety, depression and HRQoL. The unadjusted model (model 1) was run with three terms including X1, X2 and interaction of X1*X2. X can be categorical independent variables (coded as 0 and 1 for eating behaviour, smoking, drinking, physical activity) or ordinal independent variable (with one quartile increment for HL). The adjusted model (model 2) was run with terms in model 1 and selected confounders. The univariable and multivariable logistic regression models were used for dichotomised-dependent variables (eg, anxiety and depression). The univariable and multivariable linear regression models also were used for the continuous dependent variable (eg, HRQoL). Factors that showed associations with anxiety, depression or HRQoL at $p<0.20$ in the univariable model were selected into the multivariable model. In addition, age and gender were forced into the multivariable models to avoid their residual confounding.[70] HL was analysed as 1 score increment in univariable and multivariable models and as 1 quartile increment in the univariable and multivariable interaction models. All statistical analyses were performed using the IBM SPSS V.20.0 (IBM, Armonk, New York, USA).[71] The significance level was set at a p value <0.05.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting or dissemination plans of our research.

RESULTS
Participants' characteristics

The mean age of HCWs was 34.4±8.8 years, with 20.9% aged between 41 and 60 years. Of the study sample, 33.8% were men, 49.3% were nurses, 28.8% were doctors, 21.9% were other HCWs. In all, 27.0% of the HCWs were involved in healthcare interactions with

other departments or healthcare facilities to respond to the COVID-19 pandemic. During the pandemic, the proportion of HCWs who had 'unchanged/healthier' eating behaviour and those reporting 'unchanged/more' smoking, drinking and physical activity was 95.7%, 3.6%, 4.0% and 61.6%, respectively. Their proportion of anxiety (GAD ≥8) and depression (PHQ ≥10) were 6.6% (473/7124) and 7.9% (561/7124), respectively (table 2). A visual inspection of histogram and normal Q-Q plot showed that HRQoL score was approximately normally distributed (online supplemental figure 1).

Associated factors of anxiety

In the multivariable analysis, the odds of anxiety were statistically significantly smaller in HCWs aged 41–60 years (OR, 0.58; 95% CI 0.42 to 0.78; p<0.001). They were also smaller for those stating they could very easily or fairly easily pay for medication (OR, 0.40; 95% CI 0.31 to 0.51; p<0.001), those who were nurses (OR, 0.58; 95% CI 0.43 to 0.77; p<0.001, reference group was 'others'), those with 'unchanged/healthier' eating behaviour (OR, 0.21; 95% CI 0.15 to 0.28; p<0.001), those with 'unchanged/more' physical activity (OR, 0.24; 95% CI 0.19 to 0.31; p<0.001) and those scoring 1 increment higher on HL (OR, 0.92; 95% CI 0.90 to 0.93; p<0.001) compared with counterparts (table 3).

The likelihood of anxiety was significantly greater in HCWs working at frontline areas (OR, 1.69; 95% CI 1.35 to 2.11; p<0.001), those involved in healthcare interactions in other departments or healthcare facilities (OR, 4.41; 95% CI 3.53 to 5.51; p<0.001) and those who reported 'unchanged/more' smoking (OR, 3.46; 95% CI 2.12 to 5.66; p<0.001) or 'unchanged/more' drinking (OR, 2.14; 95% CI 1.32 to 3.47; p=0.002) compared with counterparts (table 3).

Associated factors of depression

In the multivariable analysis, the odds of depression were statistically significantly smaller in HCWs aged 41–60 years (OR, 0.67; 95% CI 0.51 to 0.87; p=0.003), men (OR, 0.73; 95% CI 0.59 to 0.91; p=0.005), those who could pay for medication very or fairly easily (OR, 0.58; 95% CI 0.47 to 0.71; p<0.001), those who were nurses (OR, 0.60; 95% CI 0.46 to 0.78; p<0.001, reference group was 'others'), those with 'unchanged/healthier' eating behaviour (OR, 0.23; 95% CI 0.17 to 0.30; p<0.001) or 'unchanged/more' physical activity (OR, 0.36; 95% CI 0.29 to 0.44; p<0.001) and those with 1 score increment of HL (OR, 0.92; 95% CI 0.91 to 0.93; p<0.001) compared with counterparts (table 3).

