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Adapting the COVID Stress Scale (CSS) to investigate the level of stress among Hong Kong Chinese people 1 year after the COVID-19 pandemic

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ABSTRACT

Background: Stress is a crucial driver that affects hygiene behavior. The Hong Kong population lacks a COVID-19 or pandemic related stress measure investigating the COVID-19 related stress after one year of outbreak.
Design and methods: The original COVID Stress Scale (CSS) was translated and culturally adapted into the Chinese (Cantonese) version (CSS-C). Six hundred and twenty-four participants were recruited from the general public to examine the internal consistency, and concurrent and convergent validity of the CSS-C. The test-retest reliability of CSS-C was examined using 39 university students.
Results: People with old age, women, single, low educational level and borderline and abnormal levels of anxiety and depression were likely to perceive high level of COVID-19 related stress. All CSS-C subscales demonstrated good internal consistency, moderate to good test-retest reliability, and weak to moderate correlations with various mental health-related measures.
Discussion: The CSS could help monitor the stress associated the current and potential future pandemics.

Introduction

Coronavirus disease 2019 (COVID-19) is a disease caused by the SARS-CoV-2 virus and was first reported in China in December 2019. The virus spread globally within a short period and >259 million cases and 5 million deaths have been reported worldwide as of November 2021 (World Health Organisation [WHO], n.d.). The estimated prevalence of COVID-19 is as high as 25 % among the general population globally (Cooke et al., 2020), presenting an international health crisis that has caused profound suffering around the world (United Nations [UN], 2020). During previous pandemics in this century, such as the severe acute respiratory syndrome (SARS) and influenza A virus subtype H1N1 (H1N1) outbreaks, people experienced moderate to severe levels of stress that were comparable to those reported in recent COVID-19 studies (Taylor et al., 2020).

Several nationwide studies have assessed stress levels during the COVID-19 pandemic (Kassaw, 2020; Khan et al., 2020; Mazza et al., 2020; Odriozola-Gonzalez et al., 2020; Tee et al., 2020; Wang et al., 2020) using the stress subscale of the Depression Anxiety Stress Scale (DASS) (Lovibond & Lovibond, 2020). The original DASS consists of three subscales (depression, anxiety, and stress) and 42 items. The stress subscale contains 14 items that assess negative affective responses such as irritability and nervousness. The original DASS has been used for both non-clinical (Crawford et al., 2011) and clinical samples, including for patients with depressive symptoms (Page et al., 2007) and chronic pain (Taylor et al., 2005). Although the original DASS has demonstrated psychometric reliability and validity (Norton, 2007; Page et al., 2007; Taylor et al., 2005), it was developed to capture responses to stress without considering factors specific to pandemics. The validity of the DASS for assessing pandemic-related stress is questionable due to specific stress responses that arise during the pandemic, such as the fear of being infected, that are not operationalized in any DASS items.

Taylor et al. (2020) developed the COVID Stress Scales (CSS) to assess stress or anxiety responses specifically related to the COVID-19 pandemic. There are two main advantages of the CSS. First, the CSS expands the scope captured in common stress measures by including items that address the specific consequences of the current COVID-19 pandemic and associated preventive measures and societal responses, such as “Sought reassurance from friends or family about COVID-19,” “I am worried that social distancing is not enough to keep me safe from the virus,” and “I am worried that foreigners are spreading the virus because they're not as clean as we are.” Second, in addition to assessing COVID-

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19-related distress, the CSS is readily adaptable to examine stress and anxiety responses to other pandemics in the future. The CSS has been translated into different languages and used for the general population (Elhai et al., 2020; Taylor et al., 2020), people with anxiety-related disorders, and people with mood disorders (Asmundson et al., 2020).

Anxiety is a crucial driver that affects health seeking behavior, with excessive anxiety even leading to socially disruptive behavior (Taylor, 2019) during pandemics such as SARS, H1N1, and COVID-19. In the 21st century, COVID-19 is an unprecedentedly serious pandemic outbreak globally in terms of the time period needed to contain the outbreak and the number of reported case. Even though we experienced SARS and H1N1, to our knowledge, there is no transmissible respiratory pandemic specific stress assessment measure developed.

The negative emotional experience associated with the social disruptions during the post COVID-19 pandemics continues to affect our lifestyle (Taylor et al., 2020), and, in turn, it could compromise our quality of life and level of life satisfaction. A valid and reliable measure designed for COVID-19 and pandemic-related stress can improve our understanding of the associated mental health risks and facilitate informed public health policy decisions during pandemics (Taylor et al., 2020). However, the Hong Kong population lacks a COVID-19 or pandemic-related stress measure for current and future use. Thus, the objectives of this study are to (i) translate and culturally adapt the English CSS to create the Chinese (Cantonese) version (CSS-C); (ii) establish the psychometric properties of the CSS-C, including internal consistency, test-retest reliability, concurrent and convergent validity; and (iii) investigate the level of COVID-19-related stress in the general population in Hong Kong 1 year after the start of the pandemic.

