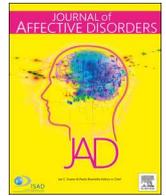




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Research paper

Psychometric property study of the posttraumatic stress disorder checklist for DSM-5 (PCL-5) in Chinese healthcare workers during the outbreak of corona virus disease 2019

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ABSTRACT

Background: Previous studies about the reliability and validity of the updated PCL version for the fifth edition of the Diagnostic and Statistical Manual for Mental Disorders (PCL-5) have only been evaluated in certain samples of the population, which lacks in the sample of Healthcare Workers. Our study focused on the factor structure, reliability and validity of the PCL-5 among Chinese Healthcare Workers during the Outbreak of Corona Virus Disease 2019.

Methods: We conducted an online survey of frontline healthcare workers using the PCL-5 for PTSD. Total of 212 frontline healthcare providers were included in this study.

Results: The findings showed that PCL-5 is a reliable instrument in our sample. The total and subscale scores showed good internal consistency. The convergent and discriminant validity of the PCL-5 were also well demonstrated. Our result showed a better fit with the seven-factor hybrid model compared with other models and supported that the PCL-5 Chinese version can be used as a reliable screening tool to conduct psychological screening for Chinese healthcare workers.

Limitation: We could not examine other aspects of reliability and validity like test-retest reliability or criterion validity. We didn't use the gold-standard structured interview for PTSD in our study. Besides, most of our samples were young people who had access to the internet. Not all professional levels and seniorities were presented because our sample had a lower mean income and educational level.

Conclusion: Our study shows that the Chinese PCL-5 has good validity and reliability in frontline healthcare workers during the outbreak.

1. Background¹

Post-traumatic stress disorder (PTSD) is a mental health condition that occurs when an individual experienced or witnessed a terrifying and traumatic event that exceeds the limit of personal psychological endurance. PTSD can cause significant psychological distress, cognitive dysfunction, and impairment in social and occupational functionality.

The serious negative effects can extend to other individuals, families, and even society (Horesh and Brown, 2018). The four core symptoms of PTSD are repeated recurrence of traumatic experience, continuous avoidance of stimuli related to the traumatic event, negative cognitive and mood changes, and sustained increased alertness (American Psychiatric Association, 2013).

PTSD is a commonly studied psychopathology in the aftermath of

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¹ PTSD, posttraumatic stress disorder; SARS, Severe Acute Respiratory Syndrome; 2019-nCoV, The 2019 novel coronavirus; COVID-19, Corona Virus Disease 2019; PCL-5, posttraumatic stress disorder checklist, updated version for the 5th edition of the Diagnostic and Statistical Manual for Mental Disorders; DSM-5, Diagnostic and Statistical Manual for Mental Disorders, 5th edition; PCL, posttraumatic stress disorder checklist; CFA, confirmatory factor analytic; IES-R, Impact of Event Scale-Revised; EFA, Exploratory Factor Analysis; KMO, The Kaiser–Meyer–Olkin statistic; RMSEA, Root-mean-square-error of Approximation; SRMR, Standardized Root-mean Residual; TLI, Tucker–Lewis Indices; CFI, Comparative Fitness Index; AVE, Average Variance Extracted; CR, Composite Reliability; GAD-7, the 7-item Generalized Anxiety Disorder;

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Table 1
Item mapping for the alternative models for the PCL-5.