The odds of depression were statistically significantly greater in HCWs who worked in frontline areas (OR, 1.48; 95% CI 1.21 to 1.81; p<0.001), who were involved in healthcare interactions in other departments or healthcare facilities (OR, 3.31; 95% CI 2.71 to 4.05; p<0.001) and who reported 'unchanged/more' smoking (OR, 3.11; 95% CI 1.99 to 4.84; p<0.001) or 'unchanged/

Table 2 Participants' characteristics and anxiety, depression and health-related quality of life

Variables	Total (n=7124) Frequency (%)	GDA <8 (n=6651) Frequency (%)	GDA≥8 (n=473) Frequency (%)	PHQ <10 (n=6563) Frequency (%)	PHQ ≥10 (n=561) Frequency (%)	HRQoL (n=7124) Mean±SD
COVID-19 response involvement*						
Not involved	5201 (73.0)	4989 (75.0)	212 (44.8)	4915 (74.9)	286 (51.0)	73.9±15.0
Involved	1923 (27.0)	1662 (25.0)	261 (55.2)	1648 (25.1)	275 (49.0)	71.7±15.9
Age, years						
21–40	5638 (79.1)	5228 (78.6)	410 (86.7)	5167 (78.7)	471 (84.0)	73.4±15.4
41–60	1486 (20.9)	1423 (21.4)	63 (13.3)	1396 (21.3)	90 (16.0)	72.9±15.0
Gender						
Women	4713 (66.2)	4412 (66.3)	301 (63.6)	4350 (66.3)	363 (64.7)	73.2±14.9
Men	2411 (33.8)	2239 (33.7)	172 (36.4)	2213 (33.7)	198 (35.3)	73.5±16.1
Marital status						
Never married	1574 (22.1)	1470 (22.1)	104 (22.0)	1449 (22.1)	125 (22.3)	73.0±15.6
Ever married	5550 (77.9)	5181 (77.9)	369 (78.0)	5114 (77.9)	436 (77.7)	73.4±15.2
Ability to pay for medication						
Very or fairly difficult	3744 (52.6)	3396 (51.1)	348 (73.6)	3373 (51.4)	371 (66.1)	71.7±15.7
Very or fairly easy	3380 (47.4)	3255 (48.9)	125 (26.4)	3190 (48.6)	190 (33.9)	75.1±14.6
Social status						
Low	972 (13.6)	907 (13.6)	65 (13.7)	900 (13.7)	72 (12.8)	69.7±16.5
Middle or high	6152 (86.4)	5744 (86.4)	408 (86.3)	5663 (86.3)	489 (87.2)	73.8±15.0
Type of healthcare personnel						
Others	1560 (21.9)	1450 (21.8)	110 (23.3)	1431 (21.8)	129 (23.0)	73.4±15.4
Nurse	3510 (49.3)	3315 (49.8)	195 (41.2)	3281 (50.0)	229 (40.8)	72.6±15.0
Doctor	2054 (28.8)	1886 (28.4)	168 (35.5)	1851 (28.2)	203 (36.2)	74.4±15.6
Type of healthcare facility †						
Non-front-line	4198 (58.9)	3952 (59.4)	246 (52.0)	3895 (59.3)	303 (54.0)	73.2±15.3
Front-line	2926 (41.1)	2699 (40.6)	227 (48.0)	2668 (40.7)	258 (46.0)	73.5±15.2
Epidemic containment experience						
No	4490 (63.0)	4187 (63.0)	303 (64.1)	4122 (62.8)	368 (65.6)	73.1±15.3
Yes	2634 (37.0)	2464 (37.0)	170 (35.9)	2441 (37.2)	193 (34.4)	73.7±15.2
S-COVID-19-S ‡						
No	6323 (88.8)	5905 (88.8)	418 (88.4)	5831 (88.8)	492 (87.7)	74.0±15.1
Yes	801 (11.2)	746 (11.2)	55 (11.6)	732 (11.2)	69 (12.3)	67.9±15.9
BMI, kg/m^2						
Normal weight (BMI <25.0)	6330 (88.9)	5904 (88.8)	426 (90.1)	5836 (88.9)	494 (88.1)	73.4±15.2
Overweight/obese (BMI ≥25.0)	794 (11.1)	747 (11.2)	47 (9.9)	727 (11.1)	67 (11.9)	72.7±16.2
Comorbidity						
None	6845 (96.1)	6386 (96.0)	459 (97.0)	6307 (96.1)	538 (95.9)	73.5±15.2
One or more	279 (3.9)	265 (4.0)	14 (3.0)	256 (3.9)	23 (4.1)	69.4±16.7
Pregnancy status §						
Not pregnant	6694 (94.0)	6245 (93.9)	449 (94.9)	6164 (93.9)	530 (94.5)	73.6±15.2
Pregnant	430 (6.0)	406 (6.1)	24 (5.1)	399 (6.1)	31 (5.5)	67.9±15.9
Eating behaviour ¶						
Eat less-healthy diet	306 (4.3)	189 (2.8)	117 (24.7)	187 (2.8)	119 (21.2)	62.6±14.6
Unchanged or healthier diet	6818 (95.7)	6462 (97.2)	356 (75.3)	6376 (97.2)	442 (78.8)	73.8±15.1
Smoking ¶						
Never, stopped, or smoke less	6870 (96.4)	6434 (96.7)	436 (92.2)	6354 (96.8)	516 (92.0)	73.4±15.2