Materials and methods

CSS-C development

This study is a validation study consisting of two phases. In phase one, the original CSS was forward- and backward-translated and cross-culturally adapted based on the standard translation model (Brislin, 1986). The English version was translated into Cantonese by two independent bilingual translators, one with a mental health nursing background and one a professional translator without health science training. Two initial Cantonese drafts were produced independently (CSS-C-D_1 and D_2). The CSS-C- D_1 and D_2 and the original English version of the CSS were reviewed by the two independent bilingual translators involved in forward translation. Discrepancies between the CSS-C-D_1 and D_2 were discussed between the translators and a consensus Cantonese version (CSS-C-D_3) was developed. Then, the CSS-C-D_3 was translated backward into English by two additional independent bilingual translators who were not involved in the forward translation procedure, one of whom had a mental health nursing background and the other who was a professional translator without health science training. After linguistic discrepancies were discussed and resolved among these translators, a CSS-C-consensus version (CSS-C-D_C) was reached. An expert panel consisting of six members, each with at least 6 years of experience in mental health or infectious disease (two registered mental health nurses, two registered general nurses, one psychologist, and one nursing academic), was assembled to evaluate the CSS-C-D_C on its cultural equivalence regarding the content, semantics, and any conceptual and technical discrepancies with the original English version of the CSS. Based on this evaluation, the expert panel produced a pilot version of the Cantonese CSS (CSS-C-pilot). Finally, the CSS-C-pilot was tested on 10 participants recruited from the general public to ensure its fluency, clarity, and comprehensibility and produce the final version of the CSS-C.

Examination of the psychometric properties of the CSS-C

In phase two, the psychometric properties of the CSS-C were examined. Participants were recruited from the general public and the three major districts of Hong Kong (Hong Kong Island, Kowloon, and New Territories) from February to March 2021. The target population included Cantonese-speaking Hong Kong residents aged 18 or older. Participants under the age of 18 were excluded to avoid the need for parental consent. Research assistants invited potential participants to provide sociodemographic data and complete the CSS-C and other mental health-related measures. Because it was impractical to retest participants who were randomly recruited through street intercepts, a convenience sample of 39 undergraduate students was recruited to take the CSS-C twice, at a 1-week interval, to assess the test-retest reliability. The sample size calculation for test-retest reliability was based on an alpha level of 0.05 (two-tailed) and power of 90 %. To avoid under- or over-estimation of the agreement at two time points, the expected reliability (intraclass correlation coefficient [ICC]) was set at 0.50 and the minimum required sample size was determined to be 30 (Bujang & Baharum, 2017).

Measures

Quality of life is affected by various mental health-related factors, including stress, anxiety and depression during the COVID-19 pandemic (Copur & Karasu, 2021). Current literature revealed that the COVID-19 pandemic has led to increased level of psychological distress (Wang et al., 2020). To examine the relationships between perceived level of pandemic related stress with psychological distress and subjective well-being, measures for depression, anxiety, health-related quality of life and perceived level of well-being were included in the present study.

CSS. The CSS has 36 self-rated items in a 6-factor structure, including (i) danger, (ii) socioeconomic consequences, (iii) xenophobia, (iv) contamination, (v) traumatic stress, and (vi) compulsive checking subscales. Respondents are given five response options (0 = not at all, 1 = slightly, 2 = moderately, 3 = very, 4 = extremely), with higher scores indicating higher levels of COVID-19-related stress. To quantify the construct of the measure, the CSS uses self-reported statements (e.g., "I am worried about catching the virus," "Searched the internet for treatments for COVID-19," "I had trouble concentrating because I kept thinking about the virus and searched the internet for treatments for COVID-19") to obtain information regarding COVID-19 stress-related feelings, thoughts, and behaviors. The CSS subscales demonstrated good to excellent internal consistency (Cronbach's α = 0.83–0.95) and convergent validity with the main subscale of the Short Health Anxiety Inventory (Salkovskis et al., 2002) and the Obsessive–Compulsive Inventory-Revised (Foa et al., 2002) among population-representative samples from Canada and the United States. All of the items in the original version were included in the Cantonese translation of the CSS.

Hospital Anxiety and Depression Scale (HADS). The original HADS is a 14-item self-reported questionnaire rated on a four-point ordinal scale (0 = not at all, 1 = from time to time, 2 = a lot of time, 3 = most of the time). The original HADS has two subscales, the anxiety and depression subscales, each with seven items. The total score for each subscale ranges from 0 to 21, with higher scores indicating higher levels of depression or anxiety. The Chinese version of the HADS (HADS-C) demonstrated good internal consistency (Cronbach's α = 0.86) (Leung et al., 1999).

Short Form 12-item Health Survey version 2 (SF-12v2). The original SF-12v2 assesses the self-perceived quality of life. Two summary scores, the physical component summary (PCS) and mental component summary (MCS), were obtained and converted into a score from 0 to 100, representing the minimum and maximum levels of self-perceived mental health-related and physical health-related quality of life, respectively. The SF-12v2 was translated into Chinese and demonstrated unacceptable to good internal consistency across subscales (Cronbach's α = 0.48–0.89) (Lam et al., 2013).

Personal Well-being Index (PWI). The PWI assesses the level of subjective personal well-being. The Chinese version of the PWI (PWI-C)

has 8 items of satisfaction rated on an 11-point end-defined scale (0 = extremely dissatisfied, 5 = neither satisfied nor dissatisfied, 10 = extremely satisfied)[26]. The item scores can be summed to yield an overall subjective well-being score, with higher scores representing higher levels of life satisfaction. The PWI-C had good internal consistency (Cronbach's α = 0.73–0.80) (Lau et al., 2005).

