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# Mental health issues and health disparities amid COVID-19 outbreak in China: Comparison of residents inside and outside the epicenter

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## ABSTRACT

The Coronavirus Disease-2019 (COVID-19) has exerted an impact on not only individuals who have contracted the virus but also the general public. This study compared the mental health condition of residents in the epicenter province of Hubei with that of other Chinese residents during the initial stage of the COVID-19 outbreak, and to examine emerging issues revolving around health disparities in disease prevention. A survey was administered in February 2020 to 433 Chinese adults spanning 28 regions across China. Participants residing in Hubei reported lower levels of affective and cognitive well-being than those in other regions. Perceived behavioral control and healthy lifestyle maintenance were associated with both dimensions of well-being and sleep quality for all participants. Income level was positively associated with facemask use and healthy lifestyle maintenance. These results indicate that Hubei residents reported poorer mental health than those of other regions, but perceived behavioral control and healthy lifestyle maintenance correlate with better mental health across regions. The likelihood of undertaking preventive measures for COVID-19 tends to be greater among residents with higher income, reflecting the need to address the oft-neglected concerns of health disparities in preventing this highly contagious novel disease.

## 1. Introduction

An atypical type of coronavirus was identified in Wuhan, the capital of the Chinese province of Hubei, in late 2019 (e.g., Wang et al., 2020a). The World Health Organization (WHO) has officially named this novel virus Coronavirus Disease 2019 (COVID-19). On January 30, 2020, with more than 7700 confirmed cases and 170 deaths reported in China, the WHO declared a global health emergency (Sohrabi et al., 2020). On March 11, 2020, the WHO then upgraded the status of the outbreak from epidemic to pandemic (World Health Organization 2020b). As of June 6, 2021, there were more than 103,000 confirmed cases in China, with more than 4800 deaths (Johns Hopkins Coronavirus Resource Center 2021).

To combat the COVID-19 pandemic, medical scientists have launched epidemiological and clinical studies to examine the pathology of this novel type of coronavirus (e.g., Guan et al., 2020; Wang et al., 2020c). Drastic community mitigation measures have been imposed by governments around the world. For instance, in March 2020, towns and cities in both China and Italy have been locked down (e.g., MacIntyre, 2020; Shen et al., 2020), and the U.S. and other countries have

implemented travel entry bans and stay-at-home orders (Cheng et al., 2020)(Gostin and Hodge, 2020). Also, non-pharmaceutical disease control measures have been recommended for the general public. For instance, the WHO has issued health advice on COVID-19 prevention that includes good hand hygiene and cough etiquette, as well as the avoidance of close contact with others (World Health Organization, February 2020).

Considerable effort is being devoted to developing diagnosis and treatment methods for this novel disease and containing its transmission, but the mental health of those residing in affected regions also deserves attention. Public panic has been observed in both the present COVID-19 outbreak and those involving atypical symptoms such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (e.g., Cheng and Tang, 2004; Peeri et al., 2020). Since the onset of the COVID-19 outbreak, studies have revealed that anxiety, depression, posttraumatic stress disorder, and sleep-related symptoms have been prevalent (e.g., (Cheng et al., 2020)Chi et al., 2020; Guo et al., 2020; Huang and Zhao, 2020; Wang et al., 2020b).

While empirically consistent patterns have been identified pertinent to the adverse effects of the pandemic on the mental health of residents

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in affected regions, significant heterogeneity in prevalence rates of anxiety and depression was detected among studies conducted in China (e.g., Luo et al., 2020; Ren et al., 2020) and other countries alike (e.g., Cheng et al., 2021a; Prati and Mancini, 2021). For instance, the prevalence of anxiety and depression was the highest among Chinese residents with COVID-19 infection and those with pre-existing psychiatric conditions, foregrounding the need to further investigate individual differences in mental health issues among Chinese respondents from diverse demographic groups.