| Item description | DSM-5 model | Dysphoria model | Dysphoric Arousal model | Anhedonia model | Externalizing behavior model | Hybrid model |
|---|-------------|-----------------|-------------------------|-----------------|------------------------------|--------------|
| 1. Intrusive thoughts | R | R | R | R | R | R |
| 2. Nightmares | R | R | R | R | R | R |
| 3. Flashbacks | R | R | R | R | R | R |
| 4. Emotional cue reactivity | R | R | R | R | R | R |
| 5. Physical cue reactivity | R | R | R | R | R | R |
| 6. Avoidance of thoughts | A | A | A | A | A | A |
| 7. Avoidance of reminders | A | A | A | A | A | A |
| 8. Trauma-related amnesia | NACM | D | NACM | NACM | NACM | NA |
| 9. Negative beliefs | NACM | D | NACM | NACM | NACM | NA |
| 10. Distorted blame | NACM | D | NACM | NACM | NACM | NA |
| 11. Persistent negative emotional state | NACM | D | NACM | NACM | NACM | NA |
| 12. Lack of interest | NACM | D | NACM | AN | NACM | AN |
| 13. Feeling detached | NACM | D | NACM | AN | NACM | AN |
| 14. Inability to experience positive emotions | NACM | D | NACM | AN | NACM | AN |
| 15. Irritable/ angry | AR | D | DA | DA | EB | EB |
| 16. Recklessness | AR | AR | DA | DA | EB | EB |
| 17. Hypervigilance | AR | AR | AA | AA | AA | AA |
| 18. Exaggerated state | AR | AR | AA | AA | AA | AA |
| 19. Difficulty concentrating | AR | D | DA | DA | DA | DA |
| 20. Sleep disturbance | AR | D | DA | DA | DA | DA |

Note: R re-experiencing, A avoidance, NACM negative alterations in cognitions and mood, AR alterations in arousal and reactivity, AN anhedonia, DA dysphoric arousal, AA anxious arousal, NA negative affect, EB externalizing behavior.

disasters because of its high incidence and burden among people who were exposed to disasters (North et al., 1999; Galea et al., 2005). While the rate of PTSD in the general population is between 5% and 10%, the incidence of PTSD can be as high as 45.9% among direct victims of disasters and ranges between 10% and 20% among rescue workers (Neria et al., 2008; Luo et al., 2008). A global meta-analysis which included 76,101 earthquake survivors demonstrated that shows nearly a quarter of earthquake survivors were diagnosed with PTSD (Dai et al., 2016). In addition, a survey of the survivors following the 2008 Wenchuan earthquake in China showed an incidence of PTSD as high as 45.9% (Luo et al., 2008). Also, results from a one-year follow-up study of Severe Acute Respiratory Syndrome (SARS) patients documented a PTSD diagnosis rate of 38.8% (Gao et al., 2006).

The 2019 novel coronavirus (2019-nCoV) pandemic was the most devastating health disaster in China since the 2003 outbreak of SARS and is the first infectious disease outbreak in a social media age. The rapidly growing number of cases, lack of knowledge related to the virus and super-fast information exchange quickly threw people into a psychological turmoil. While this pandemic has had widespread impact, healthcare providers as frontline fighters in this combat are at extremely high risk of virus infection and mental distress including PTSD. A recent publication demonstrated that Chinese healthcare workers who dealt with COVID-19 patients were 52.0% more likely to have symptoms of depression, 57.0% more likely to have symptoms of anxiety (Lai et al., 2020).

The escalating PTSD among healthcare workers in this large public disaster call for a reliable assessment tool that can be used to evaluate this treatable condition. While there are many other instruments studied and being used in different settings, this article focuses on the Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5), a 20-item self-report measure that assesses the presence and severity of PTSD symptoms (Weathers et al., 2013).

Since initial development in 1990, the Posttraumatic Stress Disorder Checklist (PCL) has been widely used in self-assessment of PTSD symptoms (C Armour et al., 2016; Blevins et al., 2015; J. Elhai et al., 2005). The PCL is one of the most studied screening instruments for adults at risk of PTSD. While the PCL assesses a small number of core symptoms, it appears to be effective and reliable, and yields similar results as longer and more complex measurements (Brewin, 2005). With the release of the fifth edition of the Diagnostic and Statistical

Manual of Mental Disorders (DSM-5), the PCL has been updated to meet the new diagnostic criteria for PTSD (Weathers et al., 2013). The DSM-5 revised the diagnostic structure of PTSD from a three-factor-model with 17 symptoms to a four-factor-model comprising 20 symptoms. This change required a re-examination of reliability and validity of both the total and subscale of PCL-5. For the purpose of introduction of our current research, we briefly summarized the relevant studies on the psychometric properties of PCL-5:

1.1. Reliability and validity of PCL-5

The reliability and validity of PCL-5 have been well studied in different populations. The internal consistency of the total score has been reported as 0.90–0.96 (for the four subscales respectively, intrusions: $\alpha = 0.77 - 0.92$; avoidance: $\alpha = 0.74 - 0.92$; negative alterations in cognitions and mood: $\alpha = 0.78 - 0.89$; hyperarousal: $\alpha = 0.75 - 0.84$). (Blevins et al., 2015; Bovin et al., 2016; Sveen et al., 2016; Wortmann et al., 2016)). The test/re-test reliability r has been reported in four different studies as between 0.66 and 0.91 (Blevins et al., 2015; Bovin et al., 2016; Krüger-Gottschalk et al., 2017; Sveen et al., 2016).

