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# Associations between psychological responses and quality of life at early and late time of quarantine among residents of a collective quarantine facility in central Taiwan

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## ABSTRACT

**Objectives:** Few countries required people living in collective facilities to undergo quarantine during the COVID-19 pandemic, which could lead to more psychological effects than quarantine at home or hotels. This study assessed the changes in depression, anxiety, and quality of life (QOL) among residents of a collective quarantine facility in central Taiwan.

**Methods:** Between April and November 2020, 660 collective quarantine facility residents participated in the survey conducted on the first and last days of the 14-day quarantine period. Questionnaires of Patient Health Questionnaire (PHQ-9), Generalized Anxiety Disorder (GAD-7), and WHO quality of life (WHOQOL)-BREF were used to measure depression and anxiety symptoms, and QOL, respectively. Linear regression model with generalization estimation equation method was for estimating the differences in depression, anxiety, and QOL between two surveys and to test the changes of associations between them over time.

**Results:** PHQ-9 and WHOQOL-BREF scores showed no significant changes, but GAD-7 score decreased during quarantine ( $p = 0.011$ , Cohen's  $d = -0.11$ ). Both PHQ-9 and GAD-7 were negatively associated with overall and domain-specific WHOQOL-BREF scores on both the first and last days of quarantine. Such associations did not significantly vary with time, except for the association between PHQ-9 and environmental domain WHOQOL-BREF score, being stronger on the first day than on the last day of quarantine ( $p = 0.041$ ,  $\eta^2 = 0.0021$ ).

**Conclusion:** A significant decrease in anxiety among quarantined individuals over a 14-day quarantine period was found. While depression was negatively associated with overall QOL, the strength of association between depression and environmental domain QOL decreased over the period.

## 1. Introduction

Coronavirus Disease-2019 (COVID-19) was announced as a Public Health Emergency of International Concern (PHEIC) by the World Health Organization (WHO) on 30th January 2020. This event has been deeply influencing not only people's physical health, but also mental health by causing anxiety and depression [1]. The COVID-19 outbreak also led to a poor quality of life (QOL) because of the many restrictive

measures [2].

Many countries imposed quarantines to control the transmission of disease, including stay at home/hotel or at specific facilities. Based on a review, a longer period of quarantine was stressful due to fears of infection, frustration, boredom, inadequate supplies or information, financial loss, and stigma [3]. Quarantine also led to negative psychological effects, such as anxiety, depression, confusion, anger, and post-traumatic stress symptoms [3–5]. Loneliness during quarantine was

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also linked to worse mental health outcomes [6]. Additionally, the isolation of individuals due to quarantine led to high stress and anxiety [5]. Psychological stress might affect QOL during COVID-19 pandemic.

Government-imposed quarantine level was associated with the anxiety and depression of the residents [7]. Different quarantine levels might cause dissimilar effects on people's psychological conditions. On 28th January 2020, the first local confirmed case of COVID-19 was reported in Taiwan, and the government started a series of quarantine measures to prevent the epidemic. There were three types of quarantines in Taiwan, namely, home quarantine, hotel quarantine, and quarantine at collective quarantine facilities. According to the Taiwanese government regulations, people returning or travelling to Taiwan or those who have contact with confirmed cases need to be quarantined. They can choose any one of the above quarantine types. However, special projects approved by the command center, those with non-compliance to home isolation/quarantine, those without a home isolation/home quarantine facility, and migrant workers needed to stay in collective quarantine facilities for 14 days. The facility was retrofitted from training centers or barracks. People cannot leave the room without proper agreement with the administration and need to report their health conditions twice per day [8].

The measures and environment in collective quarantine facilities were relatively unfriendly and with limited freedom, compared to quarantine at home or hotels. For example, the location of collective quarantine facilities was mainly assigned by the government, and people who were put under quarantine couldn't choose facilities at their preferences. In addition, compared to quarantine at home or hotels, the collective quarantine facility tended to have smaller rooms, limited choices of meals, no smoking, no alcohol drinking, and the policy of "one person one room". People choose under the quarantine at home must stay in an isolated space (e.g., isolated room) with a bathroom, but can still live with their family at home. In additional, family members travelling together can choose to stay in the same room under quarantine. Moreover, people who choose under quarantine at home or hotels could freely do what they want to do and to eat their preferred food but at their own payment. On the other hand, the collective quarantine facility residents did not need to pay for the stay at the facility. Such differences in quarantine conditions made us to expect that collective quarantine residents tended to have stronger psychological effects than those under quarantine at home or hotels.