Data analysis

The item content validity index (I-CVI) was computed by averaging the number of expert panel members assigning relevance ratings of 3 or 4 for each item (Polit & Beck, 2006). The expert panel members could examine the relevancy of CSS-C rating on a 4-point scale but only items with ratings of 3 or 4 were included in the calculation of I-CVI. The average scale content validity index (S-CVI/Ave) was computed by dividing the sum of the I-CVI by the number of items. The universal agreement score for each item was 1 or 0, indicating that the item either did or did not reach 100 % expert panel member consensus, respectively. The proportion of universal agreement (S-CVI-UA) was calculated by dividing the sum of the universal agreement score by the number of items.

Quantitative data were analyzed using SPSS software version 23.0 (IBM, Armonk, NY). The level of confidence for significance was set as α = 0.05. Internal consistency was evaluated using Cronbach's α coefficient. An Cronbach's α ≥ 0.9, 0.8 to 0.9, 0.7 to 0.8, 0.6 to 0.7, 0.5 to 0.6 and 0.5 > indicate excellent, good, acceptable, questionable, poor and unacceptable internal consistency, respectively (George & Mallery, 2003). Test-retest reliability was assessed using $ICC_{3,1}$. An ICC > 0.90 indicated excellent reliability, an ICC of 0.75–0.90 indicated good reliability, an ICC of 0.50–0.75 indicated moderate reliability, and an ICC < 0.50 indicated poor reliability (Koo & Li, 2016). Concurrent validity was examined using the correlations of the CSS-C subscale mean scores with the HADS-C subscale mean scores. Convergent validity was examined using the correlations of the CSS-C subscale mean scores with the SF-12v2-C and PWI-C results. Depending on the data normality, Pearson's or Spearman's correlation coefficient was used to analyze the correlations between normally distributed and non-normally distributed variables, respectively. The Kolmogorov–Smirnov test was used to examine the normality of data. The correlation strength was defined as either weak (< 0.35), moderate (0.36–0.67), or strong (0.68–1.0) (Polit & Beck, 2006).

Ethical considerations

Before the study, written informed consent was obtained from the university student participants and verbal informed consent was obtained from the general public participants. The study procedures were conducted in accordance with the Declaration of Helsinki. Ethical approval (HE-KS2020/06) was obtained from the Institutional Review Board of the University Research Centre of the Open University of Hong Kong.

Results

Content validity

For the I-CVI, all ratings except for item 14 on the xenophobia subscale were > 0.83, indicating item acceptability (Kline, 2000). The S-CVI/Ave and S-CVI/UA were calculated for all six subscales and yielded ratings ranging from 0.95 to 1 and 0.83 to 1, respectively. The S-CVI/Ave and S-CVI/UA values indicated that the overall scale-level content validity of the CSS-C was satisfactory. The I-CVI and S-CVI indicated that the relevancy agreement of the CSS-C was satisfactory.

Participant characteristics

Six hundred and twenty-four participants recruited from the general public completed the questionnaires. Among them, 52.4 % were women, 27.9 % were aged 18–29, nearly half were married or cohabitating (49.7 %), 47.4 % had university/college or above education, and 89.3 % were living with others (Table 1).

Internal consistency

The Cronbach's α of the CSS-C subscales ranged from 0.85 to 0.88, indicating good internal consistency (Table 2). There were moderate to strong item-total correlations among the CSS-C subscales ranging from 0.51 to 0.76. Only item 1 (I am worried about catching the virus) had item-total correlation <0.60. None of the items improved the overall Cronbach's α of any of the CSS-C subscales when individually deleted.

Test-retest reliability

Thirty-nine university students completed the reassessment after a 1-week interval and the details were summarized in Table 1. The CSS-C subscales demonstrated moderate to good test-retest reliability (Koo & Li, 2016) as reflected in the $ICC_{3,1}$ values. The $ICC_{3,\ 1}$ values for individual items ranged from 0.51 to 0.85, with item 23 ("I am worried that I might catch the virus from handling money or using a debit machine") showing the most repeatability ($ICC_{3,\ 1}$ = 0.85, 95 % CI = 0.73–0.92) and item 34 ("I am worried that I can't keep my family safe from the virus") showing the least repeatability ($ICC_{3,\ 1}$ = 0.51, 95 % CI = 0.20–0.72) (Table 3).

Concurrent and convergent validity

The concurrent validity of CSS-C with HADS-C and the convergent validity of CSS-C with SF-12v2-C subscales and PWI-C were presented in Table 4. The CSS-C subscales had statistically significant positive weak correlations with the HADS-C anxiety (r = 0.083–0.132) and the HADS-C depression (r = 0.15–0.222), and statistically significant negative weak to moderate correlations with the PCS (r = −0.209 - −0.374) and statistically significant negative weak correlations with the MCS (r = −0.266 - −0.349), respectively. The CSS-C subscales also had statistically significant negative weak correlations (r = −0.051 - −0.313) with

Table 1
Characteristics of the participants.

