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The role of intolerance of uncertainty in explaining mental health symptoms among adults in Hong Kong

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ABSTRACT

Intolerance of uncertainty (IU) has been reported as a transdiagnostic risk factor for a variety of mental health outcomes, including post-traumatic stress disorder (PTSD) in response to an acute stressor. However, there is relatively little understanding of the impact of a population-wide long-term stressor (e.g., a pandemic) and its associated risk factors on mental health. The current study evaluated the association between IU components, post-traumatic stress symptoms, general anxiety, and depression in the context of a long-term stressor (towards the end of the COVID-19 pandemic). From October 27, 2022 to December 23, 2022, cross-sectional data were collected through a telephone survey from a sample of 3023 adults aged 18–96 ($M = 57.08$, $SD = 19.05$) who lived in Hong Kong. The results indicated that 8.8 % of the respondents were likely to have PTSD (based on the IES-R), 10.4 % depression (based on the PHQ-2), and 10 % general anxiety (based on the GAD-2). IU components were significant risk factors for experiencing more severe PTSD symptoms and general psychological distress in terms of general anxiety and depression. The results of this study highlight the important and differential roles of IU components in explaining psychological trauma and poor mental health in response to a long-term stressor.

1. Introduction

1.1. The psychological impacts of the COVID-19 pandemic

The COVID-19 pandemic was a long-lasting and stressful healthcare crisis on a global level. Not only did it pose threats to our physical health, a meta-analysis of the mental health impact of the COVID-19 pandemic also found that 12 %–24 % of the general population showed symptoms of post-traumatic stress disorder (PTSD; Yunitri et al., 2022). The pandemic-related stressors, such as direct exposure to the viruses (Fekih-Romdhane et al., 2020; Mohammadian Khonsari et al., 2021) and secondary exposure through the pandemic-related news reports (Cao et al., 2022) were shown to be risk factors for developing PTSD symptoms in the early stage of the pandemic. In Hong Kong, Lau et al. (2021) conducted a survey study ($n = 761$) and found that 28.6 % of the participants showed probable PTSD in early 2020. At the end of 2020, a large-scale random telephone survey ($n = 3,011$) by Cao et al. (2022) revealed 12.4 % of probable PTSD using the same measurement. Apart from PTSD, Zhao et al. (2020) found that the prevalence of other mental health burdens, such as depression and anxiety, also increased in Hong Kong when comparing the cross-sectional data before the pandemic (in 2016, 2017) and during the local outbreak (in 2020). It should, nevertheless, be noted that most studies on this topic, and our general understanding of the impact of the pandemic, are based on data from the early stages of the pandemic (i.e., the first half of 2020).

1.2. Intolerance of uncertainty and psychological problems

Intolerance of uncertainty (IU) is defined as a predisposition to respond negatively (emotionally, cognitively, or behaviourally) to situations or events that lack certainty or are ambiguous (Carleton et al., 2012). For example, when facing uncertainty, individuals with higher levels of IU were more likely to experience negative emotions, such as anxiety and sadness, and less likely to experience positive emotions,

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such as joy and excitement (Morriss et al., 2023). In an attention study, participants with high IU showed patterns of eye movements that were characterised as attention bias even in the absence of a direct threat (Morriss and McSorley, 2019). Behaviourally, Morriss et al. (2021) reviewed the evidence and found that IU played a significant role in classical threat conditioning, particularly in the maintenance of learned fear and anxiety.

IU was initially conceptualised as a key component in the model of Generalised Anxiety Disorder (GAD; Dugas et al., 1998) and later has been identified as a transdiagnostic risk factor for anxiety and mood disorders (Carleton et al., 2012). In a review by Shihata et al. (2016), IU was found to be associated with not only GAD, but also other emotional disorders, such as PTSD and depression. A systematic review of experimental and longitudinal studies by Rosser (2019) found strong support for the causal role of IU in predicting anxiety symptoms and preliminary support for depression. Although the causal evidence of IU on PTSD was limited, Oglesby et al. (2016) collected data prior to and 1 week after a gun shooting incident on a university campus in the U.S. and found that the level of IU before the traumatic event also predicted the level of post-traumatic stress symptoms the week after the shooting. Because of its transdiagnostic nature, IU has been positioned as one of the critical components within the Integrative Hierarchical Model of emotion disorders (Carleton, 2016) and operates alongside other dimensions of transdiagnostic factors, such as neuroticism, anxiety sensitivity, and ruminative style (Morriss, 2023).

Additionally, PTSD and depression have been shown to share high comorbidity (Stander et al., 2014). Although different hypotheses were proposed to explain such a relationship, Stander et al. (2014) reviewed the evidence in combat-related PTSD and found stronger and more consistent support for the causal role of PTSD for depression than other mechanisms. Besides the military population, this causal relationship was also supported by a large-scale study ($n = 1007$) on different trauma types using prospective analysis (Breslau et al., 2000). Despite the transdiagnostic role of IU, and the causal role of PTSD for depression, few studies have examined how these variables could be related. Taken together with the above literature, it is possible that individuals with high levels of IU would be at risk of PTSD during the stressful pandemic, and that PTSD symptoms would then lead to more severe depressive symptoms.

1.3. Importance of IU in the COVID-19 pandemic

As pointed out by Funkhouser et al. (2022), the COVID-19 pandemic induced a significant amount of contextual uncertainty, such as the uncertainty of infections and the uncertainty of vaccines' effectiveness. The future-oriented nature of IU and its focus on psychological responses (Rosen et al., 2014) make it one of the most important constructs to study during and after the pandemic. Bredemeier et al. (2023) showed that individuals' health anxiety and anxiety sensitivity were predicted by their initial levels of IU. Theoretical models, such as the Threat Reactivity Model (Funkhouser et al., 2022) and Uncertainty Distress Model (Freeston et al., 2020), conceptualised IU as a key component that exacerbates the distress caused by pandemic uncertainty. Given that the pandemic has induced a lot of psychological burden, such as PTSD (Cao et al., 2022; Lau et al., 2021), depression, and anxiety (Zhao et al., 2020), the transdiagnostic nature of IU and its role in the maintenance of emotion disorders (Morriss et al., 2021) may provide a potential intervention point to alleviate these symptoms.