For convergent and discriminant validity, many studies have found that the PCL-5 total score was correlated with measures of related constructs. These include the old versions of PCL (PCL-Civilian and PCL-specific; $r = 0.85-0.87$) and other measurement questionnaires about PTSD, such as the Impact of Event Scale-Revised (IES-R; $r = 0.58-0.64$) (Ashbaugh et al., 2016; Sveen et al., 2016)). The discriminant validity was demonstrated by the weak correlations of PCL-5 with those unrelated constructs, such as alcohol abuse ($r = 0.10-0.40$) and anger ($r = 0.33$) (Blevins et al., 2015; Bovin et al., 2016; Wortmann et al., 2016).

1.2. Structural validity of the PCL-5

Although the DSM-5 proposed a four-factor model of PTSD that was based on a large collection of research evidence, many studies applying confirmatory factor analytic (CFA) have shown poor fit of DSM-5 model with the studied population. (Blevins et al., 2015; Liu et al., 2014). Recent findings suggested that PTSD could also be described with a various number of factors. Table 1 item-maps the DSM-5 and five alternative models for PCL. (1) Dysphoria Model (Simms et al., 2002):

Table 2
Participants characteristics ($N = 212$).

| Characteristic | Variable | N | Percent% |
|----------------------------|-------------------------|-----|----------|
| Age (years) | 18–20 | 10 | 4.7 |
| | 20–30 | 76 | 36 |
| | 30–40 | 70 | 33 |
| | 40–45 | 56 | 26 |
| Gender | Male | 109 | 51.4 |
| | Female | 103 | 48.6 |
| Educational level | Junior college | 96 | 45.3 |
| | Undergraduate | 15 | 7.08 |
| | Graduate school or more | 101 | 47.6 |
| Medical department | Emergency | 40 | 18.9 |
| | Infectious disease | 37 | 17.5 |
| | Pulmonology | 35 | 16.5 |
| | Outpatient clinic | 31 | 14.6 |
| | Intensive care unit | 24 | 11.3 |
| | Radiology | 23 | 10.8 |
| Monthly income level (CNY) | Clinical lab | 22 | 10.4 |
| | 1000–2000 | 113 | 53.3 |
| | 2000–3000 | 88 | 41.5 |
| | 3000 or more | 11 | 5.2 |

this is a four-factor model based on four different groups of symptoms in DSM-5 - re-experience, avoidance, irritability and over-excitement. (2) Dysphoric Arousal Model (J. D. Elhai et al., 2011): this model has 5 factors. It was also modified per DSM-5. In this model, the hyperarousal was further divided into two distinct subscales of dysphoric arousal and anxious arousal. (3) Anhedonia Model (Liu et al., 2014): this is a six-factor model proposed by a Chinese study from a sample of earthquake survivors. This model separates the Negative Alterations in Cognitions and Mood into two different factors, representing changes in negative and positive affect respectively. (4) Externalizing Behavior Model (Tsai et al., 2014): it is a model with six factors. The Dysphoric Arousal factor was split into two separate factors, External Arousal and Externalizing Behavior. (5) Hybrid Model (Cherie Armour et al., 2015): a seven-factor model that was integrated from several six-factor models. It recently caught the most attention because it has been closely studied in different populations and proven to be the best fit for Chinese earthquake survivors, trauma-exposed college students, veterans receiving care at a medical center and military service members seeking PTSD treatment while stationed in garrison. (Blevins et al., 2015; Wang et al., 2015; Bovin et al., 2016; Wortmann et al., 2016). Also, a recent study revealed differential patterns of associations between the seven PTSD factors and comorbid psychopathology, suicidal ideation, hostility, physical and mental functioning, and quality of life, supporting the external validity of this model (Pietrzak et al., 2015).