Characteristics	General public (n = 624)		Undergraduate students (n = 39)	
	Frequency	Percentage	Frequency	Percentage
Age range, years				
18–29	174	27.9	39	100.0
30–39	145	23.2	–	–
40–49	142	22.8	–	–
50–59	99	15.9	–	–
60 or above	64	10.2	–	–
Sex, no.				
Men	297	47.6	16	41.0
Women	327	52.4	23	59.0
Marital status				
Single	232	27.2	37	94.9
Married/cohabit	310	49.7	1	2.6
Widow/widower	82	13.1	1	2.6
Education				
Primary or below	66	10.6	–	–
Secondary	252	42.0	–	–
University/college or above	296	47.4	39	100.0
Living situation				
Alone	67	10.7	1	2.6
With others	557	89.3	38	97.4

Table 2
Internal consistency of the CSS-C.

Item no.	Item	Corrected item-total correlation	Cronbach's Alpha if item deleted
Danger subscale, Cronbach's Alpha = 0.85			
1.	I am worried about catching the virus	0.51	0.85
2.	I am worried that I can't keep my family safe from the virus	0.65	0.83
3.	I am worried that our healthcare system won't be able to protect my loved ones	0.66	0.82
4.	I am worried our healthcare system is unable to keep me safe from the virus	0.65	0.83
5.	I am worried that basic hygiene (e.g., handwashing) is not enough to keep me safe from the virus	0.70	0.82
6.	I am worried that social distancing is not enough to keep me safe from the virus	0.67	0.82
Socio-economic consequences subscale, Cronbach's Alpha = 0.88			
7.	I am worried about grocery stores running out of food	0.76	0.85
8.	I am worried that grocery stores will close down	0.60	0.88
9.	I am worried about grocery stores running out of cleaning or disinfectant supplies	0.62	0.87
10.	I am worried about grocery stores running out of cold or flu remedies	0.67	0.87
11.	I am worried about grocery stores running out of water	0.75	0.85
12.	I am worried about pharmacies running out of prescription medicine	0.76	0.85
Xenophobia subscale, Cronbach's Alpha = 0.88			
13.	I am worried that foreigners are spreading the virus in my country	0.61	0.87
14.	If I went to a restaurant that specialized in foreign foods, I'd be worried about catching the virus	0.67	0.86
15.	I am worried about coming into contact with foreigners because they might have the virus	0.73	0.85
16.	If I met a person from a foreign country, I'd be worried that they might have the virus	0.74	0.85
17.	If I was in an elevator with a group of foreigners, I'd be worried that they're infected with the virus	0.70	0.86
18.	I am worried that foreigners are spreading the virus because they're not as clean as we are	0.70	0.86
Contamination subscale, Cronbach's Alpha = 0.87			
19.	I am worried that if I touched something in a public space (e.g., handrail, door handle), I would catch the virus	0.66	0.84
20.	I am worried that if someone coughed or sneezed near me, I would catch the virus	0.65	0.85
21.	I am worried that people around me will infect me with the virus	0.68	0.84
22.	I am worried about taking change in cash transactions	0.73	0.83
23.	I am worried that I might catch the virus from handling money or using a debit machine	0.73	0.83
24.	I am worried that my mail has been contaminated by mail handlers	0.53	0.87
Traumatic stress subscale, Cronbach's Alpha = 0.87			
25.	I had trouble concentrating because I kept thinking about the virus	0.64	0.85
26.	Disturbing mental images about the virus popped into my mind against my will	0.68	0.84
27.	I had trouble sleeping because I worried about the virus	0.71	0.84
28.	I thought about the virus when I didn't mean to	0.71	0.84
29.	Reminders of the virus caused me to have physical reactions, such as sweating or a pounding heart	0.64	0.85
30.	I had had dreams about the virus	0.62	0.85
Compulsive checking subscale, Cronbach's Alpha = 0.85			
31.	Searched the internet for treatments for COVID-19	0.71	0.81
32.	Asked health professionals (e.g., doctors or pharmacists) for advice about COVID-19	0.60	0.83
33.	Checked YouTube videos about COVID-19	0.67	0.82
34.	Checked your own body for signs of infection (e.g., taking your temperature)	0.61	0.83
35.	Sought reassurance from friends or family about COVID-19	0.60	0.83
36.	Checked social media posts concerning COVID-19	0.64	0.82

the PWI-C.

Stress levels of Chinese people in Hong Kong 1 year after the beginning of the COVID-19 pandemic

The mean CSS-C subscale scores and item scores ranged from 4.26 to 11.25 and 0.40 to 2.34, respectively (Table 5). The subscale with the highest score (11.25 ± 4.80) was the xenophobia subscale and that with the lowest score (4.26 ± 3.84) was the traumatic stress subscale. Item 20 ("I am worried that if someone coughed or sneezed near me, I would catch the virus") had the highest score (2.34 ± 1.03) and item 30 ("I had bad dreams about the virus") had the lowest score (0.40 ± 0.70). Table 6 compares the CSS-C subscale scores between participants with normal (HADS-C score 0–7) and borderline to abnormal (HADS-C score 8–21) levels of anxiety and depression. Participants with borderline to abnormal anxiety levels scored higher than those with normal anxiety levels on all of the CSS-C subscales. Similarly, participants with borderline to abnormal depression levels scored higher than those with normal depression levels on all of the CSS-C subscales.

