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The Fear of COVID-19 Scale: Psychometric properties and measurement invariance across 10 months

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ABSTRACT

The coronavirus disease 2019 (COVID-19) has led to various negative consequences including fear. The Fear of COVID-19 Scale (FCV-19S) has been widely used in diverse cultures, but no study has ever investigated its longitudinal measurement invariance and predictive validity. Therefore, we examined its longitudinal measurement invariance and predictive validity over 10 months. A sample of Chinese undergraduates ($N = 682$; first wave 842; 682 second wave) completed the FCV-19S as well as measures assessing depression, anxiety, and stress. Exploratory and confirmatory factor analyses were conducted along with measurement invariance testing. The results showed that the bifactor model fitted well, and significantly predicted stress and anxiety, but not depression. The FCV-19S demonstrated partial measurement invariance (i.e. configural and metric invariances) across time. These findings suggest that the Chinese version of FCV-19S is a reliable tool and could be used in evaluating the severity of fear of COVID-19 among Chinese young adults.

The coronavirus disease 2019 (COVID-19) outbreak in January 2020 spread to over 200 countries because of its high infectivity, leading to various negative consequences. Individuals diagnosed with COVID-19 experienced fever, a dry cough, fatigue, and diarrhea, and nearly seven million people worldwide died (World Health Organization, 2023). The mortality rate of COVID-19 was 15%, which is higher than many other infectious diseases (Baud et al., 2020).

The spread of COVID-19 led to further increased psychological challenges such as fear. Fear is adaptive because it facilitates individuals to cope with threats. For example, evidence indicates that COVID-19-related fear facilitates preventive behaviors (Olapegba et al., 2022; Pilch et al., 2021). On the other hand, intense and unregulated fear can be maladaptive because it impairs mental health (Sep et al., 2019).

To assess COVID-19-related fear, Ahorsu et al. (2020) developed the seven-item Fear of COVID-19 Scale (FCV-19S). In a general sample of Iranian adults ($N = 717$) the FCV-19S had a stable unidimensional structure with sound psychometric properties including internal consistency and concurrent validity with depression, anxiety, perceived infectability, and germ aversion. Consequently, the FCV-19S became much used around the world. It has been translated and validated in many countries including Argentina (Caycho-Rodríguez, Vilca, et al., 2022), Bangladesh (Sakib et al., 2022), Brazil (Cavalheiro & Sticca, 2022), China (Chi et al., 2021), Ethiopia (Elemo et al., 2023), France (Mailliez et al., 2022), Indonesia (Nazari et al., 2021), Israel (Bitan et al., 2021), Japan (Wakashima et al., 2020), Malaysia (Pang et al., 2020), New Zealand (Winter et al., 2023), Pakistan (Ullah et al., 2023), Poland (Pilch et al., 2021), Romania (Stănculescu, 2022), and Spain (Martínez-Lorca et al., 2020). These studies demonstrated that the FCV-19S has adequate reliability and validity. However, validation studies have predominantly focused on cross-sectional data, paying little attention to the

stability of the FCV-19S (Caycho-Rodríguez, Vilca, et al., 2022). Therefore, the present study utilized a longitudinal design to assess whether the FCV-19S has measurement invariance and predictive validity across time.

A handful of studies have examined the measurement invariance of FCV-19S. For instance, studies have shown that the FCV-19S is measurement invariant across gender (Sakib et al., 2022; Stănculescu, 2022), age (Caycho-Rodríguez, Vilca, et al., 2022; Sakib et al., 2022), and culture (Ali et al., 2023; Caycho-Rodríguez, Valencia, et al., 2022; Sawicki et al., 2022). However, measurement invariance of the FCV-19S across time has yet to be evaluated. Due to the unique nature of the COVID-19 pandemic, exploring longitudinal measurement invariance of the FCV-19S could provide evidence to conduct longitudinal research, thereby verifying the long-term impacts of fear of COVID-19 and designing prevention and intervention programs.