In addition to anxiety about contracting the unknown disease and being quarantined, concerns about non-health issues such as personal finance and shortage of daily necessities were also common during the pandemic (e.g., Cheng et al., 2021b; Wilder-Smith and Freedman, 2020). Long lines to purchase and the stockpiling of facemasks, personal hygiene products, and food have been seen in many countries with confirmed COVID-19 cases, and panic-buying has inevitably led to price gouging. For example, packs of 20 facemasks are selling at prices in excess of \$100 in some online stores (CNBC, March 3, 2020). Hoarding and price gouging have raised particular concerns over the ability of low-income families to purchase those overpriced products for protecting themselves from infection, whereas high-income families are less affected or not affected at all (South China Morning Post 2020). Such income-related health disparities may hinder efforts to combat the COVID-19 pandemic (New York Times 2020). In view of these unusual phenomena, the WHO advocates that “the relative importance of non-pharmaceutical control measures including masks, hand hygiene, and social distancing require[s] further research to quantify their impact” (World Health Organization, 2020).

In response to the WHO’s call for empirical evidence, the present study addressed the following unexplored but important issues. First, we examined the mental health condition of adult residents of China. As 84% of confirmed cases and 96% of deaths were concentrated in Hubei province at the initial wave of the outbreak (Johns Hopkins Coronavirus Resource Center 2021), the epicenter of the outbreak, we compared the mental health condition of Hubei residents with that of residents of other regions of China. The theory of psychological entropy postulates that uncertainty regarding potential future threats elicits anxiety responses, which have a neurological basis (Hirsh et al., 2012). In this light, we predicted that the mental health of Hubei residents would be poorer owing to their province’s heaviest caseload of this novel virus and strictest quarantine policy imposed among all regions of China. The severity of the residents’ mental health condition during the COVID-19 outbreak was evaluated through comparison with benchmarks derived from previous population surveys in China.

Second, we identified factors crucial to mental health to generate an evidence base for the development of non-pharmaceutical public health interventions, which are vital to combatting the unprecedented COVID-19 pandemic. According to self-efficacy theory and integrative theory of behavioral prediction (Bandura, 1997; Fishbein, 2008), a sense of behavioral control plays an influential role in health practice and health-related outcomes, with empirical data providing support for its beneficial role in effecting desirable changes in health behavior and symptom improvement in psychological interventions (Breland et al., 2020; Sheeran et al., 2016). Perceived behavioral control has also been identified as an adaptive quality for handling uncertain, stressful events (Engel et al., 2014). In light of these theories and findings, we tested the hypothesized positive association between perceived behavioral control and mental health in the context of the COVID-19 outbreak.

Third, the theory of planned behavior posits that perceived behavioral control plays an influential role on the undertaking of health-enhancing behavior (Ajzen, 1991), and thus we investigated preventive measure adoption for COVID-19 in China, particularly those in Hubei province, which has seen the most stringent of the community mitigation and disease control measures implemented by the Chinese authorities (World Health Organization, 2020). For instance, every Hubei resident is required to wear a facemask in public (World Health

Organization, 2020). We compared the frequency with which Hubei residents have adopted a range of preventive measures relative to that of residents of other regions of China to test our prediction that the former would adopt such measures more frequently.

Finally, disease prevention is crucial for a novel, highly contagious disease like COVID-19. Some scholars have raised the concerns about health disparities in disease prevention among individuals from distinct socioeconomic (SES) backgrounds (e.g., Diez Roux, 2012; Willson, 2009). Specifically, socioeconomically disadvantaged individuals are predisposed to higher risks of developing otherwise avoidable health conditions and have higher mortality rates when having a disease infection (Marmot, 2005; Pickett and Wilkinson, 2015). According to the fundamental cause theory (Phelan and Link, 2013), individuals of higher (vs. lower) SES have a wider range of and accessibility to resources, such as the accrual of greater social capital, more extensive interpersonal connections, and/or more information on disease prevention; and thus are generally more capable of mitigating any particular threat to their health. Studies have provided support to this theory by revealing inverse associations between SES and the risk of developing a myriad of life-threatening but preventable diseases such as tuberculosis, cancer, and HIV (e.g., Mackenbach et al., 2015; Rubin et al., 2014).