Continued

Table 2 Continued

Variables	Total (n=7124) Frequency (%)	GDA <8 (n=6651) Frequency (%)	GDA≥8 (n=473) Frequency (%)	PHQ <10 (n=6563) Frequency (%)	PHQ ≥10 (n=561) Frequency (%)	HRQoL (n=7124) Mean±SD
Unchanged or smoke more	254 (3.6)	217 (3.3)	37 (7.8)	209 (3.2)	45 (8.0)	70.1±16.7
Drinking alcohol ¶						
Never, stopped, or drink less	6840 (96.0)	6406 (96.3)	434 (91.8)	6328 (96.4)	512 (91.3)	73.3±15.2
Unchanged or drink more	284 (4.0)	245 (3.7)	39 (8.2)	235 (3.6)	49 (8.7)	73.2±16.2
Physical activity ¶						
Never, stopped, or exercise less	2735 (38.4)	2376 (35.7)	359 (75.9)	2350 (35.8)	385 (68.6)	68.0±15.7
Unchanged or exercise more	4389 (61.6)	4275 (64.3)	114 (24.1)	4213 (64.2)	176 (31.4)	76.6±14.0
HL index, mean±SD	33.9±9.0	34.3±8.9	28.1±7.7	34.4±8.9	28.5±8.2	
HRQoL score, mean±SD	73.3±15.3	74.5±14.9	55.9±9.1	74.6±14.8	58.0±11.8	

*Healthcare workers have involved in healthcare interactions with other departments or healthcare facilities in order to response to the COVID-19 pandemic.

†Frontline areas are outpatient department, emergency department, isolation areas, imaging and laboratory diagnosis department, patient administration areas.

‡The suspected COVID-19 symptoms including common symptom (fever, cough, dyspnoea), less common symptom (myalgia, fatigue, sputum production, confusion, headache, sore throat, rhinorrhea, chest pain, haemoptysis, diarrhoea, and nausea/vomiting).

§Healthcare workers were asked whether they (or their wife if they are men) are currently pregnant.

¶People were asked whether their health-related behaviours are getting worse, better, or unchanged during COVID-19 pandemic as compared with those before the pandemic.

BMI, body mass index; GAD, generalised anxiety disorder; HL, health literacy; HRQoL, health-related quality of life; PHQ, patient health questionnaire; S-COVID-19-S, suspected COVID-19- symptoms.;

more' drinking (OR, 2.24; 95% CI 1.46 to 3.43; p<0.001), compared with counterparts (table 3).

Associated factors of HRQoL

In multivariable analysis, HRQoL scores were significantly lower in HCWs aged 41–60 years (regression coefficient, b, −1.14; 95% CI −1.99 to −0.29; p=0.009) and for those involved in healthcare interactions in other departments or healthcare facilities (b, −2.14; 95% CI −2.89 to −1.38; p<0.001), with S-COVID-19-S (b, −5.28; 95% CI −6.33 to −4.23; p<0.001) and those with comorbidity (b, −3.71; 95% CI −5.42 to −1.99; p<0.001), those who had a pregnancy status (b, −6.09; 95% CI −7.47 to −4.71; p<0.001) and those who reported unchanged or increased smoking (b, −4.72; 95% CI −6.50 to −2.94; p<0.001) compared with counterparts. HRQoL scores were significantly higher in HCWs who could pay for medication very or fairly easily (b, 2.82; 95% CI, 2.14 to 3.49; p<0.001), who were doctors (b, 1.40; 95% CI, 0.44 to 2.37; p<0.001, the reference group was 'others'), whose eating behaviours were unchanged or healthier (b, 6.14; 95% CI, 4.49 to 7.78; p<0.001), whose physical activity was unchanged or increased (b, 6.95; 95% CI, 6.26 to 7.65; p<0.001) and who had a 1-score increment of HL (b, 0.33; 95% CI, 0.29 to 0.37; p<0.001; table 3).

Interactions of COVID-19 response involvement with lifestyles and health literacy

The results of interaction analysis showed that in comparison to HCWs who uninvolved in the COVID-19 response and smoked 'never/stopped/less', those involved in the COVID-19 response, and 'never/stop/less' smoking

status had 4.60 times greater anxiety likelihood (p<0.001) and 3.42 times greater depression likelihood (p<0.001), those uninvolved in the pandemic response who reported 'unchanged/more' smoking had 5.46 times greater anxiety likelihood (p<0.001) and 4.69 times greater depression likelihood (p<0.001), those involved in the response with 'unchanged/more' smoking status had 66% lower anxiety likelihood (p=0.017) and 67% lower depression likelihood (p=0.007; table 4).