Very few countries required people to live in collective facilities for quarantine during the global COVID-19 pandemic period, though collective quarantine coordinates with borders control might be an effective pandemic-prevention method at the early epidemic stage. This study aimed to investigate the following under the strictest quarantine conditions: (1) the changes in depression, anxiety, and QOL scores on the first and the last days of the 14-day quarantine; and (2) the changes in the association of depression/anxiety with QOL on the first and last days of quarantine. It's relative unique to investigate individual's psychological change and QOL in the collective quarantine facility over-time. Choosing this quarantine method in epidemic prevention would need paying attention to the aspects of residents' psychological health and QOL.

## 2. Methods

This was a two-wave cross-sectional study conducted on the first (first survey) and the last (second survey on the fourteenth day) days of quarantine. This study was ethically approved by the National Chung Kung University Governance Framework for Human Research Ethics (No. 110-381).

### 2.1. Study participants and settings

The main aim of this study was to compare the strength of association between depression (or anxiety) and QOL on the first and last days

of quarantine. We estimated that a sample size of 2102 may achieve 90% power to reject the null hypothesis of equal slopes of linear regression models when the actual difference in population slopes is 0.1 (i.e., small difference) and with a standard deviation of 1.0 for depression (or anxiety) on both the first and last days of quarantine. The standard deviation of residuals was 1.0, and the significance level (alpha) was 0.05 when a two-sided test was used. When the magnitude of slope increased to 0.2 (moderate difference) and 0.5 (big difference), the sample size required decreased to 526 and 86, respectively (NCSS, Statistical Software, Wilton, Connecticut).

Between April and November 2020, 678 people were successively requested to be quarantined at the only collective quarantine facility in Chunghua county located in the central part of Taiwan. Most of the residents in this collective quarantine facility were migrant workers from South East Asia. One of the coauthors (CSL) explained the study objectives and the procedure of questionnaire administration, as well as the contents of the questionnaires, to the residents when they arrived at the facility. All participants must complete a signed informed consent should they agree to take part in the study. According to Taiwan Infectious Disease Control Act, all residents of collective quarantine facilities are provided with water, meals, and a wash bag for free during the 14-day quarantine. They are also financially compensated (New Taiwan Dollar 1,000 per day) for the loss of work during quarantine. We did not provide any additional payment or gifts for their participation in this study. Considering that no face-to-face contact with the quarantined individuals was allowed, the communication between the researcher (CSL) and the residents was done through transparent isolation glasses. The questionnaires were completed primarily by self-administration, and the researcher left a phone number to the participants to call if they encounter problems while completing the questionnaires. We traced back the participants whose returned questionnaires had some missing information and provided more explanations by one author (CSL) to the participants to help fully complete the questionnaires before they left the facility. As such, the research data involving in this survey included no missing information.

Two residents declined to participate in the study at the time of the initial contact. The first and second surveys were conducted on the first and the last (i.e., fourteenth) day of quarantine, respectively, and this information was disclosed to the participants in the morning of the survey day to remind them to complete the questionnaires. Despite that, 146 participants (22.1%) did not complete the questionnaire at the first survey, mainly due to self-reported tiredness after travel and transportation. Nine participants (1.4%) did not respond to the second survey, and most of them reported that they were no longer interested in the study. Fig. 1 shows the flow chart of study participant enrollment. In

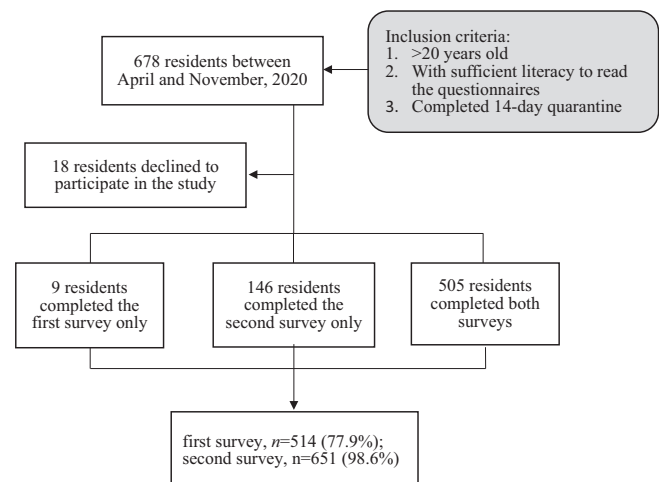


Fig. 1. Flow chart of enrolling study participants.

addition, Supplementary Table 1 shows the characteristics of study participants who completed the first survey only, the second survey only, and both surveys.