This body of findings implies that mitigating socioeconomic inequality are integral to attenuating health disparity and the prevalence of preventable diseases. Nevertheless, scant effort has been devoted by far to decipher the association between SES and the display of health behavior to prevent a COVID-19 contraction. The present study is the first to extend the theory of fundamental causes to the context of the COVID-19 pandemic. We predicted a positive association between income level and the adoption of preventive measures, facemask use in particular, because facemask hoarding has been a serious problem during the COVID-19 outbreak, leading to severely inflated facemask prices (Fong and Oh, February 6, 2020; New York Times 2020). Such new findings can provide insights for government intervention, health policy development, and further community efforts in minimizing health inequality to help combat the COVID-19 pandemic.

## 2. Methods

### 2.1. Study design and procedures

Our study protocol received ethical approval from the Human Research Ethics Committee at the University of Hong Kong prior to study commencement. Owing to the time constraint in addressing this emergency incident, we relied on the online survey method with a cross-sectional design for data collection. The study was conducted from February 21–27, 2020, during which Hubei province remained in lockdown while the community mitigation measures imposed in other regions had been lifted.

The study was administered through an anonymous online survey disseminated by Tencent Survey, an online participant pool maintained by Tencent, one of the largest technology companies in the world. The survey began after the participants had given their consent online. All participants were rewarded with 5 Chinese yuan (about \$0.75).

### 2.2. Participants

Participants were eligible to take part if they were between 18 and 65 years of age, currently residing in China, and willing to provide consent. Potential participants were prescreened based on two demographic characteristics: age (18 or over) and self-reported region of residence (the quota was 225 for Hubei province and 225 for all other regions). As some of the participants might have been outside their self-reported region at the time of study, we checked the IP addresses recorded by the survey platform to verify their current location. Group membership (Hubei vs. non-Hubei) was categorized based on participants’ IP addresses to ensure data accuracy.

Twenty-four participants initially signed up but failed to complete the survey (completion rate: 95%), and additional participants were recruited as replacements. A total of 450 participants completed the survey, but the data of six ineligible participants (i.e., age below 18) were omitted. In addition, the data of another 11 were deemed invalid because of a short completion time or repetitive answering pattern (e.g., answering “1” for all items). The final sample comprised 433 participants.

### 2.3. Measures

Mental wellness is reflected by four indicators: (a) high levels of happiness (the affective component of subjective well-being), (b) high levels of life satisfaction (the cognitive component of subjective well-being), (c) low sleep disturbance (i.e., high sleep quality), and (d) low anxiety about COVID-19 infection.

Both components of subjective well-being were tapped by items extracted from Wave 6 of the World Values Survey (WVS; Inglehart et al., 2014). More specifically, respondents indicated the intensity of their feelings of happiness by rating the item “*Generally speaking, you’d say you are now*” using a 4-point scale (1 = *not at all happy*; 4 = *very happy*) and their degree of life satisfaction by rating the item “*Overall speaking, how satisfied are you with your life at present*” on a 10-point scale (1 = *completely dissatisfied*; 10 = *totally satisfied*). Their levels of subjective well-being were further evaluated by comparing them with benchmarks derived from the WVS database, including data from Waves 2 to 6 conducted in China. Single-item measures of subjective well-being were found to be both reliable and valid, and their psychometric properties were highly similar to those of well-established, validated multiple-item measures of the same constructs (e.g., Cheung and Lucas, 2014; Lucas and Donnellan, 2012).

Sleep disturbance was measured by the PROMIS™ Sleep Disturbance short form (version 1.0 8b; Yu et al., 2011) with respondents rating each of the instrument’s eight items on a 5-point scale. A sample item of this measure was “*I had difficulty falling asleep.*” Composite scores were converted into a T-metric in accordance with the PROMIS™ scoring scheme. This scale was found to be reliable in this study (Cronbach’s  $\alpha = 0.84$ ).