To establish a psychometrically robust instrument, it is imperative to test its criterion-related validity. For the FCV-19S, prior studies have demonstrated good concurrent validity related to loneliness (Elemo et al., 2023), happiness (Stănculescu, 2022), perceived vulnerability to disease (Wakashima et al., 2020), preventive behavior (Pilch et al., 2021), negative affect, neuroticism, and extraversion (Nazari et al., 2021), stress, depression, and anxiety (Ahorsu et al., 2020). However, these studies have mainly examined the concurrent validity of FCV-19S using cross-sectional samples, and no study has explored the predictive validity of FCV-19S using longitudinal samples.

Among the validity examination studies, stress, depression, and anxiety were the most examined criterion variables as they are the most common mental health problems caused by COVID-19-related fear (Şimşir et al., 2021). As aforementioned, fear is an automatic response to threats. If these threats (e.g., COVID-19 infection) are hard to avoid, they may cascade into general mental health problems such as stress, anxiety, and depression (Gross & Jazaieri, 2014). People who feared COVID-19 infection may also amplified negative thoughts that impaired their mental health further (Ahorsu et al., 2020). Indeed, a growing body of work has established a positive relationship between COVID-19-related fear and stress, depression, and anxiety (Caycho-Rodríguez, Vilca, et al., 2022; de Medeiros et al., 2021; Mailliez et al., 2022; Pang et al., 2020; Ullah et al., 2023). Therefore, the present study aimed to replicate and to extend previous evidence by examining the predictive validity of FCV-19S using stress, anxiety, and depression as external criteria.

Method

Participants

A total of 682 participants involving in this longitudinal study. The mean age was 19.43 years (*SD* = 1.39), ranging from 18-25 years, and a majority were female (n = 501; 73.5%).

Procedure

The study was approved by the Research Ethics Committee of the first author's university and adhered to the Declaration of Helsinki. An online investigation was conducted using the

WENJUANXING platform (https://www.wjx.cn/). At a Chinese public university, the research team invited counselors who were interested in the research to send a link to their students via *Tencent QQ* and *WeChat* groups. The link first directed students to the informed consent statement, which included objectives, benefits, risks, and their rights. Then the link took them to questions about demographics and psychometrics. Participation was voluntary without compensation and participants can withdraw at any time.

The first wave of data (T1) was collected in November 2021, and the second wave of data (T2) was collected in September 2022. In the first wave, a total of 842 participants (69.7% female) completed all the measures and were aged between 18 and 25 years (M_{age} = 19.39, *SD* =1.34); in the second wave, a total of 682 individuals from the original sample participated again. The unique personal code was used to match the two waves' data and 682 participants were the final sample who filled in at least two measurement time points.

Measures

The FCV-19S comprises seven items (Ahorsu et al., 2020), such as *"I am afraid of losing my life because of COVID-19."* Each item is rated on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The total score is calculated by summing all items, with higher scores indicating higher levels of fear of COVID-19.

Although Chinese validations of the FCV-19-S have now been published, there was no Chinese version of the scale available when the present study first began. Therefore, for the present study, we developed the Chinese version of FCV-19S by following a forward-backward translation procedure based on established guidelines (Beaton et al., 2000). First, the FCV-19S was forward translated into Chinese by two psychology PhD students whose native language is Chinese. This initial Chinese version was then back-translated into English by a bilingual PhD student. A psychology professor also gave some suggestions based on the translations resulting in a final version. In the present study, the Chinese version of FCV-19S showed good internal consistency (α =.82) and its test-retest reliability over ten months was .52.

The DASS-21 assesses depression, anxiety, and stress over the past week (Lovibond & Lovibond, 1995). Each item is rated on a 4-point Likert scale from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). Higher overall scores represent higher levels of depression/anxiety/stress. In the present study, the internal consistencies were sufficient based on the recommendations of Barker et al. (1994): stress (α =.61), depression (α =.70), and anxiety (α =.71).

Data analysis

Data analysis was performed with IBM SPSS 26.0 and Mplus 8.3 (Muthén & Muthén, 1998–2019). First, Exploratory Factor Analysis (EFA) was conducted to identify a unidimensional or multidimensional structure of FCV-19S using Mplus 8.3. The EFA allows items load on all factors, and the number of factors was determined by comparison of fitting

between a one-factor model and a two-factor model based on prior studies (e.g., Ahorsu et al., 2020; Caycho-Rodríguez, Vilca, et al., 2022). Second, Confirmatory Factor Analysis (CFA) was conducted to tested two competitive models: a two-factor model with two correlated first-ordered factors (i.e., Fear-related thoughts and Physical response) and a bifactor model with a general fear as well as two uncorrelated specific factors (i.e., Fear-related thoughts and Physical response) if the EFA showed two factors. According to Hu and Bentler (1999), the model fit is good if the comparative fit index (CFI) and the Tucker-Lewis Index (TLI) > .95, and the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR) < .08.