## 2.2. Measures

In addition to socio-demographic variables, three scales were included in the questionnaire. Our study sample comprised participants who spoke different languages. Thus, questionnaires were in various languages, including Chinese, Thai, Vietnamese, Bahasa Indonesia, and English.

### 2.2.1. Patient Health Questionnaire (PHQ-9)

The PHQ-9 comprised 9 DSM-IV depression criteria related items and was initially developed by Kroenke et al. [9]. Each item was scored 0 to 3, with a total score ranging from 0 to 27. A higher score indicated higher severity of depression. Categorical levels of 0–4, 5–9, 10–14, 15–19, and 20–27 were commonly used to indicate minimal or none, mild, moderate, moderately severe, and severe levels of depression, respectively [9,10].

Psychometric properties of PHQ-9 have been frequently tested. A meta-analysis of 29 studies that included 6725 patients found similar sensitivity (0.88, 95% CI 0.83–0.92) and specificity (0.85, 95% CI 0.82–0.88), which were associated with a cutoff of  $\geq 10$  for determining major depressive disorders among overall and various subgroups [11]. Data from one of the most updated meta-analysis that included 44,503 reported similar sensitivity and specificity at 0.85 (0.79 to 0.89) and 0.85 (0.82 to 0.87), respectively, for the standard cut-off value of  $\geq 10$ . Notably, from various reference standards and cut-off values, specificity was found to be 0%–10% (median 3%) higher for men and 0%–12% (median 5%) higher for people aged 60 years old or older [12]. The PHQ-9 also demonstrated a satisfactory level of internal consistence (Cronbach's alpha = 0.81) and test-retest reliability (intra-class correlation coefficient = 0.92) [13].

In addition to English version, the translated PHQ-9 also demonstrated satisfactory psychometric properties. The cut-off values of  $\geq 10$  and  $\geq 9$  were associated with the sensitivity/specificity values of 0.86/0.94 and 0.84/0.77 for Chinese [14] and Thai language [15] version PHQ-9, respectively. In addition, the Vietnamese [16] and Bahasa Indonesia [17] versions of PHQ-9 also showed a satisfactory level of construct validity. Cronbach's alpha values for the PHQ-9 of the above languages were between 0.72 and 0.86 [14–16,18].

### 2.2.2. Generalized Anxiety Disorder (GAD-7)

GAD-7 is a tool for the rapid screening of the presence of clinically significant anxiety disorders, including GAD, panic disorder, social phobia, and post-traumatic stress disorder (PTSD), especially in outpatient settings [19]. The GAD-7 comprised 7 items, with 0–3 points for each of the seven questions and a total score of 0–21. A score of 10 or greater on the GAD-7 represents a reasonable cutoff point for identifying GAD cases. Cutoff points of 5, 10, and 15 might represent mild, moderate, and severe levels of anxiety on the GAD-7 [19].

The GAD-7 was initially validated in 2149 patients as a diagnostic tool for GAD, and sensitivity and specificity rates of 89% and 82%, respectively, for a cutoff point of  $>10$  [19]. The GAD-7 was later found to have reasonable sensitivity (0.7–0.9) and specificity (0.8–0.9) as a tool for screening panic disorder, social phobia, and PTSD across cutoffs [20]. Higher GAD-7 scores were correlated with disability and functional impairment in terms of work productivity and health care utilization [19,21]. Plummer et al. [22] conducted a systematic review of a total of 11 samples involving 5223 participants on the accuracy of the GAD-7 in identifying GAD. Pooled sensitivity and specificity values appeared acceptable at a cutoff point of 8 (sensitivity: 0.83, 95% CI 0.71–0.91; specificity: 0.84, 95% CI 0.70–0.92) despite that the cutoff scores of 7–10 also had similar pooled estimates of sensitivity and specificity [22]. The GAD-7 also demonstrated good levels of internal

consistence (Cronbach's alpha = 0.89) [23] and test-retest reliability (intra-class correlation coefficient = 0.83) [19]. Psychometric measures of the GAD-7 in Chinese [24], Vietnamese [25], Thai [26], and Bahasa Indonesia [27] have been documented.