Anxiety about COVID-19 infection was assessed using a validated measure assessing state anxiety experienced during the SARS outbreak (Cheng and Cheung, 2005). Respondents reported the extent to which they felt nervous, worried, and fearful about contracting COVID-19 on a 4-point scale ranging from 1 (*not at all*) to 4 (*very*). A sample item asked “*How nervous do you feel about contracting the novel coronavirus (COVID-19)?*”. The scale exhibited good internal consistency (Cronbach’s  $\alpha = 0.88$ ).

A scale specifically developed and validated to measure cognitive and behavioral responses to the SARS outbreak (Cheng and Ng, 2006) was used. For assessing perceived behavioral control, a single item (“*How capable/incapable do you think you are of preventing the novel coronavirus (COVID-19)?*”) was included that instructed respondents to appraise the extent to which they think they can prevent COVID-19 infection using a 4-point scale (1 = *very incapable*; 4 = *very capable*). Single-item measures of behavioral control were found to demonstrate convergent, discriminant, predictive, and incremental validities (e.g., Ajzen and Timko, 1986; Hoepfner et al., 2011).

This scale also assessed three broad types of preventive measure for COVID-19: facemask use, hygiene practices (4 items; e.g., *washing hands with soap before eating*), and healthy lifestyle maintenance (3 items; e.g., *eating a nutritious diet*). Respondents rated the frequency with which they had engaged in each preventive behavior during the past week on a 4-point scale (0 = *never*; 3 = *more than 4 days*). Principal component analysis documented a two-factor structure (eigenvalue = 3.23 and 1.11, explained variance = 46% and 16%). As different subscales comprised a distinct number of items, the composite scores were averaged for ease of between-subscale comparisons. The two multiple-item

subscales (hygiene practices and healthy lifestyle maintenance) were reliable (Cronbach’s alphas = 0.80 and 0.64).

Finally, participants were instructed to provide the following demographic information: sex, age, employment status, and monthly income level. Age was a continuous variable, whereas employment status was a discrete variable with six levels (i.e., full-time worker, part-time worker, homemaker, student, retired, and currently not working). Monthly income level was an ordinal variable, ranging from 1 (less than 1000 Chinese yuan) to 12 (more than 30,000 Chinese yuan).

### 2.4. Statistical analysis

A priori power analysis was performed using G\*Power (version 3.1.9.2), with the results indicating that at least 346 participants (i.e., 173 per group) would be required to achieve statistical power of 90% with a small-to-medium effect size (Cohen’s  $d = 0.35$ ) and an alpha level of 0.05.

Before performing the main analyses, a series of preliminary analyses was conducted. Both Kolmogorov-Smirnov and Shapiro-Wilk tests for normality were employed to check the normal distribution assumption for each scale or sub-scale. A significant test result ( $p < 0.05$ ) indicated that the data of a particular variable were not normally distributed. A boxplot analysis was then performed, and outliers were defined as any data points located three times above or below the interquartile range. The data points of outliers for a particular variable would be omitted. If non-normal distribution was still found after removing the outliers, nonparametric tests would be conducted.

To detect differences between the Hubei and non-Hubei (i.e., all other regions) groups, chi-square tests were performed for both discrete (e.g., sex, employment status) and ordinal (i.e., monthly income level) variables; and independent-samples  $t$ -tests or Mann-Whitney U tests (nonparametric equivalence) for continuous variables (e.g., sleep disturbance, perceived behavioral control). Associations of the perception and preventive measure adoption with mental health were tested using multiple regression analyses or bootstrap regression analyses (nonparametric equivalence), each with a mental health indicator as the criterion variable. To examine the hypothesized associations between income level and preventive measure adoption, Spearman rank-order correlation coefficient ( $\rho$ ) was performed because income level was an ordinal variable.

All of these statistical analyses were conducted with SPSS (version 26). All reported  $p$  values were two-tailed, and the level of statistical significance was set at  $p < 0.05$  for all tests.

