Chinese public's knowledge, perceived severity, and perceived controllability of the COVID-19 and their associations with emotional and behavioural reactions, social participation, and precautionary behaviour: A national survey

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Abstract

Background The outbreak of the coronavirus disease-19 (COVID-19) has caused enormous stress among the public in China. Intellectual input from various aspects is needed to control the COVID-19, including the understanding of the public's emotion and behaviour and their antecedents from the psychological perspectives. Drawing upon the cognitive appraisal theory, this study examined three cognitive appraisals (i.e., knowledge, perceived severity and perceived controllability of the COVID-19) and their associations with a wide range of emotional and behavioural outcomes among the Chinese public. Methods Participants were 4607 citizens (age range: 17–90 years, Mage=23.71 years) from 31 provinces in China and they took part in an online survey. Results The results showed that the public's emotional and behavioural reactions were slightly affected by the outbreak of the COVID-19. Moreover, the public had limited participation in the events regarding the COVID-19 but actively engaged in precautionary behaviour. In addition, results of hierarchical regression analysis revealed that the three appraisals were differentially related to the outcome variables. Conclusions The findings highlight the utility of cognitive appraisal, as a core process of coping stress, in explaining the public's emotion and behaviour in the encounter of public health concern. Practically, the findings facilitate the government and practitioners to design and deliver targeted intervention programs to the public affected by the COVID-19.

Background

In December 2019, several cases of pneumonia with unknown causes were reported in Wuhan, the capital of Hubei Province in central China. The pneumonia is later diagnosed to be caused by a novel coronavirus and named the Coronavirus Disease-19 (COVID-19) by the World Health Organization [1]. Since then, the COVID-19 has outbroken from Hubei Province, particularly from Wuhan city, and spread across mainland China rapidly. Later, the COVID-19 has spread outside China as well, posing risks to countries beyond its origin. At the end of January 2020, The World Health Organization has declared the outbreak of the COVID-19 in China a Public Health Emergency of International Concern [2]. At the beginning of February 2020 right before the current survey commenced, the COVID-19 has caused thousands of diagnosed cases and hundreds of deaths. The Chinese government has been actively adopting a variety of measures to control the COVID-19, including implementing effective medical treatment, monitoring the progress of the COVID-19, issuing the facts and the precautionary measures of the COVID-19, and even controlling the mobility of the population within the city and between cities. However, citizens receive the information about the COVID-19 from various channels and may have different knowledge about the COVID-19. In addition, the numbers of suspicious and diagnosed cases and mortality are still increasing in most provinces, which may affect the public's estimation about the severity and controllability of the COVID-19. All of these information could associate with the public's emotional and behavioural reactions towards the COVID-19 differentially.

A timely understanding of the public's knowledge, perception of the COVID-19 and their influence on individuals' emotion and behaviour is still lacking. Public's knowledge, perception, precautionary behaviour and active social participation have been found to be important in the control of epidemics, as learned regarding SARS, Ebola, and H1N1 [3-5]. Nevertheless, every public health concern issue occurs at different periods in different places and each country/region possesses different magnitudes of resources to reduce the detriment it brings. In this sense, there could be both commonalities and variations in the emotional and behavioural reactions caused by different events of public health concern. Therefore, it is necessary to investigate the public's emotional and behavioural outcomes and their antecedents in the encounter of the COVID-19. Hopefully, the findings may deepen the understanding of the public's appraisal processes in the encounter of emergent public health concern and provide early evidence to relevant stakeholders, policy-makers, and practitioners to better develop and deliver tailor-made psychological aids to the public affected by the COVID-19. In sum, drawing upon the proposition that cognitive appraisal as a process of coping stress [6, 7], the present research aims to examine the public's knowledge, perceived severity, and perceived controllability of the COVID-19 and their associations with emotional and behavioural reactions.

Cognitive appraisal and emotion and behaviour

Studies on the severe acute respiratory syndrome (SARS) have indicated that the outbreak of an unprecedented virus can cause immense stress to the public of different age, professionals, and regions [8-11]. Encounter of environmental stress may induce individuals to use different methods to cope with the stress and maintain their health and well-being. Cognitive appraisal, as a core process in coping stress, is supposed to closely associate with the immediate and long-term outcomes [12].