### 2.2.3. WHOQOL-BREF

The WHOQOL-BREF assesses QOL within the context of an individual's culture, value system, personal goals, standards, and concerns [28]. The WHOQOL-BREF is a 26-item instrument consisting of four domains: physical health (7 items), psychological health (6 items), social relationships (3 items), and environmental health (8 items). It also contains QOL and general health items. Each individual item of the WHOQOL-BREF is scored from 1 to 5 based on a five-point ordinal scale. The scores are then transformed linearly to a 0–100 scale [29,30].

The WHOQOL-BREF had good validity and reliability in different segments of population [31,32], as well as in various languages, including Chinese [33], Thai [34], Vietnamese [35], and Bahasa Indonesia [36]. The WHOQOL-BREF is widely applicable to clinical trials in which brief measures are needed [37,38] and also in epidemiological studies in which QOL might be one of several outcome variables [39,40]. The questionnaires of multi-language WHOQOL-BREF were downloaded from the WHO website (<https://www.who.int/tools/whoqol/whoqol-bref>) after obtaining written permission from the WHO field center.

## 2.3. Statistical analysis

We first described characteristics of the study participants using mean/standard deviation (SD) and number/percentage for continuous and discrete variables, respectively. Linear regression model with generalization estimation equation (GEE) method was used to estimate the differences in depression, anxiety, and QOL between the first and second surveys. We also reported effect sizes using Cohen's *d* for differences between two means, that  $d = 0.2$  was as a small effect size, 0.5 as a medium effect size, and 0.8 as a large effect size [41]. Considering the ordinal nature of PAQ-9, GAD-7, and QOL-BREF, we calculated the Spearman's correlations to indicate the associations of QOL with depression and anxiety at the first and second surveys, respectively. We further performed multiple linear regression analysis with the GEE method. This analysis simultaneously included the interaction terms of depression/anxiety and time (first or second survey) to assess whether the above associations varied with quarantine duration. We computed effect size measures for multiple linear regression analysis with the GEE method, known as the partial Eta-squared statistic ( $\eta^2$ ). According to Cohen's suggestion,  $\eta^2 = 0.01$  was defined as a small effect size, 0.06 as a medium effect size, and 0.15 as a large effect size [42]. All statistical analyses were performed using SAS statistical software (SAS System for Windows, Version 9.4, SAS Institute Inc., Cary, NC, USA). The results with two-sided *P* values of  $<0.05$  were considered statistically significant.

## 3. Results

The study sample had a mean age of 34.73 years old (SD, 10.19 years), and males and females were almost equal in number. While married participants accounted for  $>50\%$  of the study sample, the education levels and occupations were quite heterogeneous among the study participants. The rate of participants who were quarantined along with their family was 11%, and 17.42% of participants were current smokers. The study participants had multiple nationalities. Taiwan citizens accounted for only 25.91% of the sample. Vietnamese (27.73%), Indonesian (21.36%), and Filipino (20.45%) represented most of the foreign nationalities (Table 1). The distributions of depression and anxiety scores among the study participants at early and late quarantine were almost minimal and on a mild level (Supplementary Table 2).