Our stratified comparisons (Table 6) revealed that there were significant differences in all CSS-C subscales between those participants with normal (HADS-C anxiety subscale = 0 to 7) and borderline to abnormal (HADS-C anxiety subscale >7–21) anxiety level ($t = -2.12$ to -3.06, $p < 0.05$), and between those participants with normal (HADS-C depression subscale = 0 to 7) and borderline to abnormal (HADS-C depression subscale >7–21) depression level ($t = -2.14$ to -2.68, $p < 0.05$). Furthermore, women had higher mean scores than men in the danger subscale ($t = -2.519$, $p = 0.04$). There were significant differences in all the CSS-C subscale mean scores between participants with different ages [$F(5, 618) = 3.22–7.79$, $p < 0.05$] and those with different

Table 3
Item and subscale test-retest reliability of the CSS-C.

Item number	Test 1 mean	Test 2 mean	ICC	95%CI low	95%CI high
Danger subscale	10.97	9.56	0.76	0.48	0.88
1.	1.82	1.79	0.79	0.63	0.88
2.	2.18	1.70	0.53	0.18	0.75
3.	1.59	1.77	0.63	0.39	0.78
4.	1.87	1.51	0.65	0.40	0.81
5.	1.59	1.56	0.58	0.33	0.76
6.	1.77	1.38	0.60	0.28	0.78
Socio-economic consequences subscale	5.69	4.79	0.76	0.59	0.87
7.	0.95	0.95	0.63	0.40	0.79
8.	0.72	0.95	0.70	0.49	0.83
9.	0.95	1.26	0.70	0.49	0.84
10.	0.85	1.05	0.54	0.28	0.73
11.	0.54	0.56	0.75	0.57	0.86
12.	0.92	0.79	0.69	0.48	0.82
Xenophobia subscale	10.05	9.68	0.88	0.79	0.94
13.	1.92	2.62	0.54	0.10	0.77
14.	0.97	1.05	0.55	0.29	0.74
15.	1.71	1.82	0.65	0.42	0.80
16.	1.67	1.74	0.78	0.62	0.88
17.	1.64	1.54	0.70	0.50	0.83
18.	1.38	1.72	0.78	0.58	0.89
Contamination subscale	10.15	9.54	0.84	0.71	0.91
19.	1.69	2.13	0.59	0.28	0.78
20.	2.64	2.33	0.59	0.34	0.74
21.	1.79	1.97	0.61	0.38	0.78
22.	1.28	1.38	0.77	0.61	0.87
23.	1.38	1.36	0.85	0.73	0.92
24.	0.87	0.85	0.57	0.31	0.75
Traumatic stress subscale	5.10	4.15	0.72	0.51	0.84
25.	0.79	0.95	0.55	0.30	0.74
26.	0.72	1.03	0.57	0.30	0.75
27.	0.56	0.72	0.71	0.51	0.84
28.	0.92	1.23	0.72	0.48	0.85
29.	0.77	0.62	0.54	0.27	0.73
30.	0.38	0.56	0.70	0.50	0.83
Compulsive checking subscale	7.62	6.79	0.69	0.48	0.82
31.	1.15	0.90	0.57	0.32	0.75
32.	0.67	0.64	0.62	0.38	0.78
33.	1.10	1.15	0.55	0.28	0.74
34.	1.51	1.97	0.51	0.20	0.72
35.	0.85	1.00	0.54	0.28	0.73
36.	1.67	1.79	0.65	0.43	0.80

ICC = intraclass correlation coefficient, CI: confidence interval.

educational level attained [F(2, 621) = 5.85–11.71, $p < 0.05$]. There were also significant differences in the danger, xenophobia and traumatic stress subscale mean scores between those who were single, married/cohabit and widow/widower [F(2, 621) = 3.20–4.99, $p < 0.05$].

Our post hoc analysis using Hochberg's GT2 revealed significant differences between participants who were aged 70 or above had higher danger subscale mean score [mean (M) = 14.23, standard deviation (SD) = 4.44] than all the other age groups (M = 8.79–11.24, SD = 3.87–4.62), higher socio-economic consequence subscale mean score (M = 7.92, SD = 4.66) than those aged between 50 and 59 (M = 4.24, SD = 4.50), higher xenophobia (M = 16.0, SD = 6.27) and traumatic subscale (M = 8.62, SD = 5.04) mean scores than all the other age groups (xenophobia subscale, M = 10.18–11.46, SD = 4.40–5.21; traumatic subscale, M = 3.06–5.33, SD = 2.72–4.09) except for those who were aged between 60 and 69 (xenophobia subscale, M = 12.65, SD = 5.21; traumatic subscale, M = 5.33, SD = 3.77), higher contamination subscale (M = 12.23, SD = 5.57) mean score than those who were aged 50 to 59 (M = 8.19, SD = 3.95), and higher compulsive subscale (M = 11.08, SD = 4.73) mean score than those who were aged 30 to 39 (M = 7.08, SD = 4.07), respectively. Participants educated up to primary or below level had higher mean scores than those educated at secondary level and university/college or above in all the CSS-C subscales. Participants who were married/cohabit, they had higher danger subscale mean score than those who were single, and higher xenophobia and traumatic subscale mean scores than those who were widow/widower.