1.4. IU components and associations with psychological problems

According to Carleton et al. (2007), IU consists of two factors, namely prospective IU (IUP) and inhibitory IU (IUI). The two-factor structure was found to have superior fit indices than the single-factor structure across clinical and non-clinical samples (Carleton et al., 2012). Birrell et al. (2011) reviewed the factor structure and proposed that IUP was characterised as "desire for predictability", whereas IUI was characterised as "uncertainty paralysis".

Recently, emerging evidence has suggested that IUP and IUI may differentially lead to psychological problems. In general, it was found that IUP is more related to non-phobic anxiety disorder (e.g., GAD and OCD), while IUI was more related to phobic disorder (e.g., social anxiety disorder) and depression (Boelen et al., 2016; Carleton et al., 2016; Hong and Lee, 2015; McEvoy and Mahoney, 2011; McEvoy and Mahoney, 2012). However, research on this topic is still in its early stages and further work is needed to delineate their effects. For example, mixed findings were reported by Boelen et al. (2016) regarding the differential influences of IUP and IUI between cross-sectional and longitudinal data. Additionally, a cross-cultural study conducted in the U.S., Mexico, and China found that the relationship between IU and mental wellness could be moderated by the country of membership (Al-Khaz'Aly et al., 2023). As a result, investigation of the potentially differential relationships between IU dimensions and psychological symptoms could inform a more targeted treatment strategy (McEvoy and Mahoney, 2012) in a non-Western context and contribute to a more comprehensive understanding of IU.

1.5. Current study

In this study, we aimed to examine potential risk factors that negatively affected mental health in the context of a long-term stressor (3 years into the pandemic). An updated understanding of the long-lasting effects and its associated risk factors on the mental health could inform mental health-related clinical practice and policy during the post-COVID-19 era (Vadivel et al., 2021). Risk factors including IU, demographic variables, and exposure to the stressor were included. We hypothesised that in general, higher levels of IU components should explain both more severe PTSD symptoms and poorer mental health. Additionally, IUP and IUI should be differentially associated with PTSD symptoms, general anxiety, and depression, according to previous research (Boelen et al., 2016; McEvoy and Mahoney, 2012). However, due to the limited available evidence, we were not certain about the differential associations with mental health outcomes in a non-Western population. Regarding demographic variables, because some factors such as age, appeared to have no consistent association with mental health during the pandemic (Vindegaard and Benros, 2020) and were not the focus of our study, no specific hypothesis was made regarding their effects.

Since the literature has shown the transdiagnostic role of IU on PTSD (Oglesby et al., 2016) and depression (Rosser, 2019), and found strong evidence for the causal role of PTSD for depression (Breslau et al., 2000; Stander et al., 2014), we explored the mediating relationships among IU, PTSD symptoms, and depressive symptoms. It is hypothesised that individuals with higher levels of IU would be hypervigilant towards situational uncertainty (Oglesby et al., 2016) during the pandemic and constantly look for COVID-19-related information to reduce uncertainty (Bartoszek et al., 2022), eventually leading to hyperarousal symptoms in PTSD. Consequently, individuals in sustained hyperarousal states and preoccupied by certainty-seeking behaviours may find no pleasure in other activities, putting them at risk of depression. Finally, we also attempted to supplement the previous literature by replicating the transdiagnostic role of IU in anxiety-related disorders (Rosser, 2019; Oglesby et al., 2016) in a non-Western sample using mediation analysis.

2. Method

2.1. Setting and procedure

Cross-sectional data were collected through telephone surveys conducted by a survey company, which has extensive experience in conducting research and data collection in Hong Kong. The data collection period was from October 27, 2022 to December 23, 2022 and was

carried out by interviewers with an average five years of work experience. To ensure the data quality, the agency randomly selected at least 5 % of the telephone interviews for examination. The inclusion criteria for respondents were as follows: aged 18 years or above, a Hong Kong resident, and able to verbally communicate in Cantonese. The exclusion criterion was inability to understand or answer the interviewer's questions. If there was more than one eligible respondent in the same household (for the landline numbers), the person whose birthday closest to the date of the call was invited to participate in the survey.

A total of 184,993 calls were placed to both landline and mobile numbers. The eligibility of 3691 respondents were confirmed and 3025 completed the survey. After each call, interviewers were instructed to evaluate the credibility of responses in terms of interviewees' cooperativeness, seriousness, and overall attitude and document suspicious cases. Two suspected cases with arbitrary or nonsense responses were reported and were eventually dropped from the sample. The number of respondents involved and excluded in each stage is presented in Fig. 1. Finally, 3023 respondents provided informed consent and were included in the analysis, which yielded a margin of error of 1.8 % (size of the general adult population in Hong Kong = 6,445,391, 95 % confidence level; Census and Statistics Department, 2022), but some of the respondents chose not to answer some of the survey questions or items. Therefore, the sample sizes reported in some of the Results subsections varied. The average duration of the telephone survey was 20.40 min (*SD* = 6.56 min, *Mdn* = 19.06 min). Ethical approval for this project was obtained from the Institutional Review Board of The Hong Kong Polytechnic University (HSEARS20220725004).

2.2. Measures

This project was part of a large-scale study on the impact of the COVID-19 pandemic on the mental health and behaviours of the general adult population in Hong Kong. It focused on aspects of mental health, namely PTSD symptoms, general psychological distress/depression symptoms, general anxiety symptoms, and IU, as well as exposure to the stressor of the pandemic (via infection) and the effects of demographic variables. The large-scale survey also contained questions on COVID-19-related knowledge and practice that were not analysed in this study.

12-item Intolerance of Uncertainty Scale (IUS-12). The IUS-12 measures IU on a 5-point Likert scale, from 1 (*not at all characteristic of me*) to 5 (*entirely characteristic of me*). It contains 12 items that measure IU in terms of IUP and IUI. A higher total score indicated a higher level of IU. This scale, developed by Carleton et al. (2007), has been reported to have excellent internal consistency (α = .91) and proper convergent validity with measurements of anxiety and worry. In the present study, the Cantonese version translated by Tsang et al. (in preparation) was adopted, and the scale showed good reliability (total score: α = .84; IUP: α = .74; IUI: α = .76).