1.3. Aims of current study

The rampant 2019-nCoV outbreak in China calls close mental health attention, especially to those front-line healthcare workers. Close contacts with those infected make them highly vulnerable, not only medically to infection but also psychologically to mental health illnesses. In order to better evaluate their mental health condition, and also to predict PTSD during and after this public health emergency, we developed a Chinese version of PCL-5 and tested its reliability, convergent and divergent validity. As the factor model of the PCL-5 was inconclusive from previous studies, given that the seven-factor model has been proven to fit well in different studies, this study aims to test the structural validity of this PCL-5 Chinese version and compare the seven-factor hybrid model with other models suggested in the literature.

2. Methods

2.1. Participants and study design

Convenience sampling was used in this study. Participants were recruited from the Second Xiangya Hospital, affiliated with Central South University. The hospital is located in Changsha City, Hunan Province, China. This study was conducted between two months of the outbreak from February 1st and February 25th, 2020, within two months of the coronavirus outbreak. The peak number of confirmed cases during the study period was 58,097 in China. The study hospital is a general hospital with a capacity of 3500 beds. It is one of the designated hospitals by the Chinese government to admit febrile patients to rule out 2019-nCoV infection. All participants in this study were frontline medical residents or clinical lab specialists at a high risk of infection and psychological stress. We chose an online questionnaire to survey because: (1) face-to-face survey was impractical given the requirement of quarantine and risk of viral transmission from close personal interaction. (2) The online survey was fast, easy and convenient for data collection and analysis.

Participants were selected from those hospital departments that involved either direct contact care to suspected or confirmed 2019-nCoV cases or direct handling of biospecimen. This included the emergency department, outpatient clinic, clinical lab, radiology, infectious disease, pulmonology, and intensive care unit. The policy of Central South University required every radiology resident to conduct direct patient interview and be involved in performing image scanning with the radiology technologist. The studied clinical lab specialists are medical doctor equivalent trainees who graduated from medical school with a Preventive Medicine degree. One selection criterion was that the current working environment is at high risk of infection, i.e., reported close contact with 2019-nCoV patients or pathogen. A total of 212 subjects were successfully recruited in this study. The sample ($N = 212$) was diverse in terms of demographic characteristics (Table 2). Since this survey was a web-based self-report, in order to ensure the accuracy, only the individuals aged from 18 to 45 were included. The exclusion criteria included inability to consent, cognitive deficit, severe depression, schizophrenia, bipolar disorder or other mental disorders. The inclusion and exclusion criteria questions were asked by the study personnel to assess the participant's eligibility at the beginning of the survey. This cross-sectional study was approved by the Ethics Committee of the Second Xiangya Hospital, Central South University.

2.2. Measures

2.2.1. The PCL-5 Chinese version

The PCL-5 is a self-report measure consisting of 20 items that correspond to the DSM-5 criteria for PTSD. The PCL-5 has 4 subscales, corresponding to each of the symptom clusters in the DSM-5. Participants rate how much a problem described in the item statement bothered them over the past month on a 5-point scale from 0 (not at all) to 4 (extremely). Item scores are summed to yield a total score ranging from 0 to 80. A Chinese version of PCL-5 was developed and used in a previous study on the earthquake-related PTSD symptomatology (Wang et al., 2015). We revised this previously studied PCL-5 Chinese version by using translating-callback method (F, C, and D, 1993). After the original version was translated into Chinese by two Chinese native speaker researchers, the translation was then back-translated into English by two medical English specialists. The back-translation was compared with the original English version. Then a psychiatrist and two clinical psychologists reviewed and verified the accuracy of the translation. Minor edits were subsequently made until the Chinese version of the PCL-5 was adequate.

2.3. Statistical analysis

Descriptive analysis was used to characterize the study sample in terms of demographic information. For reliability test, the internal consistency of PCL-5 was accessed using Cronbach's alpha coefficient, where 0.70 was considered satisfactory (Santos, 1999). Analyses were performed using the SPSS 25.0 and Amos 17.0.