Table 2 shows a significant reduction in mean anxiety score between

**Table 1**  
Characteristics of the study participants (n = 660).

Characteristics	n	%
<b>Sex</b>		
Men	331	50.15
Women	329	49.85
<b>Age (years)</b>		
Mean ± SD <sup>a</sup>	34.73 ± 10.19	
Min./Med./Max. <sup>a</sup>	20/33/74	
<b>Education</b>		
Elementary or less	36	5.45
Junior high school	167	25.3
Senior high school	228	34.55
Vocational	34	5.15
College/University	145	21.97
Postgraduate	50	7.58
<b>Marital status</b>		
Unmarried	257	38.93
Married	349	52.88
Divorced	45	6.82
Widowed	9	1.37
<b>Occupation</b>		
Elementary occupations <sup>b</sup>	450	68.18
Technology professionals	50	7.58
Service workers and shop/market sales workers	42	6.36
Students	39	5.91
Plant and machine operators and assemblers	32	4.84
Craft and related trades workers	12	1.82
Clerks	10	1.52
Business executives and managers	4	0.61
No job	21	3.18
<b>Quarantine with family<sup>c</sup></b>		
Yes	77	11.67
No	583	88.33
<b>Current smoker</b>		
Yes	115	17.42
No	545	82.58
<b>Nationality</b>		
Taiwan	171	25.91
Vietnam	183	27.73
Indonesia	141	21.36
Filipino	135	20.45
Others <sup>d</sup>	30	4.55

<sup>a</sup> SD, standard deviation; Min., minimum; Med., median; Max., maximum.  
<sup>b</sup> Based on Taiwan's standard occupational classification system, the category of elementary occupations includes a total of 15 occupations, as follows: sanitation workers, construction workers, assembly workers, meat packers and producers, telephone sales, domestic helpers and cleaning workers, business and public cleaning staff/personnel, doorkeepers, meter readers, street food vendors, street vendors (non-food products), shoes shining/car wash workers, caretakers, dry cleaning and launderers, and messengers/package/luggage porters and delivers.  
<sup>c</sup> Either living in the same room or in the different rooms of the same collective quarantine facility.  
<sup>d</sup> Including Thailand (n = 14), Mongolia (n = 13), India (n = 1), Hong Kong (n = 1), and Japan (n = 1).

the first and second surveys, but the magnitude of this difference was considered small (Cohen's d = -0.11). The mean depression and QOL scores (overall and domain-specific) did not significantly change over the quarantine period. Both depression and anxiety showed significantly negative associations with overall and domain-specific QOL at both the first and second surveys; a greater magnitude of negative association was noted in the first survey than in the second survey (Table 3). Similar findings were noted in the sub-group analyses according to participants' gender or smoking status (data not shown). Further multiple regression analysis indicated that only the association of depression with environmental domain QOL score showed a significant reduction in magnitude over the quarantine period (p = 0.041), but the strength of such effect-modification by time was also considered small (effect size η<sup>2</sup> = 0.0021) (Table 4).

**4. Discussion**

To our knowledge, no prior studies investigated the relationship between psychosocial response and QOL in people quarantined in collective facilities during the global COVID-19 pandemic period. This study revealed a significant decrease in anxiety, but not in depression and QOL, among residents over a 14-day quarantine period at a collective quarantine facility. Additionally, depression was significantly associated with environmental domain QOL but not overall QOL, and the strength of association between them significantly decreased over the quarantine period.

**Table 3**  
Associations of depression and anxiety with overall and domain-specific quality of life among study participants at early and late quarantine.

	Quality of life <sup>a</sup>				
	Physical	Psychological	Social	Environmental	Overall
<i>First survey</i>					
Depression	-0.51 (-0.57, -0.44) ***	-0.39 (-0.46, -0.31)***	-0.38 (-0.45, -0.30) ***	-0.32 (-0.40, -0.24)***	-0.47 (-0.54, -0.40) ***
Anxiety	-0.45 (-0.52, -0.38) ***	-0.33 (-0.41, -0.25)***	-0.34 (-0.41, -0.26) ***	-0.26 (-0.34, -0.18)***	-0.41 (-0.48, -0.33) ***
<i>Second survey</i>					
Depression	-0.44 (-0.51, -0.37) ***	-0.32 (-0.39, -0.24)***	-0.36 (-0.43, -0.29) ***	-0.21 (-0.29, -0.13)***	-0.40 (-0.46, -0.33) ***
Anxiety	-0.36 (-0.43, -0.28) ***	-0.28 (-0.36, -0.21)***	-0.28 (-0.36, -0.21) ***	-0.19 (-0.27, -0.11)***	-0.33 (-0.41, -0.26) ***

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.  
<sup>a</sup> Numbers in the table cells are Spearman's correlation coefficients.