Impact of Event Scale – Revised (IES-R). PTSD symptoms were measured using the IES-R on a 5-point Likert scale, from 0 (*not all*) to 4 (*extremely*; Horowitz et al., 1979). This scale consists of 22 items and screens participants for probable PTSD based on three symptom clusters, namely intrusion, avoidance, and hyperarousal. In this study, the potential traumatic event was defined as the COVID-19 pandemic, so that each item assessed the participants' level of distress in relation to this

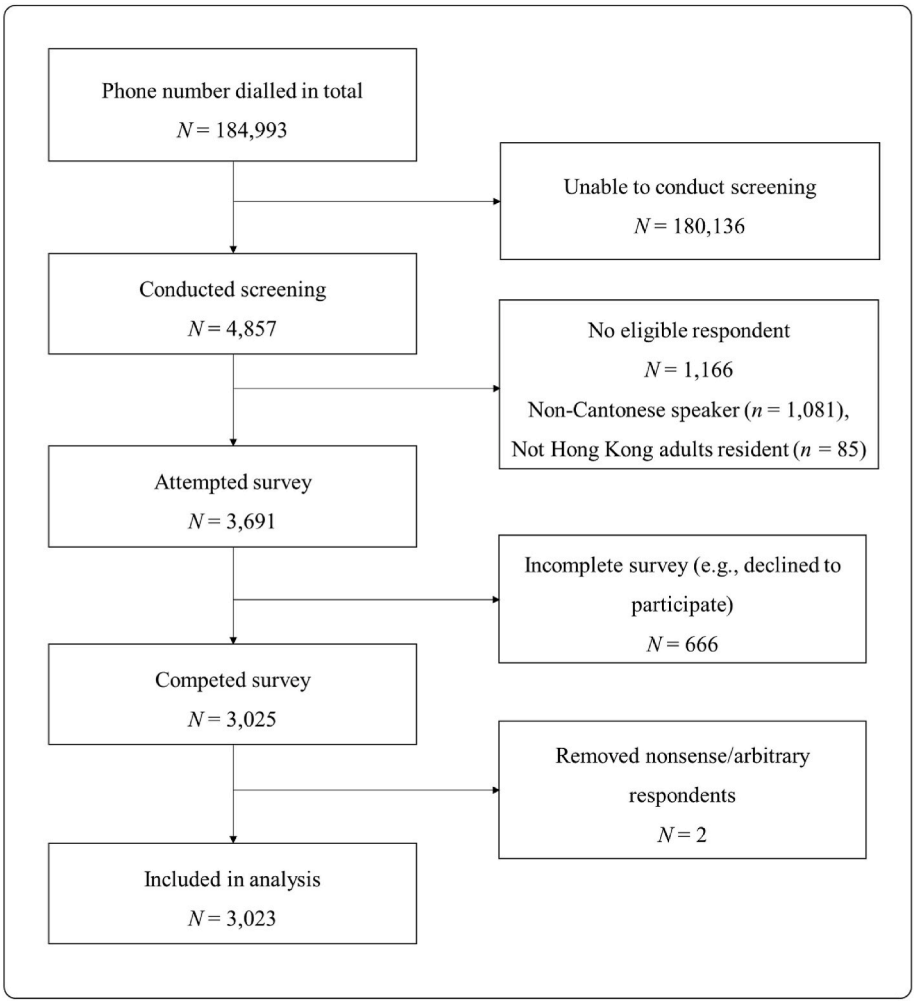

Fig. 1. Flow diagram of respondents involved in each stage of telephone survey.

event (e.g., *'I avoided letting myself get upset when I thought about COVID-19 or was reminded of it'*). In this study, the Chinese version of the IES-R validated by Wu and Chan (2003) was adopted. This version displayed excellent reliability in a previous study (α > .79 for the subscales; Cao et al., 2022), as well as in the current study (α > .75 for the subscales). Total scores and subscale scores were calculated, and higher scores indicated more severe PTSD symptoms. A cut-off score of 33 or above was adopted to indicate probable PTSD (Cao et al., 2022; Lee et al., 2020).

Four-item Patient Health Questionnaire (PHQ-4). The PHQ-4 is a short and validated screening tool developed by Kroenke et al. (2009). It is comprised of the two-item Patient Health Questionnaire (PHQ-2), which screens for possible depression and the two-item Generalised Anxiety Disorder (GAD-2) questionnaire, which screens for possible anxiety. The respondents were asked to rate how often they had been bothered by the symptoms mentioned in each item over the past 2 weeks, from 0 (*not at all*) to 3 (*nearly every day*). In this study, the total scores of the PHQ-2 and GAD-2 were analysed separately. The Chinese version adopted in the current study has been validated locally and found to show good reliability (Guo et al., 2020). Cronbach's alpha in the current study was 0.76 for the PHQ-2 and 0.81 for the GAD-2. A cut-off score of 3 or above was applied to both the PHQ-2 and the GAD-2 (Guo et al., 2020; Kroenke et al., 2009).

Exposure to the stressor, i.e., the pandemic. Previous exposure to the stressor, i.e., the COVID-19 pandemic, was assessed by asking the respondents whether they had been diagnosed with COVID-19 (*yes* or *no*).

Other variables. At the end of the survey, data on the respondents' sociodemographic characteristics, including gender, age, education level, marital status, employment status, monthly income, and carer status, were obtained.

2.3. Data analyses

Version 28 of the IBM Statistical Package for Social Sciences (SPSS) was used to perform the data analyses. Before the formal data analysis, impossible values were screened to rule out invalid responses. Pearson's correlation coefficients were calculated to ascertain the relationships between the variables. Because of the large number of statistics obtained, Bonferroni correction was applied to adjust the critical *p* values of the correlation coefficients. Similar to other studies conducted during the pandemic (e.g., Mazza et al., 2022; Toh et al., 2022), no imputations of missing data were performed.

To further investigate the risk factors for clinically significant symptoms of PTSD (IES-R ≥ 33), anxiety (GAD-2 ≥ 3), and depression (PHQ-2 ≥ 3), three logistic regression analyses were carried out, because the data did not meet the assumptions for running multiple regressions.