In comparison to HCWs who were not involved in the COVID-19 response with 'never/stopped/less' drinking status, those who involved in the response with 'never/stopped/less' drinking status had 4.74 times greater anxiety likelihood (p<0.001) and 3.54 times greater depression likelihood (p<0.001), those uninvolved in the pandemic response with "unchanged/more" drinking status had 3.89 times greater anxiety likelihood (p<0.001) and 3.85 times greater depression likelihood (p<0.001), those involved in the pandemic response with 'unchanged/more' drinking status had 74% lower anxiety likelihood (p<0.001) and 76% lower depression likelihood (p<0.001; table 4).

In comparison to HCWs who uninvolved in the COVID-19 response and reported "never/stopped/less" physical activity status, those who involved in the response with 'never/stopped/less' physical activity status had 5.26 times greater anxiety likelihood (p<0.001), 4.42 times greater depression likelihood (p<0.001) and 3.31 lower HRQoL scores (p<0.001), those uninvolved in the response with 'unchanged/more' physical activity status had 65% lower anxiety likelihood (p<0.001), 46% lower

Table 3 Determinants of anxiety, depression and health-related quality of life among healthcare workers (n=7124)

Variables	GDA≥8 Univariable OR (95%CI)	P*	GDA≥8 Multivariable OR (95%CI)	P*	PHQ ≥10 Univariable OR (95%CI)	P*	PHQ ≥10 Multivariable OR (95%CI)	P*	HRQoL Univariable b (95%CI)	P†	HRQoL Multivariable b (95%CI)	P†
COVID-19 response involvement ‡												
Not involved	1.00		1.00		1.00		1.00		0.00		0.00	
Involved	3.70 (3.06 to 4.47)	<0.001	4.41 (3.53 to 5.51)	<0.001	2.87 (2.41 to 3.42)	<0.001	3.31 (2.71 to 4.05)	<0.001	−2.21 (−3.01 to −1.42)	<0.001	−2.14 (−2.89 to −1.38)	<0.001
Age, year												
21–40	1.00		1.00		1.00		1.00		0.00		0.00	
41–60	0.57 (0.43 to 0.74)	<0.001	0.58 (0.42 to 0.78)	<0.001	0.71 (0.56 to 0.89)	0.004	0.67 (0.51 to 0.87)	0.003	−0.48 (−1.36 to 0.39)	0.278	−1.14 (−1.99 to −0.29)	0.009
Gender												
Women	1.00		1.00		1.00		1.00		0.00		0.00	
Men	1.13 (0.93 to 1.37)	0.231	0.80 (0.63 to 1.02)	0.074	1.07 (0.90 to 1.28)	0.449	0.73 (0.59 to 0.91)	0.005	0.31 (−0.44 to 1.06)	0.417	0.39 (−0.35 to 1.13)	0.302
Marital status												
Never married	1.00				1.00				0.00			
Ever married	1.01 (0.80 to 1.26)	0.954			0.99 (0.80 to 1.22)	0.911			0.39 (−0.47 to 1.24)	0.373		
Ability to pay for medication												
Very or fairly difficult	1.00		1.00		1.00		1.00		0.00		0.00	
Very or fairly easy	0.38 (0.30 to 0.46)	<0.001	0.40 (0.31 to 0.51)	<0.001	0.54 (0.45 to 0.65)	<0.001	0.58 (0.47 to 0.71)	<0.001	3.41 (2.71 to 4.12)	<0.001	2.82 (2.14 to 3.49)	<0.001
Social status												
Low	1.00				1.00				0.00			
Middle or high	0.99 (0.76 to 1.30)	0.949			1.08 (0.84 to 1.40)	0.561			4.10 (3.08 to 5.13)	<0.001		
Type of healthcare personnel												
Others	1.00		1.00		1.00		1.00		0.00		0.00	
Nurse	0.78 (0.61 to 0.99)	0.039	0.58 (0.43 to 0.77)	<0.001	0.77 (0.62 to 0.97)	0.026	0.60 (0.46 to 0.78)	<0.001	−0.78 (−1.69 to 0.14)	0.095	−0.01 (−0.87 to 0.86)	0.987
Doctor	1.17 (0.92 to 1.51)	0.208	1.15 (0.85 to 1.57)	0.372	1.22 (0.97 to 1.53)	0.097	1.15 (0.87 to 1.52)	0.319	0.96 (−0.05 to 1.96)	0.062	1.40 (0.44 to 2.37)	0.004
Type of healthcare facility§												
Non-front-line	1.00		1.00		1.00		1.00		0.00			
Front-line	1.35 (1.12 to 1.63)	0.002	1.69 (1.35 to 2.11)	<0.001	1.24 (1.05 to 1.48)	0.014	1.48 (1.21 to 1.81)	<0.001	0.33 (−0.39 to 1.05)	0.372		
Epidemic containment experience												
No	1.00				1.00		1.00		0.00		0.00	
Yes	0.95 (0.79 to 1.16)	0.630			0.89 (0.74 to 1.06)	0.189	1.07 (0.87 to 1.31)	0.537	0.61 (−0.12 to 1.35)	0.101	−0.23 (−0.92 to 0.47)	0.521
S-COVID-19-S ¶												
No	1.00				1.00				0.00		0.00	
Yes	1.04 (0.78 to 1.39)	0.784			1.12 (0.86 to 1.45)	0.410			−6.04 (−7.15 to −4.93)	<0.001	−5.28 (−6.33 to −4.23)	<0.001
BMI, kg/m²												
Normal weight (BMI <25.0)	1.00				1.00				0.00			
Overweight/obese (BMI ≥25.0)	0.87 (0.64 to 1.19)	0.388			1.09 (0.83 to 1.42)	0.532			−0.63 (−1.76 to 0.50)	0.274		
Comorbidity												
None	1.00				1.00				0.00		0.00	
One or more	0.74 (0.43 to 1.27)	0.269			1.05 (0.68 to 1.63)	0.815			−4.09 (−5.91 to −2.26)	<0.001	−3.71 (−5.42 to −1.99)	<0.001