## 3. Results

### 3.1. Preliminary analyses

Both tests for normality revealed that the various variables were not normally distributed ( $ps > 0.05$ ). The outlier analyses identified two outliers for sleep disturbance and healthy lifestyle maintenance, respectively. After eliminating the data points of these outliers,<sup>1</sup> non-normal distributions were still found. Nonparametric analyses were thus performed.

### 3.2. Sample characteristics

The sample comprised 433 Chinese adults (49% men), of whom 223 resided in Hubei province and 210 in other regions of China, spanning 20 provinces, four municipalities, and three autonomous regions. Their average age was 25.65 ( $SD = 7.15$ , range = 18–63). More than half of the participants (53%) were in full-time employment, 33% were

<sup>1</sup> The pattern of results yielded from the outlier removal method was identical to that of results yielded from the full dataset.

students, 7% worked part-time, and the remaining 7% were not working (e.g., homemakers, retired). The median income level was from 5000 to 7500 Chinese yuan, which is highly comparable to the national average income level reported in the latest census of China (National Bureau of Statistics of China, 2019). No significant differences were found in the distribution of any of these demographic variables between the Hubei and non-Hubei groups ( $p > 0.08$ ).

### 3.3. Group differences in mental health condition and benchmark comparisons

Descriptive statistics for all of the study variables are shown in Table 1. As predicted, the Mann-Whitney U test revealed that the Hubei group in general reported lower levels of both happiness (affective well-being) and life satisfaction (cognitive well-being) than the non-Hubei group ( $z_s = -5.28$  and  $-5.02$ ,  $p_s < 0.0001$ , Cohen's  $d_s = 0.47$  and  $0.49$ ).

We then compared these findings with benchmarks derived from the WVS database. As revealed in the five previous waves of the WVS project, the average happiness score for China ranged from 2.84 to 3.06. The ratings given by the Hubei group ( $M = 2.52$ , 95% CI = 2.41, 2.62) were significantly lower than all of these benchmarks, whereas those of the non-Hubei group ( $M = 2.94$ , 95% CI = 2.84, 3.05) fell within the benchmark range.

In a similar vein, China's average WVS life satisfaction score ranged from 6.41 to 7.22 in the five previous survey waves. The Hubei group reported significantly lower average scores ( $M = 5.82$ , 95% CI = 5.55, 6.09) than all five benchmarks, whereas the average score of the non-Hubei group ( $M = 6.87$ , 95% CI = 6.59, 7.15) lay within the benchmark range.

### 3.4. Associations of COVID-19-related perceptions and preventive measure adoption with mental health

Bootstrap regression analysis with the widely adopted practice of 5000 resamples was performed (Henderson, 2005), and the results are summarized in Table 2. Perceived behavioral control was associated with better mental health across all four domains for both groups ( $p_s < 0.02$ ; Cohen's  $d = 0.17$ – $0.32$ ), with the exception of anxiety about COVID-19 infection for the non-Hubei group ( $p = 0.14$ ). These findings were largely in line with our predictions.

Of the three preventive measures, only healthy lifestyle maintenance was consistently associated with mental health in general ( $p_s < 0.0001$ ; Cohen's  $d = 0.26$ – $0.47$ ), albeit not with anxiety specifically related to the COVID-19 outbreak ( $p_s > 0.42$ ). It is noteworthy that hygiene practices were positively associated with the two indicators of poor mental health (anxiety about COVID-19 infection and sleep disturbance) for the Hubei group ( $p_s < 0.04$ ; Cohen's  $d = 0.14$  and  $0.17$ ).

**Table 1**

Mental health conditions, perception, and preventive measures for COVID-19 outbreak in China, February 2020.