Finally, to investigate the mediating role of PTSD symptoms between IU and general psychological distress of depression symptoms, the PROCESS macro (Model 4) developed by Hayes (2022) was used with 5000 bootstrapped estimates.

A similar mediation analysis with anxiety as the outcome variable was conducted to replicate the positive relationship between IU and anxiety-related disorders found in the previous literature (Rosser, 2019; Oglesby et al., 2016). Since it is not the primary focus of this study, the results were presented and discussed in the supplementary materials (see Supplementary Material p. 5–6).

3. Results

3.1. Participants' characteristics

The sociodemographic characteristics of the participants are summarised in Table 1. Of the 3023 participants, aged from 18 to 96 (M = 57.08, SD = 19.05), 56.1 % were female and 42.4 % had been diagnosed with COVID-19 at least once.

Table 1
Sociodemographic characteristics (N = 3023).

	N	% (of valid cases only)
Gender		
Male	1327	43.9
Female	1696	56.1
Age (M = 57.08, SD = 19.05)		
18-29	323	10.8
30-59	1067	35.7
60 or above	1596	53.4
Missing	37	–
Education		
Primary school or below	571	19
Secondary School	1414	47.1
College or above	1019	33.9
Missing	19	–
Marital Status		
Married/cohab	1847	62.3
Not married, i.e., single/divorced/separated/ widowed	1116	37.7
Missing	60	–
Work Status		
Full-time/self-employed	916	30.5
Part-time	262	8.7
Unemployed	103	3.4
Retired	1086	36.2
Student	97	3.2
Housemaker	538	17.9
Missing	21	–
Income		
No personal income	711	25.7
<HK$10,000	779	28.2
HK$10,000–19,999	519	18.8
HK$20,000–49,999	564	20.4
HK$50,000 or more	189	6.8
Missing	261	–
Carer Status		
Is a carer	671	22.5
Not a carer	2317	77.5
Missing	35	–
Being diagnosed with COVID-19		
Yes	1276	42.4
No	1736	57.6
Missing	11	–

3.2. Prevalence of probable PTSD, depression, and anxiety

The prevalence rates of PTSD, anxiety, and depression are presented in Table 2. Using the clinical cut-off of ≥33 on the IES-R, 8.8 % of the respondents presented clinically significant PTSD symptoms. The IES-R subscale results revealed that 5 %, 5.1 %, and 5.9 % of the respondents had moderate levels of distress on the intrusion, avoidance, and hyperarousal subscales, respectively, after applying the subscale cut-offs (mean score ≥2) suggested by Wu et al. (2020).

Clinically significant depression (PHQ-2 ≥ 3) and anxiety (GAD-2 ≥ 3) were identified in 10.4 % and 10 % of the respondents, respectively.

Table 2
Descriptive statistics of the instruments with clinically significant cut-off.

Instruments	*N*	*M*	*SD*	%
IES-R	2743	14.15	12.25	
≥33	242			8.8
<33	2501			91.2
PHQ-2	3000	0.76	1.36	
≥3	311			10.4
<3	2689			89.6
GAD-2	3009	0.75	1.38	
≥3	302			10
<3	2707			90

Note. IES-R = Chinese version of Impact of Event Scale – Revised. PHQ-2 = Two-item Patient Health Questionnaire. GAD-2 = Two-item Generalised Anxiety Disorder.

Notably, 6.2 % of the respondents reached the clinical thresholds for both depression and anxiety symptoms, indicating the potential co-morbidity of both disorders.

3.3. Correlations between psychological trauma and general psychological distress

As shown in Table 3, IUS-12 was moderately correlated with all of the mental health outcomes, including PTSD symptoms ($r = 0.358$), depression ($r = 0.314$), and anxiety ($r = 0.333$), with $ps < 0.001$ for all. Consistently in the subscale analysis, IUP and IUI also showed moderate correlations with all of the mental health outcomes ($ps < 0.001$). PTSD symptoms measured using the IES-R showed moderate correlations with both depression ($r = 0.550$), and anxiety ($r = 0.580$), with $ps < 0.001$.

3.4. Logistic regression for predictors of probable PTSD, depression, and anxiety

Three logistic regression analyses were conducted to examine the risk factors for psychological trauma, depression, and anxiety. The final sample entered into the three logistic regression analyses yielded a margin of error of 2.3 % (adult population = 6,445,391, 95 % confidence level; Census and Statistics Department, 2022). Assumption tests, including tests of multicollinearity and linearity of the logit, were performed before the final analyses. All of the predictors in the logistic regression analyses had the variance inflation factor (VIF) < 10 and tolerance >0.1, indicating multicollinearity was not a concern.

3.5. Risk factors for psychological trauma

In the first logistic regression model ($n = 1865$), gender, age, educational attainment, marital status, work status, monthly income, carer status, a COVID-19 diagnosis, IUP, and IUI score were entered as predictors of PTSD symptoms (IES-R < or ≥ 33).

Having an educational attainment of primary school or below (vs. college or above, $OR = 2.047$), being a carer of a family member (vs. not being a carer, $OR = 1.660$), having a higher level of IUP (for every unit increase in the IUP score, $OR = 1.077$), and a higher level of IUI (for every unit increase in the IUI score, $OR = 1.111$) significantly predicted PTSD symptoms related to the COVID-19 pandemic (Table 4).

3.6. Risk factors for depression

In the second logistic regression model ($n = 1863$), gender, age, educational attainment, marital status, work status, monthly income, carer status, a COVID-19 diagnosis, IUP, IUI, and IES-R (< or ≥ 33) were entered as predictors of depression (PHQ-2 < or ≥ 3).

Being younger (for every 1-year increase in age, $OR = 0.975$), being unemployed (vs. working part-time, $OR = 2.998$; vs. being retired, $OR = 2.913$; vs. being a student, $OR = 3.539$), having no personal income (vs. having an income of HK$10,000–19,999, $OR = 2.416$; vs. having an income of HK$20,000–49,999, $OR = 2.166$), having a higher level of IUP (for every unit increase in the IUP score, $OR = 1.091$), and having IES-R ≥ 33 (vs. IES-R < 33, $OR = 8.713$) significantly predicted depressive symptoms (Table 5).