Continued

Table 3 Continued

Variables	GDA≥8 Univariable OR (95% CI)	GDA≥8 Univariable P*	GDA≥8 Multivariable OR (95% CI)	GDA≥8 Multivariable P*	PHQ ≥10 Univariable OR (95% CI)	PHQ ≥10 Univariable P*	PHQ ≥10 Multivariable OR (95% CI)	PHQ ≥10 Multivariable P*	HRQoL Univariable b (95% CI)	HRQoL Univariable P†	HRQoL Multivariable b (95% CI)	HRQoL Multivariable P†
Pregnancy status *												
Not pregnant	1.00				1.00				0.00		0.00	
Pregnant	0.82 (0.54 to 1.26)	0.364			0.90 (0.62 to 1.32)	0.597			−5.76 (−7.25 to −4.28)	<0.001	−6.09 (−7.47 to −4.71)	<0.001
Eating behaviour ††												
Eat less-healthy diet	1.00		1.00		1.00		1.00		0.00		0.00	
Unchanged or healthier diet	0.09 (0.07 to 0.12)	<0.001	0.21 (0.15 to 0.28)	<0.001	0.11 (0.09 to 0.14)	<0.001	0.23 (0.17 to 0.30)	<0.001	11.17 (9.44 to 12.90)	<0.001	6.14 (4.49 to 7.78)	<0.001
Smoking ††												
Never, stopped, or smoke less	1.00		1.00		1.00		1.00		0.00		0.00	
Unchanged or smoke more	2.52 (1.75 to 3.61)	<0.001	3.46 (2.12 to 5.66)	<0.001	2.65 (1.90 to 3.70)	<0.001	3.11 (1.99 to 4.84)	<0.001	−3.32 (−5.24 to −1.41)	0.001	−4.72 (−6.50 to −2.94)	<0.001
Drinking alcohol ††												
Never, stopped, or drink less	1.00		1.00		1.00		1.00		0.00			
Unchanged or drink more	2.35 (1.65 to 3.34)	<0.001	2.14 (1.32 to 3.47)	0.002	2.58 (1.87 to 3.55)	<0.001	2.24 (1.46 to 3.43)	<0.001	−0.05 (−1.86 to 1.77)	0.961		
Physical activity ††												
Never, stopped, or exercise less	1.00		1.00		1.00		1.00		0.00		0.00	
Unchanged or exercise more	0.18 (0.14 to 0.22)	<0.001	0.24 (0.19 to 0.31)	<0.001	0.26 (0.21 to 0.31)	<0.001	0.36 (0.29 to 0.44)	<0.001	8.60 (7.90 to 9.31)	<0.001	6.95 (6.26 to 7.65)	<0.001
HL index, 1 score increment	0.93 (0.92 to 0.94)	<0.001	0.92 (0.90 to 0.93)	<0.001	0.93 (0.92 to 0.94)	<0.001	0.92 (0.91 to 0.93)	<0.001	0.38 (0.34 to 0.42)	<0.001	0.33 (0.29 to 0.37)	<0.001