Discussion

The purpose of this study was to translate and validate a measure of COVID-19 pandemic-related stress levels among Chinese people in Hong Kong. This assessment tool is valuable not only for the current COVID-19 pandemic but also for potential future pandemics. Our findings showed that the CSS-C is culturally relevant to the Hong Kong Chinese population. All of the CSS-C subscales showed good internal consistency, moderate to good test-retest reliability, concurrent validity with a psychological distress measure (HADS-C), and convergent validity with a health-related quality of life measure (SF-12v2-C) and a subjective well-being measure (PWI-C). Moreover, we investigated the level of stress associated with the COVID-19 pandemic 1 year after the outbreak in a sample of the Hong Kong population.

In this study, we assembled an expert panel and calculated the content validity index to represent our knowledge of the construct of the level of stress triggered by COVID-19. The good item-level content validity, except for item 14 ("If I went to a restaurant that specialized in foreign foods, I'd be worried about catching the virus"), and excellent scale-level content validity supported the cultural equivalence and validity of the CSS-C. For item 14, our expert panel suggested that the intended meaning of "foreign foods" can be translated and interpreted in various ways in Cantonese. The linguistic and content equivalence were determined through clarification and discussion among our professional translators and expert panel before conducting the pilot experiment. The feedback from our pilot experiment further confirmed the linguistic and content equivalence of the CSS-C.

To evaluate the ability of the CSS-C to measure the same traits of the construct of interest, we calculated the subscale-level and item-level Cronbach's α coefficients. Although the subscale-level Cronbach's α

Table 4
Correlations between CSS-C and HADS-C, SF-12v2-C and PWI-C.

	Danger, r (p-value)	Socio-economic consequences, r (p-value)	Xenophobia, r (p-value)	Contamination, r (p-value)	Traumatic stress, r (p-value)	Compulsive checking, r (p-value)
HADS-C, anxiety	0.127 (0.001)	0.132 (0.001)	0.083 (0.038)	0.129 (0.001)	0.12 (0.003)	0.084 (0.036)
HADS-C, depression	0.177 (< 0.001)	0.216 (< 0.001)	0.15 (< 0.001)	0.136 (0.001)	0.222 (< 0.001)	0.109 (0.006)
PCS	−0.27 (< 0.001)	−0.221 (< 0.001)	−0.210 (< 0.001)	−0.209 (< 0.001)	−0.297 (<0.001)	−0.374 (< 0.001)
MCS	−0.349 (< 0.001)	−0.266 (< 0.001)	−0.134 (0.001)	−0.303 (< 0.001)	−0.322 (< 0.001)	−0.264 (< 0.001)
PWI-C	−0.264 (< 0.001)	−0.051 (0.203)	−0.188 (< 0.001)	−0.181 (< 0.001)	−0.189 (< 0.001)	−0.313 (< 0.001)

CSS-C, the Chinese version of COVID Stress Scale; HADS-C, the Chinese version of Hospital Anxiety and Depression Scale; SF-12v2-C, the Chinese version of Short Form 12-item Health Survey version 2; PCS, physical component summary; MCS, mental component summary.

Table 5
Mean and standard deviation (SD) of CSS-C item scores.

Item number		Mean	SD
1.	I am worried about catching the virus	1.78	0.97
2.	I am worried that I can't keep my family safe from the virus	1.59	0.97
3.	I am worried that our healthcare system won't be able to protect my loved ones	1.56	1.05
4.	I am worried that our healthcare system is unable to keep me safe from the virus	1.64	1.07
5.	I am worried that basic hygiene (e.g., handwashing) is not enough to keep me safe from the virus	1.47	0.92
6.	I am worried that social distancing is not enough to keep me safe from the virus	1.56	0.93
Danger subscale (range, 0–24)		9.62	4.49
7.	I am worried about grocery stores running out of food	0.68	0.83
8.	I am worried that grocery stores will close down	0.83	0.89
9.	I am worried about grocery stores running out of cleaning or disinfectant supplies	1.14	0.94
10.	I am worried about grocery stores running out of cold or flu remedies	0.95	0.95
11.	I am worried about grocery stores running out of water	0.58	0.80
12.	I am worried about pharmacies running out of prescription medicines	0.75	0.88
Socio-economic consequences subscale (range, 0–23)		4.93	4.20
13.	I am worried that foreigners are spreading the virus in my country	1.77	1.06
14.	If I went to a restaurant that specialized in foreign foods, I'd be worried about catching the virus	1.67	0.86
15.	I am worried about coming into contact with foreigners because they might have the virus	1.96	1.08
16.	If I met a person from a foreign country, I'd be worried that they might have the virus	2.00	0.97
17.	If I was in an elevator with a group of foreigners, I'd be worried that they're infected with the virus	1.92	1.01
18.	I am worried that foreigners are spreading the virus because they're not as clean as we are	1.92	1.09
Xenophobia subscale (range, 0–24)		11.25	4.80
19.	I am worried that if I touched something in a public space (e.g., handrail, door handle), I would catch the virus	2.00	1.03
20.	I am worried that if someone coughed or sneezed near me, I would catch the virus	2.34	1.03
21.	I am worried that people around me will infect me with the virus	1.94	1.00
22.	I am worried about taking change in cash transactions	1.22	1.03
23.	I am worried that I might catch the virus from handling money or using a debit machine	1.14	1.00
24.	I am worried that my mail has been contaminated by mail handlers	0.92	1.01
Contamination subscale (range, 0–24)		9.55	4.71
25.	I had trouble concentrating because I kept thinking about the virus	0.96	0.85
26.	Disturbing mental images about the virus popped into my mind against my will	0.90	0.87
27.	I had trouble sleeping because I worried about the virus	0.62	0.80
28.	I thought about the virus when I didn't mean to	0.85	0.90
29.	Reminders of the virus caused me to have physical reactions, such as sweating or a pounding heart	0.53	0.82
30.	I had bad dreams about the virus	0.40	0.70
Traumatic stress subscale (range, 0–17)		4.26	3.84
31.	Searched the Internet for treatments for COVID-19	1.24	0.92
32.	Asked health professionals (e.g., doctors or pharmacists) for advice about COVID-19	1.03	0.97
33.	Checked YouTube videos about COVID-19	1.22	0.94
34.	Checked your own body for signs of infection (e.g., taking your temperature)	1.81	1.17
35.	Sought reassurance from friends or family about COVID-19	0.92	0.92
36.	Checked social media posts concerning COVID-19	1.42	1.05
Compulsive checking subscale (range, 0–20)		7.64	4.53