Study Variable	Hubei province (epicenter)		All other regions		z
	Mean	SD	Mean	SD	
<b>Mental health condition</b>					
Anxiety about COVID-19 infection	7.17	2.18	7.27	2.25	-0.59
Happiness	2.52	0.84	2.94	0.74	-5.28**
Life satisfaction	5.82	2.22	6.87	1.85	-5.02**
Sleep disturbance (T-metric)	49.44	8.33	48.98	9.26	0.08
Perceived behavioral control	2.77	0.84	3.05	0.77	-3.43**
<b>Preventive measure</b>					
Facemask use	2.51	0.80	2.81	0.52	-4.72**
Hygiene practice	1.92	0.83	2.17	0.71	-3.11**
Maintenance of healthy lifestyle	1.94	0.71	2.10	0.64	-2.05*

Note.  $z = z$  values derived from Mann-Whitney U tests. \* $p < 0.05$ . \*\* $p < 0.01$ .

### 3.5. Group and income level differences in preventive measure adoption for COVID-19

The results of independent-samples  $t$ -tests revealed significant group differences in the adoption of the three preventive measures. Contrary to our prediction, the Hubei group tended to adopt all these measures less frequently than the non-Hubei group,  $t_s < -2.33$ ,  $p_s > 0.02$ .

Income level was positively associated with both facemask use and healthy lifestyle maintenance, Spearman's  $\rho_s = 0.16$  and  $0.10$ ,  $p_s < 0.05$ . The association between income level and hygiene practices was marginally significant, Spearman's  $\rho = 0.09$ ,  $p_s = 0.08$ . These results were largely consistent with our predictions.

## 4. Discussion

The findings of the present study indicate that both the affective and cognitive well-being of residents in the epicenter province of Hubei have been affected by the COVID-19 outbreak. A particularly important finding is that their reported levels of subjective well-being were consistently below the benchmarks of previous large-scale population surveys conducted over the past 24 years, indicating that the mental health of Hubei residents is at an all-time low during the lockdown period. The subjective well-being of residents of other regions of China, in contrast, was comparable to all previous benchmarks, indicating that those residents of China have been less affected psychologically by the outbreak.

### 4.1. Theoretical implications

Surprising results were that Hubei residents reported adopting preventive measures less frequently than those of other regions. These results deviate from the postulations of many oft-cited theories of health behavioral change (e.g., Fishbein, 2008; Montano and Kasprzyk, 2015), which posit that a given health risk increases the probability of relevant health measures being adopted to prevent the health problem. The implication of our unexpected finding is that these postulations may not be applicable to the unprecedented COVID-19 outbreak, especially in Hubei where the drastic community mitigation measure of a lockdown was still in place at the time of study. The residents were thus required to stay at home, and the need to adopt preventive measures was lowered accordingly. During the same period, however, the residents of other regions had resumed work and thus could travel around, and hence they may have an actual need to adopt preventive measures to avoid COVID-19 contraction.

Further to the situational factors that explicate the aforementioned unprecedented findings, the present new findings highlight the importance to alert to the presumptions of oft-cited theories of health behavior change, and such assumptions may limit these theories' applications to explaining behavioral patterns observed in real-world settings. For instance, the theory of reasoned action and the theory of planned behavior are preponderantly focused on the person, such as the presupposition of how individuals' personal beliefs, attitudes, and perceptions shape their behavior. However, both of these theories lack due consideration of situational factors—especially in a health emergency—that can also exert an impact on people's behavior (e.g., Celuch and Dill, 2011; Sheppard et al., 1988).

Our new findings echo the criticisms raised by some scholars regarding an over-emphasis of these theories on the role of personal agency in explaining human behavior. Specifically, these widely adopted theories assume that individuals tend to possess a high degree of self-determination and strong ability to actualize their behavioral intentions, irrespective of contextual characteristics, social structures, and cultural norms that collectively govern an individual's behavior (e.g., Botetzagias et al., 2015; Eagly and Chaiken, 1993). The theories largely neglect environmental factors in which individuals are situated (i.e., residing in Hubei, the epicenter of the outbreak), impact of normative influence (e.

**Table 2**

Associations of COVID-19-related perception and preventive behavior with mental health conditions for residents of China, February 2020.