3.7. Risk factors for anxiety

In the last logistic regression model ($n = 1864$), gender, age, educational attainment, marital status, work status, monthly income, carer status, a COVID-19 diagnosis, IUP, IUI, and IES-R (< or ≥ 33) were entered as predictors of anxiety (GAD-2 < or ≥ 3).

Being younger (for every 1-year increase in age, $OR = 0.981$), being a carer (vs. not being a carer, $OR = 1.516$), having a higher level of IUP (for every unit increase in the IUP score, $OR = 1.116$), and having IES-R scores ≥33 (vs. IES-R scores <33, $OR = 10.915$) significantly predicted anxiety symptoms (Table 6).

3.8. Mediation analysis

3.8.1. Relationship between IU and depression and the mediating role of psychological trauma

A significant positive total effect of IU on depressive symptoms was observed, $\beta = 0.31$, $p < .001$. In particular, the total effect of IU on depressive symptoms could be explained not only by the significant direct effect of IU, $\beta = 0.13$, $p < .001$, but also by the indirect pathway via psychological trauma, $\beta = 0.18$, 95 % CI [0.15, 0.20] (did not contain zero, indicating its statistical significance). Within the indirect pathway, IU significantly and positively predicted psychological trauma symptoms, $\beta = 0.36$, $p < .001$, while psychological trauma was also significantly and positively associated with depressive symptoms, $\beta = 0.49$, $p < .001$. In sum, higher levels of IU predicted more severe depressive symptoms, and psychological trauma symptoms partially mediated this relationship (Fig. 2a). Multicollinearity was not a problem (VIF <10, tolerance >0.1) in this mediation analysis.

Additional mediation analysis was conducted using IUP and IUI, in light of their differential associations with psychological symptoms (Supplementary Material Fig. 1 & Table 2). Notably, the result showed that IUP ($\beta = 0.18$) had a similar but slightly stronger direct effect on depressive symptoms than IUI ($\beta = 0.16$).

3.8.2. Exploration: The mediating roles of the three subtypes of psychological trauma

In an exploratory mediation analysis (Fig. 2b), the three subscales of the IES-R, namely intrusion, hyperarousal, and avoidance, were entered as mediators of the relationship between IU and depression. The results revealed that the indirect effect of psychological trauma observed in the first mediation model could be further attributed to the symptoms of intrusion ($\beta = 0.06$, 95 % CI [0.03, 0.09]) and hyperarousal ($\beta = 0.12$, 95 % CI [0.09, 0.15]), but not avoidance ($\beta < 0.0001$, 95 % CI [−0.02, 0.02]). In other words, the intrusion and hyperarousal symptoms, but not the avoidance symptoms, of PTSD partially mediated the relationship between IU and depression (Table 7). Multicollinearity was not a problem (VIF <10, tolerance >0.1) in this mediation analysis.

Table 3
Descriptive statistics of measurement and correlations.

	N	*M*	*SD*	1	2	3	4	5	6
1. IES-R	2743	14.15	12.25	–					
2. PHQ-2	3000	0.76	1.36	0.550***	–				
3. GAD-2	3009	0.75	1.38	0.580***	0.732***	–			
4. IUS-12	2417	23.20	7.95	0.358***	0.314***	0.333***	–		
5. IUP	2544	14.68	5.06	0.330***	0.297***	0.317***	0.935***	–	
6. IUI	2641	8.48	3.66	0.330***	0.283***	0.290***	0.875***	0.646***	–

Note. All correlation coefficients are significant after the Bonferroni corrections were conducted. IES-R = Chinese version of Impact of Event Scale – Revised. PHQ-2 = Two-item Patient Health Questionnaire. GAD-2 = Two-item Generalised Anxiety Disorder Questionnaire. IUS-12 = 12-item Intolerance of Uncertainty Scale. IUP = Prospective Intolerance of Uncertainty Subscale. IUI = Inhibitory Intolerance of Uncertainty Subscale.
***$p < .001$.

Table 4
Logistic regression results for revised impact of event scale (IES-R).

		Wald	*df*	*p*	*OR*	95 % C.I.for *OR*	
						Lower	Upper
Gender	Male (vs. female)	0.257	1	0.612	0.910	0.631	1.312
Age		2.298	1	0.130	1.012	0.997	1.027
Education		**8.810**	**2**	**0.012**			
	Primary school or below (vs. secondary school)	0.022	1	0.881	1.036	0.650	1.652
	Primary school or below (vs. college or above)	**5.085**	**1**	**0.024**	**2.047**	**1.098**	**3.815**
Marital Status	Married/cohab (vs. not married)	0.770	1	0.380	0.850	0.592	1.221
Work Status		4.972	5	0.419			
	Part-time (vs. full-time)	0.348	1	0.555	0.809	0.401	1.634
	Unemployed (vs. full-time)	0.215	1	0.643	1.241	0.499	3.087
	Retired (vs. full-time)	2.452	1	0.117	0.575	0.288	1.149
	Student (vs. full-time)	0.016	1	0.900	0.936	0.334	2.625
	Housemaker (vs. full-time)	1.958	1	0.162	0.599	0.293	1.228
Monthly Income		2.819	4	0.589			
	<HK$10,000 (vs. no personal income)	0.014	1	0.905	0.972	0.611	1.548
	HK$10,000–19,999 (vs. no personal income)	0.561	1	0.454	0.796	0.439	1.445
	HK$20,000–49,999 (vs. no personal income)	0.716	1	0.398	0.751	0.386	1.459
	HK$50,000 or more (vs. no personal income)	2.642	1	0.104	0.395	0.129	1.211
Carer Status	**Is a carer (vs. not a carer)**	**7.195**	**1**	**0.007**	**1.660**	**1.146**	**2.405**
Being diagnosed	Yes (vs. no)	1.460	1	0.227	1.235	0.877	1.738
IUP		**13.845**	**1**	**<0.001**	**1.077**	**1.036**	**1.119**
IUI		**15.926**	**1**	**<0.001**	**1.111**	**1.055**	**1.169**
Constant		52.637	1	<0.001	0.011		

Table 5
Logistic regression results for 2-item patient health questionnaire (PHQ-2).