Cognitive appraisal is a process through which the person evaluates whether a particular encounter with the environment is relevant to his or her well-being, and if so, in what ways [12]. It consists of two stages. *Primary appraisal* refers to a person's estimate of whether he or she has anything at stake in the encounter [12]. Encounters can be evaluated as irrelevant, benign-positive (beneficial) or stressful [13]. For instance, is the encounter potentially harmful or beneficial to a person's well-being or health? Assessment of a person's evaluation of what is at stake in the outcome of the encounter is a critical indicator of the primary appraisal, such as assessing how disturbing, threatening or challenging of the encounter is [13, 14]. *Secondary appraisal* refers to a person's evaluation of what can be done to overcome or prevent harm or to increase the benefit and this process involves a complex assessment of a person's coping options [12]. Assessment of the extent to which the situation requiring more information and how controllable the situation is have been regarded as crucial indicators of the secondary appraisal [13].

Prior research has associated indicators of primary and secondary appraisals and a wide range of emotional and behavioural outcomes. For example, Peacock and Wong (1990) found that when individuals perceive an encounter to be more threatening, uncontrollable and stressful, they reported higher levels of psychological symptoms and dysphoric mood [13]. Oliver and Brough (2002) revealed that perceived controllability were predictive of individuals' well-being [15]. In another research, Gomes, Faria, and Lopes (2016) found that perceptions of threat, control, and challenge of stressful encounters were significantly related to mental health problems [16]. Besides, cognitive appraisal has also been applied to the study of the public's emotion and behaviour during the outbreak of emergent public health concerns. For instance, in Dorfan and Woody's (2011) study, they measured individuals' appraisal of danger, germ spread and responsibility and associated them with a number of emotion and behaviour towards the outbreak and transmission of the SARS, including avoidance, disgust, anxiety, urge to wash, washing duration, and wipes taken [3]. Their findings disclosed that appraisal of danger of SARS was significantly related to emotional and behavioural responses. Another research found that knowledge and perception of SARS were related to precautionary behaviour [17]. In addition, Yang and Chu (2018) found that perceived risk of virus was related to higher levels of negative emotion (i.e., fear, anxiety, disgust, and anger) about the outbreak of Ebola in the US public [4].

The current study

Drawing upon the cognitive appraisal theory, this study aims to understand the public's perceived severity, knowledge and perceived controllability of the COVID-19 and their associations with emotional and behavioural reactions, social participation, and precautionary behaviour. In this study, we consider the public's perceived severity as the primary appraisal, as it relates to an individual's evaluation of how likely their health and well-being is at stake in the encounter of the COVID-19, and we consider the public's knowledge and perceived controllability of the COVID-19 as secondary appraisal, as they reflect as the intellectual and mental resources to cope with the stress and disturbance caused by the COVID-19. In light of the findings reviewed above, these cognitive appraisals are supposed to be related to a number of emotional and behavioural responses. Since the numbers of diagnosed cases and the rate of mortality of the COVID-19 differ greatly among different regions in China, the public's emotional and behavioural responses, social participation, and precautionary behaviour could vary as well. To take this into account, we utilized multilevel modelling to control for the potential influence of the hierarchical structure of the data. We took into account a number of demographic variables as well to control for their potential effect on the outcomes.

Methods

Participants and procedure

A hierarchical random sampling was used to recruit participants from different regions in China. A total of 4826 Chinese visited the online survey between Feb-2 and Feb-9, 2020. We removed a number of participants because they met one or more of the following exclusion criteria: (1) participants were not willing to participate in the study; (2) participants indicated that they were under 16 years old, a cutting age that parent consent is optional; and (3) participants were inclined to respond to the items in a similar pattern (e.g., chose the same answer across multiple consecutive items or within the whole questionnaire). Finally, 4607 participants were included in the analyses. Participants' age ranged from 17 to 90 years old (Mean age = 23.71 years old, SD = 7.29). They were from 31 provinces / centrally-governed cities / autonomous regions / special administrative regions, with the sample size ranging from 16 (0.3% of the total sample, Ningxia Hui Autonomous Region) to 1386 (30.1% of the total sample, Guangdong Province). The sample covered a wide range of demographics. Detailed demographics are summarized in Table 1.