values (0.85–0.88) obtained in this study had a lower range than those reported in the original CSS development study (0.83–0.95) (Taylor et al., 2020), our findings suggest that there is no redundancy of items among the CSS-C subscales (Cronbach's $\alpha < 0.90$) (Portney & Watkins, 2009). Moreover, the corrected item-total correlation ($r = 0.51$–0.76) indicates that there is no redundancy or heterogeneity in the CSS-C (Cronbach's $\alpha < 0.70$).

To our knowledge, this is the first study to establish the test-retest reliability of the CSS. Moderate to good test-retest reliability among a group of university students was obtained over a short (1 week) test-retest interval. A 1-week interval is considered sufficient to preclude memory effects and minimize the possibility of impacts of significant changes in the interim (Liu et al., 2014). All items showed at least moderate test-retest reliability ($ICC_{3,1} \leq 0.50$), suggesting that the CSS-C results are highly reproducible, which is clinically desirable. Although item 34 (Checked your own body for signs of infection (e.g., taking your temperature)) showed the least test-retest reliability among the CSS-C items after a 1-week interval, it showed moderate level of agreement between the two measurements and the retention of it did not impair the internal consistency of the compulsive checking scale. One possible explanation for the comparatively lower reproducibility of item 34 is that individual checking behavior may be easily affected by various environmental (e.g., number of COVID-19 confirmed cases) and personal factors (e.g., number of social activities).

As anticipated, COVID-19-related stress levels were significantly correlated with the anxiety and depression subscales of the HADS-C. This is consistent with the previous finding that COVID-19-related stress is associated with anxiety and depression among the general population (Taylor et al., 2020). In light of the various adverse impacts of the COVID-19 pandemic, we also examined the health-related quality of life and subjective well-being in our Hong Kong Chinese cohort. We found that the fear of being infected (danger and contamination subscales of CSS-C) was significantly correlated with both mental and physical health-related quality of life (MCS and PCS of SF-12vs-C), consistent with the findings of a previous local study (Choi et al., 2021). In addition, our results provide evidence to show that other COVID-19 related issues, such as xenophobia, socioeconomic consequences, traumatic stress, and compulsive checking, are associated with the quality of life of the general population. Subjective well-being was also correlated with most CSS-C subscales, except for socioeconomic consequences. The items of the socioeconomic consequences subscale mainly assess the level of concern regarding the stability of supplies (e.g., food, cleaning, and disinfectant supplies). We believe that the availability of supplies was sufficient and stable in Hong Kong at the time of our study and thus, did not affect the subjective well-being of the general population.

In the present study, the danger, xenophobia, contamination, and compulsive checking subscales had average item mean scores of 1–2, indicating that the participants were "slightly" to "moderately" stressed by these factors. The exceptions were item 24 ("I am worried that my mail has been contaminated by mail handlers") in the contamination subscale and item 35 ("Sought reassurance from friends or family about COVID-19") in the compulsive checking subscale, which had average scores of 0.92 ± 1.01 and 0.92 ± 0.92, respectively (Table 5). Our findings were consistent with those of a local study conducted 3 months after the COVID-19 pandemic outbreak began (Choi et al., 2021), in which up to 41 % and 72 % of Hong Kong Chinese people suspected that they were infected and were worried that their family members would be infected, respectively. The low mean scores of item 24 and item 35 might have been due to the minimization of mailing services during the data collection period (February to March 2021) of this study and because, 1 year after the outbreak, the Hong Kong people may have known more about the COVID-19 pandemic, leading them to seek less reassurance from their friends and family. Moreover, our findings revealed that study participants with borderline and abnormal levels of anxiety and depression (HADS-C > 7–21) had higher levels of COVID-19-related stress than those with normal levels of anxiety and depression (HADS-C ≤ 7). The associations between COVID-19-related stress and psychological distress detected in this study echoed a previous overseas study (Taylor et al., 2020) that reported that the mental health of the general population was affected by the COVID-19 pandemic.