Construct validity was analyzed using Exploratory Factor Analysis (EFA) and CFA. EFA was performed using the Principal Component Analysis with varimax rotation. Bartlett's test of sphericity was used for testing the possibility of performing factor analysis. The Kaiser–Meyer–Olkin (KMO) statistic varied between 0 and 1 in EFA. Values of factor loadings equal or greater than 0.4 were considered satisfactory. A value close to 1 indicated relatively compact patterns of correlations, so factor analysis should yield distinct and reliable factors. Factors with eigenvalues greater than 1 were extracted. Factor loadings of more than 0.40 were considered satisfactory. CFA was performed to determine the goodness-of-fit of the extracted factor model. Root-mean-square-error of Approximation (RMSEA), Standardized Root-mean Residual (SRMR), Tucker–Lewis Indices (TLI), Comparative Fitness Index (CFI) were recorded for testing the fit of the model to the covariance matrix in CFA. $SRMR < 0.08$, $TLI > 0.95$, $CFI > 0.95$ represented a satisfactory model fit. $RMSEA < 0.06$ suggested as an indicator of close fit. (Hu and Bentler, 1999)

Convergent validity and discriminant validity were measured by factor loading, Average Variance Extracted (AVE) and Composite Reliability (CR). Factor loading was used to measure the correlation between items and factors. AVE was used to measure the number of items explained by the underlying factors. CR is used to measure the degree of consistency of the items in each factor. Good convergent validity requires factor loading greater than 0.7, AVE greater than 0.5, and CR greater than 0.6 (Anderson and Gerbing, 1988; Bacon et al., 1995; Fornell and Larcker, 1981).

3. Results

3.1. Participant demographic information and PCL-5 score

We summarized the participants' characteristics in Table 2. A total of 212 healthcare providers were included in this study. More than 50% of the participants were recruited from the emergency room, the infectious disease and the pulmonology department. Together with the intensive care unit, they represented the mainstream medical staff responsible for the diagnosis and treatment of all suspected and confirmed 2019-nCoV patients. The monthly income of the majority of subjects was less than 3000 CNY, only 5.2% reported a monthly income greater than 3000 CNY. The income level of subjects was relatively low, due to them still being in the rotation training phase. Participants reported an average sum score of 38.81 ($SD = 12.40$) on the PCL-5. Means, standard deviations, minimum and maximum values for PCL-5 are presented in Table 3. Because the cut score is 33 for provisional PTSD diagnosis, 59% of the sample met the criteria of provisional PTSD diagnosis.

3.2. Internal consistency reliability

Cronbach's alphas were calculated for the internal consistency of PCL-5. The Cronbach's coefficients of subscale scores in terms of the seven-factor model and DSM-5 four-factor model were summarized in Table 3. The Cronbach's alpha coefficient of the total score was 0.91, which exceeds the 0.70 level and indicates the high reliability of the PCL-5 Chinese version. Internal consistency reliability for each subscale is also satisfactory (0.74–0.90).

Table 3

Normative Data for the PCL-5 and subscales.

| Scale | M | SD | Possible range | Observed range | Cronbach's alpha |
|--|-------|-------|----------------|----------------|------------------|
| PCL-5 | 38.81 | 12.40 | 0–80 | 0–80 | 0.91 |
| PCL-5 intrusions ^a | 11.04 | 5.05 | 0–20 | 0–20 | 0.90 |
| PCL-5 avoidance ^a | 4.48 | 2.18 | 0–8 | 0–8 | 0.75 |
| PCL-5 neg. Cognition & emotions ^a | 16.09 | 5.74 | 0–28 | 1–26 | 0.84 |
| PCL-5 hyperarousal ^a | 14.06 | 4.71 | 0–24 | 2–24 | 0.74 |
| Re-experiencing ^b | 11.04 | 5.05 | 0–20 | 0–20 | 0.90 |
| Avoidance ^b | 4.48 | 2.18 | 0–8 | 0–8 | 0.75 |
| Negative affect ^b | 9.23 | 4.00 | 0–16 | 1–16 | 0.87 |
| Anhedonia ^b | 6.86 | 2.87 | 0–12 | 0–12 | 0.81 |
| Externalizing behavior ^b | 4.71 | 2.13 | 0–8 | 0–8 | 0.76 |
| Anxious arousal ^b | 4.77 | 2.09 | 0–8 | 0–8 | 0.76 |
| Dysphoric arousal ^b | 4.58 | 2.19 | 0–8 | 0–8 | 0.77 |

Note: a DSM-5 4-factor model, b 7-factor model.