**Table 2**  
Depression, anxiety, and quality of life of study participants at early and late quarantine periods.

	1st survey (t <sub>1</sub> ) <sup>a</sup>	2nd survey (t <sub>2</sub> ) <sup>a</sup>	Mean difference (95% CI of β)	Cohen's d	Wald χ <sup>2</sup>	p
Depression	1.47 ± 2.91	1.62 ± 2.78	0.19 (-0.02, 0.40)	0.05	3.16	0.075
Anxiety	1.07 ± 2.43	0.83 ± 2.10	-0.22 (-0.39, -0.05)	-0.11	6.50	<b>0.011</b>
<i>Quality of life</i>						
Physical	74.55 ± 12.82	74.70 ± 13.43	0.09 (-0.83, 1.01)	0.01	0.03	0.853
Psychological	72.68 ± 15.55	72.89 ± 15.26	0.41 (-0.60, 1.42)	0.01	0.62	0.430
Social	72.74 ± 17.65	73.24 ± 16.85	0.17 (-1.00, 1.34)	0.03	0.08	0.776
Environmental	68.97 ± 14.96	70.13 ± 14.50	1.55 (0.48, 2.62)	0.08	8.00	<b>0.005</b>
Overall	72.23 ± 12.76	72.74 ± 12.53	0.57 (-0.22, 1.36)	0.04	1.98	0.159

<sup>a</sup> Early and late quarantine indicated the 1st and 14th day of quarantine, respectively.

**Table 4**  
Potential effect-modification by time on the association of depression and anxiety with overall and domain-specific quality of time.

Independent variables	Estimates				Testing	
	$\beta$	s.e.	95% CI of $\beta$	Effect size ( $\eta^2$ )	Wald $\chi^2$	p
<i>Physical domain</i>						
Intercept	74.52	0.49	(73.55, 75.48)		23,002.05	<0.001
Time (late)	0.18	0.47	(-0.75, 1.11)	0.0001	0.15	0.703
Depression	-1.21	0.29	(-1.77, -0.65)	0.0273	17.74	<0.001
Anxiety	-0.93	0.34	(-1.59, -0.27)	0.0032	7.64	0.006
Depression × time	-0.04	0.32	(-0.67, 0.59)	0.0001	0.02	0.897
Anxiety × time	0.44	0.40	(-0.34, 1.22)	0.0008	1.23	0.267
<i>Psychological domain</i>						
Intercept	72.84	0.64	(71.59, 74.09)		13,087.91	<0.001
Time (late)	0.67	0.52	(-0.36, 1.69)	0.0000	1.63	0.201
Depression	-0.95	0.29	(-1.52, -0.39)	0.0187	11.06	<0.001
Anxiety	-0.78	0.30	(-1.37, -0.18)	0.0013	6.53	0.011
Depression × time	0.15	0.32	(-0.48, 0.77)	0.0005	0.21	0.646
Anxiety × time	-0.05	0.41	(-0.87, 0.76)	0.0000	0.02	0.894
<i>Social domain</i>						
Intercept	73.20	0.73	(71.78, 74.63)		10,170.79	<0.001
Time (late)	0.36	0.61	(-0.83, 1.55)	0.0003	0.35	0.557
Depression	-1.33	0.33	(-1.99, -0.68)	0.0168	16.00	<0.001
Anxiety	-0.35	0.42	(-1.17, 0.48)	0.0021	0.68	0.408
Depression × time	0.13	0.39	(-0.63, 0.90)	0.0002	0.12	0.731
Anxiety × time	-0.06	0.50	(-1.04, 0.93)	0.0010	0.01	0.907
<i>Environmental domain</i>						
Intercept	68.89	0.63	(67.66, 70.12)		12,002.96	<0.001
Time (late)	1.84	0.55	(0.76, 2.92)	0.0002	11.18	<0.001
Depression	-1.03	0.30	(-1.62, -0.43)	0.0175	11.53	<0.001
Anxiety	-0.22	0.32	(-0.85, 0.41)	0.0001	0.46	0.496
Depression × time	0.67	0.33	(0.03, 1.31)	0.0021	4.20	<b>0.041</b>
Anxiety × time	-0.53	0.40	(-1.31, 0.25)	0.0002	1.80	0.180
<i>Overall</i>						
Intercept	72.36	0.50	(71.38, 73.35)		20,726.17	<0.001
Time (late)	0.75	0.41	(-0.05, 1.55)	0.0002	3.35	0.067
Depression	-1.07	0.24	(-1.55, -0.59)	0.0280	19.23	<0.001
Anxiety	-0.56	0.26	(-1.08, -0.05)	0.0019	4.55	0.033
Depression × time	0.24	0.26	(-0.27, 0.76)	0.0001	0.85	0.358
Anxiety × time	-0.08	0.31	(-0.68, 0.53)	0.0002	0.06	0.799