The present findings suggested that people with old age, women, single, and low educational level were more likely to perceive high level

Table 6
Comparisons of CSS-C results between participants with normal (HADS-C anxiety subscale score = 0 to 7) and borderline to abnormal (HADS-C anxiety subscale score = 8 to 21) anxiety level, and participants with normal (HADS-C depression subscale score, 0 to 7) and borderline to abnormal (HADS-C depression subscale score = 8 to 21) depression level.

CSS-C subscale	Normal anxiety level (HADS-C 0 to 7) (n = 245) Mean ± SD	Borderline to abnormal anxiety level (HADS-C 8 to 21) (n = 379) Mean ± SD	Mean difference (95 % CI)	t (p-value)	Normal depression level (HADS-C 0 to 7) (n = 371) Mean ± SD	Borderline to abnormal depression level (HADS-C 8 to 21) (n = 253) Mean ± SD	Mean difference (95 % CI)	t (p-value)
Danger	9.02 ± 4.91	10.00 ± 4.16	−0.97 (−1.69, −0.25)	−2.66 (0.008)	9.28 ± 4.30	10.10 ± 4.73	−0.82 (−1.54, −0.11)	−2.26 (0.024)
Socio-economic consequences	4.41 ± 4.45	5.27 ± 4.01	−0.86 (−1.53, −0.18)	−2.45 (0.015)	4.63 ± 4.06	5.34 ± 4.36	−0.74 (−1.41, −0.06)	−2.14 (0.033)
Xenophobia	10.62 ± 4.77	11.65 ± 4.79	−1.04 (−1.80, −0.27)	−2.64 (0.008)	10.82 ± 4.85	11.86 ± 4.67	−1.03 (−1.79, −0.28)	−2.68 (0.008)
Contamination	8.84 ± 5.07	10.01 ± 4.41	−1.16 (−1.94, −0.39)	−2.94 (0.003)	9.22 ± 4.67	10.01 ± 4.74	−0.78 (−1.54, −0.03)	−2.05 (0.040)
Traumatic stress	3.68 ± 3.71	4.63 ± 3.87	−0.95 (−1.55, −0.34)	−3.06 (0.002)	3.89 ± 3.64	4.79 ± 4.05	−0.90 (−1.51, −0.29)	−2.89 (0.004)
Compulsive checking	7.17 ± 5.12	7.95 ± 4.08	−0.79 (−1.51, −0.06)	−2.12 (0.034)	7.24 ± 4.32	8.22 ± 4.76	−0.98 (−1.71, −0.25)	−2.63 (0.009)

CSS-C, the Chinese version of COVID Stress Scale; HADS-C, the Chinese version of Hospital Anxiety Depression Scale.

of COVID-19 related stress. These findings echoed those of Qiu et al. (2020) findings one year ago in which women and older people were found more likely to be psychologically distressed by the COVID-19 pandemics. However, contrary to Qiu et al. (2020) findings, we found that people with higher level of education were less distressed by the COVID-19 pandemics than those had lower level. One possible explanation for this phenomenon is that people with a higher educational level were more able to access and correctly interpret the COVID-19 information. Thus, they are now comparatively less distressed after a year of being exposed to the COVID-19 related information.

This study had several strengths. First, the CSS-C is the first Chinese (Cantonese) instrument that has been developed to measure COVID-19-related stress in the Hong Kong Chinese population. Although several studies have used specific COVID-19 stress measures in Western countries, it had not been adopted for Chinese communities. We can now expand our understanding of COVID-19-related stress and conduct cross-cultural comparisons using this well-validated measure. Second, most previous studies were conducted shortly after the COVID-19 outbreak began. As the pandemic progressed, there were significant changes in the availability of preventive measures, including the development and widespread availability of the vaccine and a downward trend in the number of people infected. The present study provides updated findings on COVID-19-related stress levels 1-year after the onset of the pandemic. Finally, the CSS-C is a pandemic-related stress measure that can be used to assess stress levels for any future pandemics.

This study is not without limitations. First, the participants were recruited from public areas; this implies that those who were unwilling to go out in public were not recruited. As such, the study cohort may not be representative of those who experienced high levels of COVID-19 stress, limiting the generalizability of the present study. Second, although we recruited a large cohort to validate the CSS-C and investigate COVID-19-related stress, the age and sex distribution of participants did not adequately represent the Hong Kong Chinese population. Third, all of the study participants recruited to calculate the test-retest reliability were university students. Further psychometric tests are recommended to confirm the repeatability of the CSS-C for the general population.

In conclusion, assessing the level of stress and psychological distress during pandemic outbreaks is important. The adaptation of validated instruments can help quantify COVID-19-related stress across cultures. With the aid of the CSS, researchers and clinicians could better design psychosocial protective interventions and understand which kinds of psychosocial interventions could better equip the community to cope with the pandemic-related stress in order to improve our emotional sequel, quality of life and subjective well-being during the post COVID-19 pandemics.

Declaration of competing interest

The authors declare that they have no competing interests with respect to either the authorship or the publication of this paper.

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