3.3. Construct validity

First, we performed an EFA with the sample data to explore the underlying structure of PCL-5. The EFA showed that the data were appropriate for factoring ($KMO = 0.877$; Bartlett's test = 2168.50, $P < 0.001$). The scree plot analysis identified seven factors, which explained a combined 77.2% of the total variance. The proportions of the variances explained were 18.2%, 14.7%, 11.8%, 8.4%, 8.3% and 8.0%. The eigenvalues were 7.42, 1.93, 1.57, 1.50, 1.13, 1.07 and 0.81 for the seven factors, respectively. The values of factor loadings of each item on their corresponding factor ranged from 0.715 to 0.903. This proved that the seven-factor structure model in this study performed same as the Hybrid model.

Subsequently, the CFA was conducted to determine the goodness-of-fit of the seven-factor model. Because the factor model of the Chinese version of PCL-5 was still unclear, to verify the structural validity of the Chinese version of PCL-5, we also tested the remaining 5 models mentioned in the literature. We used the maximum likelihood to estimate each model and summarized the result in Table 4. Hybrid model provided the best fit among the competing models ($P < .001$, $TLI = 0.952$, $CFI = 0.962$, $GFI = 0.910$, $SRMR = 0.053$; $RMSEA = 0.050$).

3.4. Convergent validity and discriminant validity

As shown in Table 5, the factor load of each item on all corresponding subscales was greater than 0.7 in the seven-factor model. Average Variance Extracted (AVE) was greater than 0.5, and Composite Reliability (CR) was greater than 0.8. These results supported a good convergent and discriminant validity of the Chinese version of PCL-5 we developed.

As shown in Table 6, there is an obvious correlation between all subscales, and the correlation coefficient was less than 0.5 and the corresponding square root of AVE. This indicated that there was a certain correlation between the factors but also a certain degree of discrimination, demonstrating a good discrimination validity.

4. Discussion

The current study was designed to test the reliability and validity of a Chinese version of PCL-5 in 2019-nCoV epidemic healthcare workers. The study focused primarily on 2019-nCoV related trauma. We showed that the PCL-5 Chinese version has satisfactory internal consistency and validity. Additionally, we tested the underlying latent structure of the questionnaire. Our results indicated that the seven-factor structure of PCL-5 is a reasonable screening instrument among Chinese healthcare providers during the 2019-nCoV epidemic.

Table 4
Fit indices from confirmatory factor analysis.

| Fit criterion | Hybrid Model | DSM-5 model | Dysphoria model | Dysphoric Arousal model | Anhedonia model | Externalizing behavior model |
|---------------|----------------|-------------|-----------------|-------------------------|-----------------|------------------------------|
| χ^2 | 226.409 | 581.524 | 635.207 | 503.114 | 327.97 | 401.996 |
| df | 149 | 164 | 164 | 160 | 155 | 155 |
| χ^2/df | 1.520 | 3.546 | 3.873 | 3.144 | 2.116 | 2.594 |
| RMSEA | 0.050 | 0.110 | 0.117 | 0.101 | 0.073 | 0.087 |
| TLI | 0.952 | 0.765 | 0.735 | 0.802 | 0.897 | 0.853 |
| CFI | 0.962 | 0.797 | 0.771 | 0.833 | 0.916 | 0.880 |
| SRMR | 0.053 | 0.090 | 0.112 | 0.086 | 0.065 | 0.077 |

Abbreviations: DSM-5: Diagnostic and Statistical Manual of Mental Disorders (5th Edition), df: degrees of freedom, RMSEA: root-mean-square-error of approximation, CFI: comparative fitness index, TLI: Tucker–Lewis indices, SRMR: standardized root-mean residual.