A longitudinal study in Argentina investigated the emotional impact of the lockdown during the COVID-19 pandemic on the general population and showed that depression increased slightly, but anxiety decreased from day 2 to 2 weeks later during the quarantine period [43]. Another longitudinal analyses of 36,520 adults across 20 weeks of lockdown in England found that the trajectories of depression had a slight increase in the first 2 weeks, but anxiety level declined over time [44]. These results were similar to our findings in the present study. In a cross-sectional study of health-related QOL among different quarantine conditions during the pandemic peak in Vietnam, a higher QOL level was obtained by EQ-VAS and EQ-5D-5L among people in the government quarantine facilities than people under self-isolation in their own homes. Anxiety and/or depression were found at any quarantine level [45]. However, this Vietnamese study did not investigate the change of QOL over time during quarantine. These studies provided empirical evidence showing that selected restriction measures, including quarantine at collective facilities, affected people's psychological responses.

We found a significant decrease in anxiety over the quarantine period. This phenomenon may be related to the level of pandemic in Taiwan and in other countries, and some measurements in the collective quarantine facility in Taiwan. This study was carried out in Taiwan between April and November 2020. Until November 30th 2020, the total cumulative confirmed cases of COVID-19 was 675 in Taiwan, which was considered low compared to many parts of the regions of the world [46]. In comparison with the dramatically growing numbers of confirmed COVID-19 cases in many South East Asian countries, the COVID-19 pandemic situation was considered mild at that time. Around the study period, the average number of confirmed COVID-19 cases per month was about 45.6 in Taiwan, which was much lower than the numbers noted in Vietnam (140.6), Indonesia (71,690.4), and in the Philippines (54,371.5) [47,48]. Therefore, people coming from abroad, especially those from Southern East Asia, might have lower initial psychological stress arising from worrying about being infected in Taiwan because health care workers would evaluate the residents' health condition before they could be sent to the collective quarantine facility, and only asymptomatic people could be allowed to check in. Besides, there were stand-by healthcare professionals to provide timely medical managements for the residents whenever they needed in the collective quarantine facility, which might provide further reassurance for the people under quarantine that the healthcare systems in Taiwan was able to take care their health even there were infected and might let the residents set their mind at rest and decrease in anxiety during quarantine. The second reason for the decrease in anxiety might be the change in emotional dynamics during quarantine. Pratt et al. [49] found that people quarantined at hotels demonstrated cyclic emotional changes over a 2-week quarantine period. In the first wave, people expressed concerns regarding their health and uncertainty during quarantine. In the second wave, people felt isolated and bored. In the third wave, people's mood was down to depression and despair. After that, in the fourth wave, people started using coping mechanisms to deal with the quarantine situation and went back to feeling hopeful, relieved, and optimistic [49]. This finding was echoed by our study, in which poor emotional effect was relieved by the anticipation of the end of quarantine. The emotional change could be also related to the participants' worry about infection initially, but after 14 days in quarantine, they finally knew that they were not infected and alleviating anxiety.

A study in Portugal showed that individuals quarantined at home with more anxiety had a lower health-related QOL, which was also lower in females and in older individuals [50]. Another study in China pointed out that worries about contracting COVID-19 and helplessness in infection prevention were related to greater depression and lower QOL for the international migrants during the COVID-19 pandemic [51].