To test the measurement invariance of FCV-19S, three nested models were compared: configural, metric, and scalar models. The configural model was carried out to test whether the confirmed factor structure was the same across time. The metric model was carried out to test whether factors loadings were constrained equally across time. The scalar model was carried out to test whether both factor loadings and item intercepts were equivalent across time. The evidence of invariance is as follows: ΔCFI < .01, ΔRMSEA < .015, and ΔSRMR < .03 for metric and configural models' comparison; ΔSRMR < .01 for scalar and metric models' comparison (Chen, 2007). Multiple hierarchical regression models were also carried out to test the predictive validity of FCV-19S using depression, anxiety, and stress as criterion variables. More specifically, fear of COVID-19, depression, anxiety, and stress at T1 were the independent variables; depression, anxiety, and stress at T2 were the dependent variables.

Results

The model fit indices for the tested structural models are presented in **Table 1**. The EFA results showed that the one-factor model was poorly fitted, whereas the two-factor model fitted well, suggesting that the FCV-19S is a multidimensional factor. For the two-factor model, Item 1, 2, and 4 belongs to Factor 1, whereas Item 3, 6, and 7 belongs to Factor 2, leaving Item 5 cross-loaded on both above two factors (see **Table 2**). According to the loading distributions, the item semantics, and consistency with previous studies' solutions (e.g., Huarcaya-Victoria et al., 2021), Item 5 along with Item 1, 2, and 4 were loaded onto Factor 1, called Fear-related thoughts, and the other items were loaded onto Factor 2, called Physical response. The CFA results showed that the two-factor model had acceptable fit, while the bifactor model indicated excellent fit. A scaled chi-square difference test further showed that the bifactor model fitted the observed data significantly better than the unidimensional and two-factor models (ΔCFI = .042, ΔTLI= .058, ΔRMSEA = .039, ΔSRMR = .019; $D = 77.22$, $df = 4$, $p < .001$). Except for Item 4 and Item 5, the standardized factor loadings were significant at $p < .001$ (see **Table 3**).

We retested the structure of FCV-19S at time 1 and time 2, respectively. As shown in **Table 4**, both two base models indicated good model fits meaning that the FCV-19S could be explained well by the bifactor structure across two measurement time points. Then, we tested the longitudinal measurement invariance of FCV-19S and the results are presented in **Table 4**.

Except for the scalar invariance model, the fit indices for the configural and metric invariance models were satisfactory. Based on the recommendations of Chen (2007), no difference was found between the metric and configural invariance models (ΔCFI = .001, ΔRMSEA = .005, ΔSRMR = .010), indicating configural and metric invariances existed for the FCV-19S. However, significant differences were found between the scalar and metric invariance models (ΔCFI = .074, ΔRMSEA = .033, ΔSRMR = .052), indicating a lack of evidence for scalar invariance in the FCV-19S. Further analysis showed that the scores of total FCV and its two factors had significant differences across two waves (t = 16.06, 17.53, 8.04; D = 2.85, 2.22, .63, respectively, ps < .001). Consequently, longitudinal measurement invariance for the FCV-19S was established in the configural and metric invariance models.

The correlations between FCV-19S at T1 and stress, depression, and anxiety at T1 and T2 were first computed. The results are reported in **Table 5**. The fear of COVID-19 was positively associated with stress (r_{T1} = .20, r_{T2} = .18, p < .001), depression (r_{T1} = .13, r_{T2} = .11, p < .01), and anxiety (r_{T1} = .21, r_{T2} = .17, p < .001).

The predictive validity was then calculated using multiple hierarchical regression models. As shown in **Table 6**, fear of COVID-19 longitudinally predicted stress (β = .09, p < .05) and anxiety (β = .07, p < .05) after controlling for stress and anxiety at T1, respectively. However, fear of COVID-19 at T1 did not predict depression at T2 (β = .03, p > .05) after controlling for depression at T1.