*Result of logistic regression models.
†Result of linear regression models.
‡Healthcare workers have involved in healthcare interactions with other departments or healthcare facilities in order to response to the COVID-19 pandemic.
§Frontline workers are outpatient department, emergency department, isolation areas, imaging and laboratory diagnosis department, patient administration areas.
¶The suspected COVID-19 symptoms including common symptom (fever, cough, dyspnoea), less common symptom (myalgia, fatigue, sputum production, confusion, headache, sore throat, rhinorrhea, chest pain, haemoptysis, diarrhoea, and nausea/vomiting).
**Healthcare workers were asked whether they (or their wife if they are men) are currently pregnant.
††People were asked whether their health-related behaviours are getting worse, better, or unchanged during COVID-19 pandemic as compared with those before the pandemic.
b, regression coefficient; BMI, body mass index; GAD, generalised anxiety disorder; HL, health literacy; HRQoL, health-related quality of life; PHQ, patient health questionnaire; S-COVID-19-S, suspected COVID-19 symptoms.

Table 4 Interactions of COVID-19 response involvement with health-related behaviours and health literacy on anxiety, depression and health-related quality of life among healthcare workers (n=7124)

Interactions	GDA≥8 Model 1 OR (95% CI)	P*	GDA≥8 Model 2 OR (95% CI)	P*	PHQ≥10 Model 1 OR (95% CI)	P*	PHQ≥10 Model 2 OR (95% CI)	P*	HRQoL Model 1 b (95% CI)	P†	HRQoL Model 2 b (95% CI)	P†
Interaction with eating behaviour												
Not Involved × Less Healthy	1.00		1.00		1.00		1.00		0.00		0.00	
Involved × Less Healthy	4.58 (2.80 to 7.51)	<0.001	4.65 (2.64 to 8.16)	<0.001	4.31 (2.64 to 7.03)	<0.001	4.05 (2.36 to 6.96)	<0.001	-3.02 (-6.45 to 0.41)	0.084	-1.59 (-4.77 to 1.58)	0.326
Not Involved × Unchanged/Healthier	0.11 (0.08 to 0.17)	<0.001	0.24 (0.16 to 0.37)	<0.001	0.15 (0.11 to 0.22)	<0.001	0.29 (0.19 to 0.43)	<0.001	10.38 (8.12 to 12.64)	<0.001	5.95 (3.84 to 8.06)	<0.001
Involved × Unchanged/Healthier	0.72 (0.42 to 1.23)	0.232	0.91 (0.49 to 1.67)	0.758	0.58 (0.34 to 0.97)	0.040	0.75 (0.42 to 1.35)	0.340	1.22 (-2.30 to 4.75)	0.496	-0.47 (-3.74 to 2.80)	0.777
Interaction with smoking												
Not Involved × Never/Stopped/Less	1.00		1.00		1.00		1.00		0.00		0.00	
Involved × Never/Stopped/Less	3.99 (3.28 to 4.87)	<0.001	4.60 (3.65 to 5.80)	<0.001	3.08 (2.57 to 3.69)	<0.001	3.42 (2.78 to 4.21)	<0.001	-2.08 (-2.90 to -1.27)	<0.001	-1.97 (-2.73 to -1.20)	<0.001
Not Involved × Unchanged/More	4.04 (2.56 to 6.36)	<0.001	5.46 (3.12 to 9.56)	<0.001	3.97 (2.64 to 5.97)	<0.001	4.69 (2.85 to 7.72)	<0.001	-2.38 (-4.67 to -0.10)	0.041	-3.97 (-6.09 to -1.85)	<0.001
Involved × Unchanged/More	0.32 (0.15 to 0.70)	0.004	0.34 (0.14 to 0.83)	0.017	0.34 (0.17 to 0.70)	0.003	0.33 (0.15 to 0.74)	0.007	-2.86 (-7.02 to 1.29)	0.177	-1.99 (-5.81 to 1.83)	0.308
Interaction with drinking alcohol												
Not Involved × Never/Stopped/Less	1.00		1.00		1.00		1.00					
Involved × Never/Stopped/Less	4.02 (3.30 to 4.90)	<0.001	4.74 (3.75 to 5.98)	<0.001	3.12 (2.60 to 3.75)	<0.001	3.54 (2.87 to 4.36)	<0.001				
Not involved × Unchanged/More	3.84 (2.46 to 5.99)	<0.001	3.89 (2.24 to 6.76)	<0.001	4.04 (2.73 to 5.97)	<0.001	3.85 (2.38 to 6.22)	<0.001				
Involved × Unchanged/More	0.30 (0.15 to 0.63)	0.002	0.26 (0.11 to 0.60)	0.002	0.30 (0.15 to 0.59)	<0.001	0.24 (0.11 to 0.53)	<0.001				
Interaction with physical activity												
Not Involved × Never/Stopped/Less	1.00		1.00		1.00		1.00		0.00		0.00	
Involved × Never/Stopped/Less	4.66 (3.70 to 5.87)	<0.001	5.26 (4.03 to 6.87)	<0.001	4.01 (3.21 to 5.01)	<0.001	4.42 (3.44 to 5.68)	<0.001	-3.70 (-4.93 to -2.48)	<0.001	-3.31 (-4.49 to -2.12)	<0.001
Not Involved × Unchanged/More	0.24 (0.18 to 0.33)	<0.001	0.35 (0.26 to 0.49)	<0.001	0.38 (0.30 to 0.48)	<0.001	0.54 (0.41 to 0.70)	<0.001	7.84 (7.02 to 8.66)	<0.001	6.29 (5.49 to 7.09)	<0.001
Involved × Unchanged/More	0.50 (0.32 to 0.77)	0.002	0.50 (0.31 to 0.81)	0.005	0.39 (0.27 to 0.61)	<0.001	0.40 (0.27 to 0.61)	0.001	2.69 (1.12 to 4.26)	0.001	2.08 (0.58 to 3.58)	0.007
Interaction with health literacy												
Not Involved × Lowest Quartile of HL	1.00		1.00		1.00		1.00		0.00		0.00	
Involved × Lowest Quartile of HL	18.96 (12.40 to 28.99)	<0.001	12.06 (7.59 to 19.16)	<0.001	11.93 (8.06 to 17.67)	<0.001	7.84 (5.14 to 11.96)	<0.001	-7.71 (-9.76 to -5.67)	<0.001	-5.00 (-6.97 to -3.02)	<0.001
Not involved × 1-Quartile Increment of HL	0.53 (0.46 to 0.61)	<0.001	0.55 (0.48 to 0.64)	<0.001	0.56 (0.50 to 0.63)	<0.001	0.58 (0.51 to 0.65)	<0.001	3.07 (2.72 to 3.43)	<0.001	2.53 (2.19 to 2.88)	<0.001
Involved × 1-Quartile Increment of HL	0.47 (0.38 to 0.58)	<0.001	0.57 (0.45 to 0.71)	<0.001	0.53 (0.44 to 0.64)	<0.001	0.63 (0.52 to 0.76)	<0.001	1.82 (1.11 to 2.52)	<0.001	1.10 (0.42 to 1.78)	0.002