		Wald	*df*	*p*	*OR*	95 % C.I.for *OR*	
						Lower	Upper
Gender	Male (vs. female)	0.002	1	0.967	1.008	0.706	1.439
Age		**11.705**	**1**	**0.001**	**0.975**	**0.960**	**0.989**
Education		0.082	2	0.960			
	Secondary School (vs. primary school or below)	0.044	1	0.834	0.943	0.547	1.626
	College or above (vs. primary school or below)	0.081	1	0.776	0.909	0.471	1.753
Marital Status	Married/cohab (vs. not married)	2.687	1	0.101	0.736	0.511	1.062
Work Status		**13.671**	**5**	**0.018**			
	Unemployed (vs. full-time)	1.045	1	0.307	1.578	0.658	3.784
	Unemployed (vs. part-time)	**5.722**	**1**	**0.017**	**2.998**	**1.219**	**7.373**
	Unemployed (vs. retired)	**7.279**	**1**	**0.007**	**2.913**	**1.340**	**6.334**
	Unemployed (vs. student)	**6.804**	**1**	**0.009**	**3.539**	**1.369**	**9.149**
	Unemployed (vs. housemaker)	2.382	1	0.123	1.895	0.841	4.268
Monthly Income		**14.767**	**4**	**0.005**			
	No personal income (vs. <HK$10,000)	1.311	1	0.252	0.754	0.464	1.223
	No personal income (vs. HK$10,000–19,999)	**6.550**	**1**	**0.010**	**2.416**	**1.229**	**4.748**
	No personal income (vs. HK$20,000–49,999)	**4.612**	**1**	**0.032**	**2.166**	**1.070**	**4.387**
	No personal income (vs. HK$50,000 or more)	1.341	1	0.247	1.710	0.690	4.240
Carer Status	Is a carer (vs. not a carer)	0.743	1	0.389	1.182	0.808	1.729
Being diagnosed	Yes (vs. no)	0.366	1	0.545	1.108	0.795	1.545
IUP		**17.839**	**1**	**<0.001**	**1.091**	**1.048**	**1.136**
IUI		0.909	1	0.340	1.027	0.972	1.085
IES-R	**IES-R ≥ 33 (vs. < 33)**	**114.724**	**1**	**<0.001**	**8.713**	**5.863**	**12.948**
Constant		5.982	1	0.014	0.196		

Additional mediation analysis using IUP and IUI showed similar indirect effects (Supplementary Material Fig. 2 & Table 2).

4. Discussion

There is relatively little understanding of the impact of long-term stressors and their associated risk factors on mental health. On May 5, 2023, the World Health Organization (2023) declared that COVID-19 was no longer an international public health emergency, 3 years after its announcement of the global pandemic. Whilst the number of diagnosed cases is decreasing worldwide, the long-term psychological impact of the pandemic remains unknown. Crucially, the pandemic provides a context for studying the risk factors for mental health problems in response to a long-term stressor. We therefore explored the relationship of IU components with PTSD, anxiety, and depression symptoms.

To highlight the key results, we found that IUP and IUI were associated with a higher likelihood of PTSD. Also, IUP, but not IUI, was significantly associated with a higher likelihood of general anxiety, and depression. Finally, we found in our exploratory analysis that the relationship between IU and depression was partially mediated by the intrusion and hyperarousal symptoms of PTSD.

4.1. Prevalence of mental health symptoms following long-term stress

The results of the current study provide an updated mental health profile of the general adult in Hong Kong towards the end of the COVID-19 pandemic (between 27 October and December 23, 2022), i.e., in response to a long-term stressor. It appears that fewer adults in Hong Kong reported active symptoms of PTSD, from the prevalence being

Table 6
Logistic regression results for 2-item generalised anxiety questionnaire (GAD-2).

		Wald	*df*	*p*	*OR*	95 % C.I.for *OR*	
						Lower	Upper
Gender	Male (vs. female)	2.869	1	0.090	0.720	0.493	1.053
Age		**5.802**	**1**	**0.016**	**0.981**	**0.966**	**0.996**
Education		1.806	2	0.405			
	Secondary School (vs. primary school or below)	0.832	1	0.362	0.769	0.437	1.353
	College or above (vs. primary school or below)	0.002	1	0.960	0.983	0.497	1.944
Marital Status	Married/cohab (vs. not married)	0.251	1	0.616	0.905	0.613	1.337
Work Status		2.231	5	0.816			
	Part-time (vs. full-time)	0.038	1	0.845	1.073	0.531	2.165
	Unemployed (vs. full-time)	1.128	1	0.288	1.677	0.646	4.358
	Retired (vs. full-time)	0.020	1	0.888	0.946	0.439	2.039
	Student (vs. full-time)	0.078	1	0.780	0.880	0.359	2.156
	Housemaker (vs. full-time)	0.088	1	0.767	1.121	0.526	2.389
Monthly Income		2.622	4	0.623			
	<HK$10,000 (vs. no personal income)	0.225	1	0.635	1.134	0.675	1.903
	HK$10,000–19,999 (vs. no personal income)	0.551	1	0.458	0.781	0.407	1.499
	HK$20,000–49,999 (vs. no personal income)	0.743	1	0.389	0.734	0.363	1.483
	HK$50,000 or more (vs. no personal income)	0.024	1	0.876	1.075	0.432	2.677
Carer Status	**Is a carer (vs. not a carer)**	**4.388**	**1**	**0.036**	**1.516**	**1.027**	**2.237**
Being diagnosed	Yes (vs. no)	0.034	1	0.854	0.967	0.678	1.381
IUP		**25.162**	**1**	**<0.001**	**1.116**	**1.069**	**1.165**
IUI		0.345	1	0.557	1.018	0.960	1.079
IES-R	**IES-R ≥ 33 (vs. < 33)**	**134.362**	**1**	**<0.001**	**10.915**	**7.287**	**16.351**
Constant		26.589	1	0.000	0.035		