Discussion

The present study examined the structural model of FCV-19S among Chinese college students. In contrast to Ahorsu et al. (2020) and Huarcaya-Victoria et al. (2021), who reported unidimensional and two-factor models respectively, the present study's findings indicated that the bifactor model fitted well, indicating that the FCV-19S can be viewed as the general level of fear, as well as the specific levels of fear comprfising fear-related thoughts (Items 1, 2, 4, and 5) and physical response (Items 3, 6, and 7) to COVID-19-related fear. Consequently, researchers can use the overall FCV-19S score, as well as fear-related thoughts and physical response subscales independently in COVID-19 fear-related studies. These findings extended the evidence of the structure of the FCV-19S by identifying the bifactor structure of FCV-19S via exploratory and confirmatory factor analyses.

It should be noted that the factor loadings of the items corresponding to the specific factor (i.e., fear-related thoughts and physical response) were lower than those of the general factor. This is especially the case regarding the factor loadings of two items (Items 4 and 5) corresponding to fear-related thoughts which were not significant. Similar to prior validation studies, Chi et al. (2021) also found that the FCV-19S had a bifactor structure and Items 4 and 5 had lower factor loadings among a Chinese sample. One potential explanation might be age differences as the participants for these two studies were youth or young adults (the mean age below 20 years) and they may less sensitive to death (Item 4: *"I am afraid of losing my life*

because of COVID-19") and news reports (Item 5: *"When watching news and stories about COVID-19 on social media, I become nervous or anxious"*). Therefore, it appears that Item 4 and Item 5 were not representative items in the present study based on the factor loadings. Future studies should evaluate whether Items 4 and 5 have satisfactory factor loadings in a bifactor model in different languages and populations.

The FCV-19S was partially invariant concerning the measurement time. Present participants conceptualized the fear of COVID-19 construct the same at different time-points. The metric invariance of the FCV-19S was also confirmed, suggesting that participants responded to the FCV-19S items in the same way at different time-points, which supports the use of the scale for longitudinal investigations of COVID-19 fear.

In contrast, scalar invariance was not established. This implies that the differences in mean levels observed at two measurement time points may not reflect the differences of the latent construct. This may be related to different levels of fear in relation to perceptions and emotions surrounding COVID-19, with participants in November 2021 reported a higher level of COVID-19-related fear than those in September 2022. This is consistent with prior studies conducted by Caycho-Rodríguez, Valencia, et al. (2022) and Sawicki et al. (2022), who reported that the FCV-19S was partially scalar invariant for countries and gender, respectively. Of note, Schnettler et al. (2017) argued that full measurement invariance is unlikely to occur in practice. As such, partial measurement invariance of the FCV-19S might be sufficient and trustworthy to estimate longitudinally (Sawicki et al., 2022).

The findings indicated positive associations between fear of COVID-19 and stress, depression, and anxiety. Based on Gignac and Szodorai's guidelines for correlation effect sizes (2016), fear of COVID-19 had moderate correlations with anxiety (r = .21) and stress (r = .20), while only a small correlation with depression (r = .13). Such results replicated past research in the Chinese context and revealed that the FCV-19S had different concurrent correlational patterns with stress, depression, and anxiety.

Regarding predictive validity, the results indicated that fear of COVID-19 at T1 positively predicted stress and anxiety at T2 after controlling for stress and anxiety at T1, suggesting that individuals who experience high levels of fear of COVID-19 tend to experience high levels of stress and anxiety in general. It should also be noted that the longitudinal associations between fear of COVID-19 and stress (β = .09) as well as anxiety (β = .07) were small. Nevertheless, these results replicated and extended prior studies by using a longitudinal design with two wave's data. In contrast, fear of COVID-19 at T1 did not positively predict depression at T2 after controlling for depression at T1. This is in line with prior cross-sectional studies, which demonstrated that fear of COVID-19 was not significantly associated with depression (Subhas et al., 2021).