The study was reviewed and approved by the Guangzhou University. The whole study was conducted online in compliance with the ethical standards for research outlined in the Ethical Principles of Psychologists and Code of Conduct [18]. Over 200 investigators who majored in psychology voluntarily distributed the online survey link on various internet platforms, including WeChat (the most popular APP for instant message in mainland China), Weibo, QQ, etc. By clicking the hyperlink, participants were directed to an online survey website. An information sheet stating the goal and the procedure of the study was presented to participants on the first page of the survey. If participants checked the "I understood the study and am willing to participate" box at the bottom of the information sheet, they entered the survey and answer the questionnaires. If participants were not willing to participate, they could check the "I understood the study but am not willing to participate" box and then the survey ended. Participation was voluntary and no incentive reward was given. Anonymity was emphasized and no identifiable information was collected. It took participants about 20 minutes to complete the survey.

Measures

Emotional and behavioural reactions. Participants' emotional and behavioural reactions were measured with 18 items. These items cover a number of dimensions, including negative emotion (6 items, anxiety, worry, depressive, panic, lonely, and nervous), positive emotion (3 items, happy, joy, and excited), sleep problems (4 items, insomnia, shallow sleep, have nightmares, and insufficient sleep), aggression (2 items, argue

with others and physical fight with others), substance use (2 items, smoking and drinking), and mobile phone use (1 item). Participants were asked to compare the frequencies of the said aspects after the outbreak of the COVID-19 with the ones before the outbreak on a five-point scale (from "1 = *much less compared to the days before the outbreak*" to "5 = *much more compared to the days before the outbreak*"). To align with other dimensions, the items for positive emotion were reversely scored. A higher score indicates the COVID-19 causes more negative emotion, sleep problems, aggression, substance use, mobile phone use, and less positive emotion.

Social participation. The Social Participation Scale used in prior research [19] was adapted to measure participants' social participation regarding the COVID-19. Participants were asked to indicate how often they participated in different social events related to the COVID-19 since the outbreak of the COVID-19 on a five-point scale (from "0 = *never*" to "4 = *very often*). A higher score indicates that participants more actively participated in the social events about the COVID-19. A sample item is "How often do you help improve others' life quality since the outbreak of the COVID-19?"

Precautionary behaviour. Participants' precautionary behaviour was measured with 19 items written by authors following the precautionary guideline issued by the Chinese government. Participants were asked to indicate how often they show various precautionary behaviour since the outbreak of the COVID-19 on a five-point scale (from "0 = *never*" to "4 = *very often*). A higher score indicates that participants display more precautionary behaviour. Sample items include *avoiding travelling to regions affected by the COVID-19*, *wearing a facemask*, *regularly changing a facemask*, and *washing hands*.

Knowledge about the COVID-19. Participants' perceived knowing of various aspects of the COVID-19 (e.g., cause, ways of transmission, symptoms, diagnostic criteria, etc.) was measured with 11 items. Participants indicated how much they know each item on a five-point scale (from "1 = *totally not know*" to "5 = *totally know*"). A higher score indicates participants perceived they know more about the COVID-19.

Perceived severity. Participants' perceived severity about the COVID-19 was measured with 5 items. Participants indicated their perception of how severe is the infection rate, morbidity, mortality, the negative influence on social order and the negative influence on the economics on a five-point scale (from "1 = *not severe at all*" to "5 = *very much severe*"). A higher score indicates participants perceived the COVID-19 more severe.

Perceived controllability. Participants' estimation of how much can the various aspects of the COVID-19 be controlled was measured with 9 items on a five-point scale (from "1 = *totally uncontrollable*" to "5 = *totally controllable*"). A higher score indicates participants estimated that the COVID-19 was more controllable. A sample item is "How controllable do you think the cause of the COVID-19 is?"

Demographic variables. We also collected a number of demographic variables of participants, including their biological sex (0 = *male*, 1 = *female*), age, education (1 = *junior middle school or below*, 2 = *high school or equivalent*, 3 = *college*, 4 = *bachelor degree*, 5 = *master degree*, 6 = *doctoral degree*), current residential location (referred to province and city/district), their relationship with the COVID-19 (1 = *healthy*, 2 = *other, including suspicious case, diagnosed case, relatives or friends of suspicious/diagnosed case, etc.*), the history of chronic physical diseases and psychiatric/psychological disorder (1 = *yes*, 2 = *no*), and their current physical health condition (from "1 = *very poor*" to "5 = *very good*").