*Result of logistic regression models.
†Result of linear regression models.
b, regression coefficient; BMI, body mass index; GAD, generalised anxiety disorder; HL, health literacy; HRQoL, health-related quality of life; PHQ, patient health questionnaire.

depression likelihood (p<0.001) and 6.29 higher HRQoL scores (p<0.001), their counterparts involved in the response with 'unchanged/more' physical activity status had 50% lower anxiety likelihood (p=0.005), 60% lower depression likelihood (p<0.001) and 2.08 higher HRQoL scores (p=0.007; table 4).

In comparison to HCWs uninvolved in the COVID-19 response in the lowest HL quartile, those who involved in the response with the lowest quartile of HL had 12.06 times greater anxiety likelihood (p<0.001), 7.84 times greater depression likelihood (p<0.001) and 5.00 lower HRQoL scores (p<0.001), those uninvolved in the response and with a one-quartile increment of HL had 45% lower anxiety likelihood (p<0.001), 42% lower depression likelihood (p<0.001) and 2.53 higher HRQoL score (p<0.001), their counterparts involved in the response with a one-quartile increment of HL had 43% lower anxiety likelihood (p<0.001), 37% lower depression likelihood (p<0.001) and 1.10 higher HRQoL scores (p=0.002; table 4).

DISCUSSION

Findings of the current study illustrate an important aspect of COVID-19 containment strategies: adverse psychological outcomes among HCWs. Those HCWs involved in healthcare interactions with other departments or healthcare facilities to responding to the COVID-19 pandemic had a greater likelihood of anxiety, depression and lower HRQoL. This finding is consistent with recent literature finding HCWs suffer from mental health problems (eg, fear, anxiety, depression, insomnia and distress), especially those working in the frontline positions.[33 34] These adverse psychological outcomes may affect HCWs' HRQoL. Governments and organisations urgently need to implement appropriate preparations and interventions to mitigate such psychological consequences of COVID-19.[28 29 72 73] Authorities also need to reinforce the HCWs' capacity for compassion and help them overcome the distress and fear so they can provide effective care under difficult clinical circumferences.[74] The roles of governments and leaders are critically important in containing and responding to the COVID-19 pandemic.[75]