Our study also noted a negative association of QOL with both depression and anxiety on the first and last days of quarantine. At the very beginning of quarantine, most of the study participants (mostly migrant workers) were worried about the possibility of being infected by

COVID-19 virus while travelling. The fear of COVID-19 infection at the early stage of quarantine might negatively impact their QOL. When the quarantine came to an end, the study participants' bad mood and stress were expectedly relieved, because no positive test result of COVID-19 infection was reported. However, the migrant workers might worry about problems other than the COVID-19 infection during quarantine, such as adapting to the new work in Taiwan, language and communication barriers, culture differences, or lack of income because of quarantine. All these factors possibly influence QOL and could contribute to the negative associations of QOL with both depression and anxiety at the end of quarantine. Cultural differences, like religious expression, affected people's personal perception to COVID-19 and stress regulation [52]. Different cultural backgrounds of migrants might influence their psychological response and QOL during the pandemic. It should be interpreted with caution that the association between quarantine and psychological responses or QOL could be modified by culture. Unfortunately, we did not have sufficient information concerning the culture context (e.g., religion) to further investigate this issue. Besides, the sample size for each country might not be sufficient enough to ensure adequate statistical power for the subgroup analyses.

The psychological stress might affect people's QOL during the COVID-19 pandemic, but the degree of influence might not be the same in different quarantine locations. A Vietnamese study found that the availability of subsidy from the government and free provision of livelihood supplies were essential for people quarantined at government facilities to keep their QOL [45]. This Vietnamese study also pointed out that the living environment at a quarantine location had an important influence on QOL [45]. Our study noted a negative association between depression and environmental domain of QOL, and interestingly, such association was attenuated over time. The interaction between depression and time could be due to the fact that people were initially not adaptive to the environment of the collective quarantine facility due to various psychosomatic symptoms after being transported directly from the airport. Nonetheless, interpretations of such findings should be cautious not only because this was not a prior hypothesis proposed in advance but also because the level of statistical significance in only marginal.

One of the strengths of this study is its uniqueness in examining the psychological responses and QOL of residents in collective quarantine facilities, which was an uncommon way of performing quarantine during the global COVID-19 pandemic. Another strength was the repeated assessment of psychological responses and QOL over time among the quarantined people, which allowed the examination of the effect of quarantine in the collective quarantine facilities on the changes in psychological responses and QOL. This can serve as a base for future studies to investigate the fluctuation of psychological responses at within-person level through Ecological Momentary Assessment during the quarantine period in the future. Despite the above strengths, some limitations should also be pointed out. First, participants were recruited from only one collective quarantine facility, and most of the study participants were migrant workers. Based on the statistics from Taiwan CDC, a total of 35 collective quarantine facilities were established by the end of 2020. Due to unavailability of the sociodemographic characteristics of residents in all 35 facilities, we have no idea about the representativeness of our study sample, and the generalizability of our findings to other types of quarantine or other segments of population is unclear. Second, people with psychological distress might not be willing to cooperate in completing the questionnaires, which could entail a certain degree of selection bias. This was particular true for the first survey, in which 22.1% (146/660) of the participants declined to respond. Third, the questionnaires were completed primarily by self-administration, especially in the second survey. We were unable to entirely assure the accuracy of the information provided by the study participants. Nonetheless, we used questionnaires in multiple languages, which largely removed the likelihood of misinterpreting the items in the questionnaires. Fourth, this study mainly presented and explained the

relationship between psychological responses and QOL during quarantine without including pre-pandemic data on the variables relevant to the study, such as anxiety, depression, loneliness, social support, or personality traits for comparison. Fifth, although the current study noted some significant differences in the analyses, the current sample size might not be large enough to detect an effect of quarantine which was smaller than what was assumed in the power calculation. For example, this study did not note a significant difference in PHQ-9 before and after quarantine based on 505 pairs of subjects. Given the type I error of 0.05 and the difference in the PHQ-9 of matched pairs is 0.15 with standard deviation 2.85, we were able to reject the null hypothesis that this response difference is zero with power of 0.268, which is not adequate enough.

## 5. Conclusion

Our study noted a significant decrease in anxiety among the collective quarantine facility residents over the 14-day quarantine period. While depression was consistently and negatively associated with quarantined individuals' overall QOL, only the strength of association between depression and environmental domain QOL significantly decreased over the quarantine period.

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## Author contributions

HJC, CSL, YWH, and CYL designed the study. HJC, CSL, YWH, and CYL contributed to the interpretation of results. HJC, CSL, and CYL drafted the initial manuscript. CSL and CYL performed the statistical analyses. HJC and CYL revised the manuscript.

## Declaration of Competing Interest

The authors report no conflicts of interest.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpsychores.2022.111076>.

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