	Anxiety about COVID-19 infection		Happiness		Life satisfaction		Sleep disturbance (T-metric)	
	Hubei province	All other regions	Hubei province	All other regions	Hubei province	All other regions	Hubei province	All other regions
Perceived behavioral control	-0.45**	-0.30	0.30**	0.21**	0.65**	0.45**	-1.61*	-2.69**
Facemask use	0.51**	-0.52	-0.06	-0.05	-0.29	0.12	-0.48	-0.68
Hygiene practice	0.43*	0.22	-0.001	0.11	-0.09	0.31	1.93*	1.35
Healthy lifestyle maintenance	-0.13	0.23	0.32**	0.41**	1.07**	1.32**	-3.53**	-5.14**

Note. Unstandardized regression parameter estimates (*B*) derived from bootstrap regression analysis (5000 resamples) are presented in this table.

\* $p < 0.05$ . \*\* $p < 0.01$ .

g., over facemask use to prevent contracting and spreading a highly transmissible novel disease), and the limited resources contended by some individuals (e.g., [Ajzen, 2011](#); [Yousafzai et al., 2010](#)).

The sudden occurrence of the COVID-19 outbreak and the implementation of an unprecedented drastic policy of lockdown may severely hamper the Hubei residents' social resilience, which refers to the capacity of both individuals and their communities to handle the stress brought about by disasters ([Kwok et al., 2016](#)). On a community level, the lockdown policy may elicit a shrinkage in social coping resources that impair collective decision-making and disaster planning for communities in Hubei. Hence, such circumstances may potentially hinder the adaptive capacity of residents in the Hubei communities, and increase their reliance on government interventions. Our findings have further demonstrated that at the individual level, residents in Hubei tend to perceive a lower sense of behavioral control over the pandemic than those in other regions of China. Social resilience has been found to be associated with maladaptive coping responses to disasters, such as adoption of preventive measures. In this light, the scope of existing theories of health behavioral change should incorporate situational and environmental determinants to increase their explanatory and predictive utility in the contexts of unusual health threats.

#### 4.2. Practical implications

The findings of this study have some public health implications. The WHO and governments around the world have issued public health guidelines on how to deal with the COVID-19 pandemic, but the preventive measures they have recommended are good hygiene practices and crowd avoidance ([World Health Organization, February 2020](#)). Their primary target is curbing the spread of this highly contagious virus, with the potential mental health issues faced by affected populations largely neglected. Our findings suggest that non-pharmaceutical control interventions should also target mental health enhancement.

Over the past two decades, the Chinese Government has formulated mental health initiatives to guide timely delivery of psychological crisis interventions to deal with public health crises ([Higgins et al., 2010](#)). For instance, during the 2008 Sichuan earthquake, psychological crisis interventions have been provided to survivors from the earthquake-stricken areas, and such programs are found effective in mitigating psychiatric symptoms and fostering post-traumatic growth among their participants ([Zang et al., 2013](#)). Delivery of similar psychological crisis interventions should be a top priority to residents in Hubei, who were identified in our study to be the hardest hit by the COVID-19 pandemic. Although face-to-face gatherings should be kept to a minimum while the pandemic persists, online psychological interventions (e.g., [Myers et al., 2019](#)) could play a role in promoting a healthy lifestyle and sense of self-efficacy in the present cyber age.

The study also sheds light on the issue of health disparities, which has attracted considerable discussion since the outbreak's onset. Our new findings revealed a positive association between income level and the adoption of preventive measures such as wearing a facemask and

eating a nutritious diet; echoing widespread concerns over obstacles to combat the pandemic imposed by hoarding and price hikes of necessities (e.g., personal protective equipment, food), particularly for individuals on a low income ([South China Morning Post 2020](#)). The concerns regarding health disparity have deepened over the past decades (e.g., [Diez Roux, 2012](#); [Mackenbach et al., 2015](#)), but unfortunately this social problem has been exacerbated by the COVID-19 pandemic ([Farmer et al., 2020](#)). It is of paramount importance to narrow the widening health disparity gap to prevent further incidence of COVID-19 cases. According to the fundamental cause theory ([Phelan and Link, 2013](#)), individuals of lower SES (vs. higher) are predisposed to higher risks of contracting preventable diseases, owing to their limited personal resources.