Overall, our results showed that smoking and drinking are harmful to HCWs' mental health and HRQoL, while healthy eating and higher HL are protective factors. However, in the sample of HCWs who were involved in the pandemic response, the association was interestingly changed in the interaction analysis finding that smoking and drinking were associated with better mental health in response-involved HCWs. Previous studies illustrated that in the unpleasant events, cigarette smoking may help to relieve negative emotions such as anxiety and stress.[76 77] In addition, the smoking rates are higher in people with mental health problems than in the general population.[78] Alcohol consumption has been associated with reduction of tensions, which has a positive impact on mental health.[79] Even so, smoking still considered harmful to

HRQoL in the current study, consistent with the previous studies.[80 81] It is critical to consider alternative coping strategies when designing intervention programmes, to avoid adverse long-term effects of smoking and drinking.[82 83]

In our study, physical activity was found to protect the response-involved HCWs' mental health and HRQoL. Physical activity has been shown to be a protective factor of depression an effective treatment for depression[84 85] In addition, physical activity has shown a positive association with HRQoL.[86]

Importantly, the response-involved HCWs with higher HL had a lower likelihood of anxiety and depression and higher HRQoL. HL plays an important role in evaluating online health information.[87] The HL skill is critical for people with diverse digital information sources,[88] especially during the COVID-19 pandemic. HL is necessary if HCWs are to conduct accurate and timely consultations, particularly in the fast-changing conditions and possible mobility limitations of the pandemic. In addition, higher HL scores were independently associated with healthier behaviours (eg, exercise, balanced diet)[89 90] that further contribute to improved mental health and well-being.[91]

In the present study, the effect modification of healthy eating was not found in the interaction analysis, but it was found as a protective factor of mental health and HRQoL in the multivariable analysis. The effect of diet and nutrition on mental health and well-being has been discussed previously.[91 92] Better diet's role in lowering depression risk also has been documented.[93 94] Among risk management strategies, studies have shown that diet and nutrition are important factors protecting against SARS-CoV-II infection.[95–97] Foods provide antioxidant and anti-inflammatory nutrients that influence the immune function, reduce infection risk and modulate COVID-19's clinical course.[95 96 98]

We found that older HCWs had a lower likelihood of anxiety and depression during the pandemic. This might be explained by longer working experience that can help in regulating negative emotions. However, older HCWs had lower HRQoL than younger respondents, as has been found in previous studies in Vietnam.[86 99 100] In addition, men had a lower likelihood of depression as compared with women, possibly because women face increased burdens during the pandemic such as difficulties in sourcing food and financing household costs as well as housework, child care and disrupted women's health services.[101] Clearly, it is important to equally address women's and men's health issues to most effectively fight pandemic illness.[101] Furthermore, HCWs with better ability to pay for medication had a lower likelihood of anxiety and depression as well as better HRQoL. Previous studies have shown a positive association between higher income and higher HRQoL in the general population.[86 102] In the current study, HCWs who worked at the front-line areas had a higher likelihood of anxiety and depression. The finding is consistent with previous studies.[33 34] In addition, HCWs with S-COVID-19-S or with comorbidity had lower HRQoL. These findings were

consistent with a previous study conducted in the general population who visit the outpatient department during the COVID-19 pandemic.[6] Additionally, women, or men whose wife got pregnant during the pandemic had lower HRQoL. This could be the result of nausea and vomiting of pregnancy[103] and the decreased sexual function and activity during the pregnancy.[104 105] HCWs are recognised as a groups with middle or high social status, high standard of health-related knowledge and skills. Therefore, the associations found in the current study might not as strong as that in other populations. However, the finding of a large sample study can be generated among HCWs in Vietnam and possibly in other countries.

CONCLUSIONS

Our study shows that HCWs involved in healthcare interactions in other departments or health facilities involved with the COVID-19 pandemic had a higher likelihood of anxiety, depression, and lower HRQoL. Overall, healthy eating, physical activity, and higher HL were associated with lower likelihood of anxiety and depression, and with higher HRQoL. Smoking and drinking were associated with poorer mental health and HRQoL. Physical activity and health literacy appear to protect mental health and HRQoL in response-involved HCWs, but drinking was harmful to HRQoL. Unexpectedly, smoking and drinking also were negatively associated with response-involved HCWs' mental health. The long-term effect of lifestyles and HL needs to be investigated in future studies. The findings of the current study provide evidence for governments and organisations strategizing to protect HCWs' mental health and HRQoL during and after the pandemic.

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