Some limitations of the present study should be noted. First, a convenience sample of university students was used rather than a representative sample of the Chinese population with different ages and occupations. Therefore, it is unclear how the present results would generalize

to other populations. Future studies should attempt to replicate the results here in a nationally representative and diverse population. Second, fear of COVID-19, stress, depression, and anxiety were assessed using self-report measures, which may be influenced by social desirability and memory recall biases. Future studies could use multiple data-collecting techniques such as interviews. Third, the study only found partial measurement invariance (lack of scalar invariance) across time in the present sample. This may have been due to translation issues (Oshio, 2010). Future studies could examine longitudinal measurement invariance of the FCV-19S in different languages. Finally, we only used stress, depression, and anxiety as external criteria in testing the longitudinal predictive validity of FCV-19S. Future studies could examine other criteria such as internet addiction and sleep quality (Bai et al., 2024).

The present study examined whether the Chinese version of FCV-19S has measurement invariance across time and its predictive validity using a longitudinal design over a 10-month period. The 7-item FCV-19S fit the bifactor model well, and had partial longitudinal measurement invariance. Although scalar invariance was lacking, the scale is sufficient to compare fear of COVID-19 at different measurement time points (Sawicki et al., 2022). Also, fear of COVID-19 predicted stress and anxiety, but not depression. In sum, the FCV-19S is a reliable psychometric instrument to evaluate the levels of fear of COVID-19 among Chinese young adults.

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Table 1

Model fit indices for the tested structural models of the FCV-19S ($N = 842$)

	Model	χ^2	*df*	CFI	TLI	RMSEA	SRMR	Log-likelihood
EFA	One-factor	181.35	14	.904	.856	.119	.049	−7407.40
	Two-factor	29.67	8	.988	.967	.057	.017	−7331.56
CFA	Two-factor	108.39	13	.945	.912	.093	.039	−7370.92
	Bifactor	31.18	9	.987	.970	.054	.020	−7332.31

Table 2

Standardized factor loadings for the two-factor model of the FCV-19S based on EFA ($N = 842$)

	Factor 1	Factor 2
Item 1	.76***	−.01
Item 2	.72***	−.01
Item 3	.31***	.44***
Item 4	.45***	.26***
Item 5	.34***	.36***
Item 6	−.04	.77***
Item 7	.08	.66***

Note. ***$p < .001$.

Table 3

Standardized factor loadings for the bifactor model of the FCV-19S ($N = 842$)

Facet		General factor	Specific factor
		Λ	λ
Fear-related thoughts	Item 1	.61***	.24***
	Item 2	.57***	.82***
	Item 4	.69***	.04
	Item 5	.64***	.06
Physical response	Item 3	.64***	.17***
	Item 6	.53***	.85***
	Item 7	.61***	.24***

Note. ***$p < .001$.

Table 4

Results for longitudinal measurement invariance of the FCV-19S ($N = 682$)

Model	χ^2	*df*	CFI	TLI	RMSEA	SRMR
Base model T1	21.41	9	.991	.980	.045	.018
Base model T2	46.08	9	.980	.953	.078	.024
Configural invariance	199.87	60	.961	.941	.058	.032
Metric invariance	217.99	74	.960	.951	.053	.042
Scalar invariance	491.82	81	.886	.872	.086	.094

Table 5

The correlation between FCV-19S and stress, depression, and anxiety ($N = 682$)

	1	2	3	4	5	6	7
1. Fear of COVID-19 T1	—						
2. Stress T1	.20***	—					
3. Depression T1	.13**	.39***	—				
4. Anxiety T1	.21***	.47***	.31***	—			
5. Stress T2	.18***	.51***	.36***	.35***	—		
6. Depression T2	.11**	.35***	.61***	.26***	.51***	—	
7. Anxiety T2	.17***	.37***	.27***	.50***	.47***	.34***	—

Note. $^{**}p < .01$, $^{***}p < .001$.

Table 6

Predictive validity of FCV-19S relating to stress, depression, and anxiety ($N = 682$)

	Stress T2		Depression T2		Anxiety T2	
	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
Fear of COVID-19 T1	.18***	.09*	.11**	.03	.17***	.07*
Stress T1		.49***				
Depression T1				.60***		
Anxiety T1						.48*
R^2	.03	.26	.01	.37	.03	.25
ΔR^2	.23**		.36***		.22***	

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.