Table 5
Convergent validity.

| Items | Factor | Estimate | Ave | CR |
|---|--------|----------|-------|-------|
| 1. Intrusive thoughts | <← R | 0.868 | 0.638 | 0.898 |
| 2. Nightmares | <← R | 0.762 | | |
| 3. Flashbacks | <← R | 0.775 | | |
| 4. Emotional cue reactivity | <← R | 0.789 | | |
| 5. Physical cue reactivity | <← R | 0.795 | | |
| 6. Avoidance of thoughts | <← A | 0.715 | 0.631 | 0.772 |
| 7. Avoidance of reminders | <← A | 0.866 | | |
| 8. Trauma-related amnesia | <← NA | 0.804 | 0.637 | 0.875 |
| 9. Negative beliefs | <← NA | 0.795 | | |
| 10. Distorted blame | <← NA | 0.816 | | |
| 11. Persistent negative emotional state | <← NA | 0.776 | | |
| 12. Lack of interest | <← AN | 0.758 | 0.595 | 0.815 |
| 13. Feeling detached | <← AN | 0.814 | | |
| 14. Inability to experience positive emotions | <← AN | 0.74 | | |
| 15. Irritable/ angry | <← EB | 0.767 | 0.621 | 0.766 |
| 16. Recklessness | <← EB | 0.809 | | |
| 17. Hypervigilance | <← AA | 0.698 | 0.642 | 0.780 |
| 18. Exaggerated state | <← AA | 0.893 | | |
| 19. Difficulty concentrating | <← DA | 0.691 | 0.657 | 0.790 |
| 20. Sleep disturbance | <← DA | 0.915 | | |

Note: R re-experiencing, A avoidance, NA negative affect, AN anhedonia, EB externalizing behavior, AA anxious arousal, DA dysphoric arousal.

Table 6
Discriminant validity.

| Discriminant validity | | | | | | | |
|-----------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | R | A | NA | AN | EB | AA | DA |
| R | 0.799 | | | | | | |
| A | .351** | 0.794 | | | | | |
| NA | .419** | .350** | 0.798 | | | | |
| AN | .395** | .413** | .396** | 0.771 | | | |
| EB | .492** | .385** | .445** | .410** | 0.788 | | |
| AA | .371** | .329** | .346** | .286** | .208** | 0.801 | |
| DA | .415** | .266** | .297** | .309** | .311** | .401** | 0.811 |

**There was a significant correlation at the level of.01 (bilateral). The numbers on the diagonal are the square root of the average variance extraction (AVE). Note: R re-experiencing, A avoidance, NA negative affect, AN anhedonia, EB externalizing behavior, AA anxious arousal, DA dysphoric arousal.

The internal consistency of the total (Cronbach's alpha = 0.91) and subscale scores in the context of seven-factor structures (alpha = 0.75-0.90) was similar to those reported in previous psychometric studies of the PCL-5 (alpha for total score = 0.90-0.96, and for sub-scale score in terms of four-factor structure = 0.57-0.92) (Ashbaugh et al., 2016; Blevins et al., 2015; Bovin et al., 2016; Krüger-Gottschalk et al., 2017; Sveen et al., 2016; Wortmann et al., 2016).

Further, we also tested other potential models of PCL-5 in the 2019-nCoV healthcare worker population. Our results showed that the seven-factor model fits better than other models. Previous CFA studies have

shown that seven-factor model is the best fitting model in certain populations, including military personnel (Cherie Armour et al., 2015; Blevins et al., 2015; Wortmann et al., 2016), university students (Ashbaugh et al., 2016), and an Asian population with various traumatic experiences such as physical violence, accidents, and network events. (Ito et al., 2019). The fit indices of our study (CFI = 0.962, RMSEA = 0.050) were in the same range of the aforementioned studies (CFI = 0.92-0.99; RMSEA = 0.02-0.08). Our study extended the evidence of the seven-factor model to a sample of healthcare workers with the traumatic experience of a deadly viral infection.