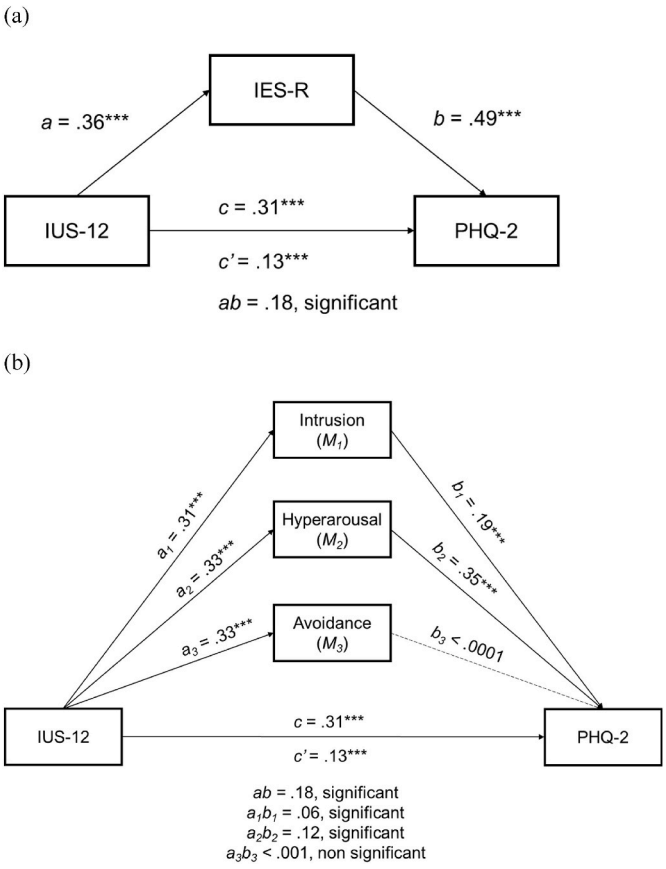

Fig. 2. Mediation Analysis: (a) PTSD symptoms mediate the relationship between intolerance of uncertainty and depressive symptoms and (b) intrusion and hyperarousal of PTSD symptoms domains mediate the relationship between intolerance of uncertainty and depressive symptoms. IUS-12 = 12-item Intolerance of Uncertainty Scale. PHQ-2 = Two-item Patient Health Questionnaire. IES-R = Chinese version of Impact of Event Scale – Revised.
***$p < .001$.

28.6 % between March and April 2020 (Lau et al., 2021) to 12.4 % between December 2020 and February 2021 (Cao et al., 2022). Almost 3 years after the outbreak, the current study revealed a reduced PTSD prevalence of 8.8 %. It is possible that adults became more resilient to the negative psychological impact of the pandemic over time.

However, despite the seemingly declining prevalence of PTSD symptoms in the general adult population, a substantial proportion of adults continue to suffer from psychological distress. The current large-scale telephone survey revealed that the prevalence of possible depression and anxiety was 10.4 % and 10 %, respectively (vs. 6.3 % for depression and 9.3 % for anxiety in 2017, Zhao et al., 2020). The presentation of high levels of distress in these adults almost 3 years after the pandemic onset could be the manifestation of chronic and delayed dysfunctional trajectories after a traumatic event (Bonanno, 2004). A study of the severe acute respiratory syndrome (SARS) epidemic in Hong Kong showed that SARS survivors continued to experience mental health problems up to 4 years after the epidemic (Lam et al., 2009). To alleviate the distress of these adults, it is important to identify those who are at risk of experiencing long-term psychological problems by investigating the possible risk factors and providing proper treatments to target the potential causes of their psychological problems.

4.2. IU components, PTSD, and general psychological distress/depression

In light of the above long-lasting psychological impacts and contextual uncertainty of the pandemic (Funkhouser et al., 2022), IU is believed to be one of the intervention points to mitigate these negative effects. In this study, we investigated the relationship of IU on PTSD, anxiety, and depression. According to the Threat Reactivity Model (Funkhouser et al., 2022) and the Uncertainty Distress Model (Freeston et al., 2020) discussed in relation to the pandemic, IU was proposed to cause poor mental health as it exacerbates the distress caused by pandemic uncertainty. Consistently, we hypothesised that, in general, higher levels of IU components would be associated with a higher risk of PTSD, anxiety, and depression. The results of logistic regression supported our hypothesis and aligned with the proposed theoretical models (Funkhouser et al., 2022; Freeston et al., 2020). It also replicated the transdiagnostic nature of IU on PTSD (Oglesby et al., 2016), anxiety, and depression (Rosser, 2019) found during the non-pandemic context.

Furthermore, we found that components of IU were differently

Table 7
Mediation analysis: PTSD symptoms mediates the relationship between intolerance of uncertainty (IU) and depressive symptoms.

	Bootstrap Estimate					95 % CI (*B*)		
Pathway	*β*	*B*	*SE(B)*	*t*	*p*	Lower	Upper	R^2
Outcome: PHQ-2								
Total effect (*c*)	0.31	0.05	0.003	15.5	<0.001	0.05	0.06	0.1
Direct effect (*c'*)	0.13	0.02	0.003	7.07	<0.001	0.02	0.03	0.31
a (IU → IES-R)	0.36	0.55	0.03	18.38	<0.001	0.49	0.61	0.13
a_1 (IU → Intrusion)	0.31	0.2	0.013	15.85	<0.001	0.18	0.22	0.1
a_2 (IU → Hyperarousal)	0.33	0.16	0.009	16.83	<0.001	0.14	0.17	0.11
a_3 (IU → Avoidance)	0.33	0.2	0.012	16.54	<0.001	0.17	0.22	0.11
b (IES-R → PHQ-2)	0.49	0.06	0.002	26.34	<0.001	0.05	0.06	0.31
b_1 (Intrusion → PHQ-2)	0.19	0.05	0.009	5.87	<0.001	0.04	0.07	0.33
b_2 (Hyperarousal → PHQ-2)	0.35	0.13	0.011	11.31	<0.001	0.11	0.15	0.33
b_3 (Avoidance → PHQ-2)	<0.001	<0.001	0.007	<0.001	0.999	−0.01	0.014	0.33
Indirect effect (*ab*)	0.18	0.03	0.003			0.03	0.04	
a_1b_1 (M_1: Intrusion)	0.06	0.01	0.003			0.01	0.02	
a_2b_2 (M_2: Hyperarousal)	0.12	0.02	0.003			0.01	0.03	
a_3b_3 (M_3: Avoidance)	<0.001	<0.001	0.002			−0.003	0.003	