Such problems are of particular importance amid the pandemic, as COVID-19 is a highly contagious disease and facemask use serves as an effective measure for decreasing the likelihood of contracting the novel virus (e.g., [Eikenberry et al., 2020](#); [Wang et al., 2021](#)). Individuals of higher SES are more capable of accruing personal resources and social capital to prevent viral contraction, especially at difficult times when pandemic hoarding and inflated prices of personal protective equipment are common (e.g., [Cheng et al., 2021b](#); [Tse et al., 2021](#)).

It is noteworthy that facemasks are widely perceived by the general public as the most efficacious preventive measure against the COVID-19 virus, serving as a strong "psychological symbol" or an effective form of protection against the anxiety imposed by the pandemic (e.g., [Duong et al., 2021](#); [Guo et al., 2020](#)). The alleviation of anxiety symptoms related to COVID-19 is critical for the disease prevention efforts. According to the theory of general adaptation syndrome ([Selye, 1978](#)), individuals who are exposed to long-term stress and are unable to cope with it adaptively will ultimately reach a stage of exhaustion. At this stage, the body's homeostatic imbalance and adverse physical reactions can disrupt an individual's bodily functioning, such as undermined immune functioning (immunosuppression), which in turn predisposes the individual at heightened risks of contracting diseases ([McCarty and Pacak, 2000](#)).

Findings have shown that individuals of higher (vs. lower) SES are generally less likely to contract highly preventable diseases ([Willson, 2009](#)), implying that efficacious government policies are essential for disease prevention efforts. Hence, if hoarding lingers, leading to such devastating consequences as facemask shortages and widespread clinic closures ([World Health Organization, March 3, 2020](#)), then appropriate policies and government intervention are essential for further curbing the transmission of COVID-19. However, such drastic measures are highly controversial and need extensive study and discussion. Research with a specific focus on the issue of hoarding during epidemics is particularly needed, and further efforts should be expended in policy development and the tackling of health disparity. More imminent measures that could be taken is the launch of public education programs designed to alert the general public to the irrationality of hoarding and its possible undesirable consequences (e.g., overstocking, quality deterioration due to long-term product storage).

#### 4.3. Limitations of the study

The present study has several shortcomings that should be noted. Specifically, the study was conducted in an unprecedented lockdown period that made it impossible for recruiting a large, representative sample. The power analysis showed that the present sample size was large enough for yielding adequate statistical power, but the sample size was deemed relatively small compared with the population of China. Although the sex ratio and median income level of both the Hubei- and non-Hubei groups are comparable to the national statistics of China, both groups are younger than the nation's average (National Bureau of Statistics of China, 2019). The present study should thus be considered as exploratory in nature that focuses on a select sample of Chinese residents who were affected by the COVID-19 pandemic.

The context of this study was set at an early stage of the pandemic. As the pandemic evolved swiftly (e.g., Kaxiras and Neofotistos, 2020), the present findings may not be generalizable to other waves. Specifically, the mental health problems tend to be less severe at later waves as more information is available about the etiology, treatment, and prevention of an atypical virus (Cheng and Cheung, 2005). Finally, the present study was conducted in China, and the pattern of results may differ if the data are derived from other countries in which distinct sets of public health mitigation measures are implemented. Future multinational research may be carried out to identify variations in tackling mental health problems and health disparities in disease prevention across countries characterized by diverse levels of socioeconomic development (Cheng et al., 2016).

#### Author contributions

Conceptualization, C.C. and H.W.; methodology, C.C. and H.W.; software, C.C. and H.W.; validation, C.C. and C.L.C.; formal analysis, H. W.; investigation, H.W.; resources, C.C.; data curation, H.W.; writing—original draft preparation, C.C.; writing—review and editing, H. W. and C.L.C.; supervision, C.C.; project administration, H.W.; funding acquisition, C.C. All authors have read and agreed to the published version of the manuscript.

#### Declaration of Competing Interest

The authors declare no conflict of interest.

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