This study also proved that the Chinese version of PCL-5 has good convergent validity and discriminant validity. The load of each item in its corresponding dimension was greater than 0.7, which confirmed that the high representativeness of the items it contains. This translated to a good convergent validity. The fact that those items have better correlation with their corresponding subscale or summary score than with the non-corresponding subscales or summary score, indicated a good divergent validity of the instrument.

Another outcome of this study was that a high percentage of subjects (59%) reported PTSD symptoms (average sum score of 38.8) and met the criteria of provisional PTSD diagnosis. This was consistent with the findings from another recently published Chinese study in the COVID-19 crisis (Lai et al., 2020) that reported among nearly 1300 Chinese frontline healthcare workers, 71.5% reported feelings of distress, although a lower percentage (44.6%) had symptoms of anxiety. In this article, the authors used the 22-item Impact of Event Scale-Revised (IES-R) and the 7-item Generalized Anxiety Disorder (GAD-7) scale to assess the severity of symptoms of distress and anxiety. The IES-R is a 22-item self-report measure of PTSD symptom severity with broader coverage than PCL-5. The majority of participants (60.5%) were medical staff in Wuhan - the most affected city in China. Another difference is that they used the GAD-7 to assess generalized anxiety in the past two weeks. As PCL-5 also evaluates other PTSD symptoms than anxiety, those people who scored high in our study may not be detected from GAD-7.

Despite the important findings of this study, there are limitations which warrant disclosure. First, due to the limited number of test scales, we could not examine other aspects of reliability and validity such as test-retest reliability or criterion validity. And we did not use other scales to evaluate PTSD symptoms and other psychological characteristics to assess convergent and divergent validities of the PCL-5. Further research is needed to compare the PCL-5 results with the diagnosis and symptoms determined using the gold-standard structured interview for PTSD, such as the Clinician Administered PTSD Scale for DSM-5 (CAPS-5). It is also necessary to test the relevance of PCL-5 to other scales to assess convergent and divergent validity. Second, the participants were limited to frontline healthcare workers in a designated treatment hospital for 2019-nCoV. The traumatic event was relatively simplistic, only limited to the risk of infection of one kind of disease. To generalize the results, we need further studies to test the psychometric properties of PCL-5 in different populations and various traumatic events. Third, due to contagious property of the new Coronavirus, our study was

conducted online with an intention to minimize the risk of virus transmission. The findings may not apply to paper-and-pencil based assessments. However, the psychometric information we obtained can offer some insights into similar research conducted remotely. Forth, the samples of our study were from the departments with a relatively high risk of exposure to 2019-nCoV, medical staff in other departments with lower exposure risks may have different symptomology therefore deserves future study. Finally, our participants did not represent all age groups because only those with access to the online questionnaire, mostly young, were able to complete the survey. Not all professional levels and seniorities were presented because our sample had a lower mean income and educational level in comparison with the general population of healthcare providers in China.

5. Conclusions

To our knowledge, this study is the first to test the reliability and validity of the Chinese version of PCL-5 using a representative sample of frontline healthcare workers during the 2019-nCoV outbreak. We have shown that the PCL-5 Chinese version is a feasible, reliable, and structurally valid instrument for screening PTSD in frontline healthcare workers. Our result demonstrated a better fit with the seven-factor hybrid model compared with other models and supported that the PCL-5 Chinese version can be used as a reliable screening tool to conduct psychological screening for Chinese healthcare workers during the outbreak of 2019-nCoV. We also found that almost 60% of healthcare workers met the criteria of provisional PTSD diagnosis. This helps establish and improve the warning mechanism of PTSD crisis for early intervention of potential PTSD patients during and after 2019-nCoV disaster. Limitations of this study include the small sample size and health disaster focus. For better generalizability, future studies on a larger population and other occupational samples are needed.

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CRedit authorship contribution statement

Peng Cheng: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing - original draft. **Li-Zhi Xu:** Data curation, Resources. **Wan-Hong Zheng:** Project administration, Writing - review & editing. **Roger M.K. Ng:** Funding acquisition, Supervision, Writing - review & editing. **Li Zhang:** Funding acquisition. **Ling-Jiang Li:** Funding acquisition, Supervision, Writing - review & editing. **Wei-Hui Li:** Funding acquisition, Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors declared that they have no conflicts of interest to this work. We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.

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