Note. β = standardised coefficient, B = unstandardised coefficient.

associated with mental health indicators. Although IUP and IUI were associated with a significantly higher risk of PTSD, only IUP was related to a higher likelihood of general anxiety and depression. Our findings were consistent with previous literature that IUP and IUI have distinct effects on psychopathology (Boelen et al., 2016; Carleton et al., 2016; Hong and Lee, 2015; McEvoy and Mahoney, 2012). However, the nature of differences found between our study and the literature appeared to be mixed. Particularly, emerging evidence suggested IUI may be more strongly related to depression due to its emphasis on past and present experiences, whereas IUP may be more closely related to generalised anxiety due to its future-oriented nature (Boelen et al., 2016; Hong and Lee, 2015; McEvoy & Mahoney, 2011, 2012). Given that studies on the differential impacts of IU components are still in the early stage and have primarily been conducted in the Western context (e.g., Boelen et al., 2016; McEvoy and Mahoney, 2011), additional studies are deemed necessary before a more definite conclusion could be drawn. Speculatively, in our study, the relative lack of association between IUI and depression may be partly explained by the cultural difference. When encountering uncertainty, whether to act or not in a collectivist culture, such as Hong Kong, may be determined more by collective decisions than the individual's dispositional characteristics towards uncertainty. Consequently, this may lead to the lack of associations between IUI (i.e., behavioral inhibition) and mental health. Indeed, cross-cultural studies have shown that nationality and race moderated the relationship between IU and mental well-being (Al-Khaz'Aly et al., 2023; Sadeh and Bounoua, 2023). Despite the mixed findings, our study contributes to the existing literature by examining components of IU and different mental health indicators in a large-scale Chinese community sample during the pandemic and providing preliminary evidence of the differential associations between IUP, IUI, and emotion disorders.

In this study, we also explored the co-occurring relationship between IU, PTSD, and depression. We hypothesised that higher levels of IU would exacerbate individuals' PTSD symptoms by increasing hyperarousal towards uncertainty threats and constantly seeking information to reduce pandemic-related uncertainty. The ongoing hyperarousal states and certainty-seeking behaviors would eventually deplete one's energy and interests in other activities, thus leading to more severe depressive symptoms. Results of mediation analyses supported this proposition. We found that PTSD symptoms partially mediated the relationship between IU and depression. Studies conducted during the pandemic also supported the predictive role of PTSD for depressive symptoms (Lee et al., 2020; Tang et al., 2020). Although the current study adopted a cross-sectional design, which may limit the interpretation of the causal effects, the predictive role of PTSD for depression has indeed been supported by a systematic review in the military population (Stander et al., 2014), a large-scale study of PTSD and major depression comorbidity (Breslau et al., 2000), and a longitudinal study in refugees (Nickerson et al., 2023).

To further explore the mediating role of pandemic-induced psychological distress, additional exploratory mediation analysis using the three clusters of PTSD symptoms – avoidance, hyperarousal, and intrusion – as mediators was carried out. IU significantly predicted all of the three subconstructs of PTSD, but only intrusion and hyperarousal symptoms acted as mediators of the relationship between IU and depression. By incorporating the transdiagnostic role of IU, our results extended the findings reported by Lee et al. (2020), who studied the roles of PTSD subconstructs in depression during the pandemic. They found that both intrusion and hyperarousal, but not avoidance, predicted depressive symptoms in a sample of Chinese adults. However, a similar study by Peng et al. (2020) found that only avoidance and hyperarousal were predictors of depression. Despite the somewhat mixed results in the literature, findings in our mediation analysis contribute to the existing knowledge by exploring the mediation effects of specific clusters of PTSD symptoms between IU and depression. It appears that hyperarousal symptoms, such as irritability and hypervigilance, could be an important intervention point for managing the effects of traumatic events on different mental health domains. This is especially important for people who already have a high predisposition to IU.

In addition to mitigating hyperarousal, interventions targeted at reducing IU, such as the computer-based intervention suggested by Oglesby et al. (2017), may be particularly useful in improving the mental health of adults in the context of a long-term stressor. However, given the inconsistent findings for the intrusion and avoidance clusters of PTSD symptoms in the literature, it is recommended that more studies are needed to clarify the roles of different PTSD symptom clusters and how they contribute to other mental health problems. By understanding the underlying mechanisms, more effective interventions can be developed.

4.3. Limitation and future studies

Our findings should be considered in light of the limitations of the study. Given the sampling method and the sample used, the results may only represent the situation of adults in Hong Kong who own a mobile or landline telephone. Because of the study's cross-sectional design, we could not confirm the causal role of IU components for PTSD or depression in response to a long-term stressor. In addition, the key roles of IU and hyperarousal in shaping mental health need to be explored in greater depth in future studies. Longitudinal studies are recommended to test our hypothesis that a predisposition to IU leads to heightened general reactivity (especially hyperarousal) after a continuous and long-term traumatic event, which then negatively affects adults' general

mental health.

5. Conclusion

In sum, this large-scale telephone survey highlighted the risk factors for poor mental health in response to a long-term stressor, namely the COVID-19 pandemic. Adults with higher levels of IU components, especially IUP, were at greater risk of developing PTSD, depression, and anxiety. Intrusion and hyperarousal symptoms of PTSD were found to partially mediate the relationship between IU and depression. Interventions that focus on reducing IU and hyperarousal could be implemented to improve the mental health of adults exposed to a long-term stressor such as COVID-19.

CRediT authorship contribution statement

Yuan Cao: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Data curation, Conceptualization. **Gerald Shiu Yin Kwan:** Writing – original draft, Formal analysis. **Judy Yuen-man Siu:** Writing – review & editing, Resources, Conceptualization. **Norman B. Schmidt:** Writing – review & editing. **David Ho Keung Shum:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2025.09.073.

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