Data analysis

We analysed the data in SPSS and Mplus 7.0 in several steps, with .05 as the significant level across all analyses. First, we performed the descriptive statistics to capture the centrality and the Cronbach's alpha of the variables. Second, we conducted correlation analysis to capture the association between participants' knowledge about the COVID-19, perceived severity, and perceived controllability and emotional and behavioural reactions, social participation, and precautionary behaviour. For the correlation analysis, we applied Cohen's (1992) standard to determine whether the correlation coefficients were substantial, with r = .01, .03, and .05 representing small, medium, and large effect size [20]. Last, we carried out multi-level regression analysis to examine the associations between the independent variables and the dependent variables, controlling for a number of demographic variables. We applied the multi-level model (MLM) to examine the path model because individual data (level-1) were nested in different provinces (level-2). A maximum likelihood (ML) approach was used as estimator. Since our main interest was to examine the association between the predictors and the outcome variables on level 1, we centred the predictors and the covariates using a centring within cluster approach [21]. The values of RMSEA (< .08), CFI and TLI (> .90) indicate the model fit is acceptable [22, 23].

Results

Descriptive statistics

As shown in Table 2, participants indicated that they had medium level of knowledge about the COVID-19 (3.56 out of 5). Moreover, participants perceived the COVID-19 to be highly severe (4.09 out of 5) and modestly controllable (3.25 out of 5). Regarding their emotional and behavioural reactions, the results showed that the COVID-19 did not change much of the frequency of participants' positive and negative feelings and a range of behaviour, with the mean score ranging from 2.61 to 3.77. In fact, participants indicated that the frequencies of sleep problem,

aggression, and substance use after the outbreak were slightly lower compared to the ones before the outbreak of the COVID-19. As for social participation, participants appeared to not very actively participate in the social events regarding the COVID-19 (1.75 out of 4). However, participants reported that they displayed intensive precautionary behaviour to prevent the COVID-19 (3.33 out of 4).

Associations between the variables of interest

The bivariate correlation coefficients of the association between the variables of interest are summarized in Table 3. The results showed that participants' knowledge about the COVID-19 was positively related to social participation and precautionary behaviour. Participants' perceived severity was positively related to the increase in negative emotion and mobile phone use, decrease in positive emotion, and more precautionary behaviour. Although the associations between perceived severity and the changes in sleep problems and social participation were also significant, the effect sizes were too trivial to explain (i.e., $r < .10$). Finally, perceived controllability was negatively related to the increase in negative emotion and more social participation and precautionary behaviour. Although the associations between perceived controllability and the changes in positive emotion, sleep problems, and mobile phone use were also significant, the effect sizes were too small to explain (i.e., $r < .10$).

The associations of knowledge, perceived severity, and perceived controllability with emotional and behavioural reactions, social participation, and precautionary behaviour

Multilevel regression analysis was conducted to examine the associations between the variables of interest. The model fit was good, $\chi^2(28) = 275.04$, *RMSEA* = .044, *CFI* = .976, *TLI* = .886. The values of intraclass correlation (ICC) ranged from .008 (sleep problem) to .032 (negative emotion). This suggests that little proportion of variance in the outcome variables is explained by the hierarchical structure in the model. Although the ICCs are not large, it is still necessary to take into account the hierarchical structure of the data, as the individuals are nested in the provinces and hierarchical random sampling was utilized in the sampling procedure. The results of the unstandardized regression coefficients and standard errors are presented in Table 4.

The model explained 8.5% variance of the changes in negative emotion, with 0.7% variance ($p = .047$) being explained by the between-level. The results showed that being female, having higher education, and perceiving the virus to be more severe and risky were positively related to the increase in negative emotion. In contrast, having better physical health condition and perceiving the virus to be controllable were negatively related to the increase in negative emotion.

The model explained 2.9% variance of the changes in positive emotion, with 0.5% variance ($p = .086$) being explained by the between-level. The results showed that being female, being older and perceiving the virus to be severe were positively related to the decrease in positive emotion. In contrast, having higher education and perceiving the virus to be controllable were negatively related to the decrease in positive emotion.

The model explained 3.0% variance of the changes in sleep problems, with 0.1% variance ($p = .164$) being explained by the between-level. The results showed that having higher education and perceiving the virus to be more severe were positively related to the increase in sleep problems. In contrast, being without history of psychiatric/psychological disorder and having good physical health condition were negatively related to the increase in sleep problems.

The model explained 2.8% variance of the changes in aggression with 0% variance ($p = .711$) being explained by the between-level. The results showed that having higher education was positively related to the increase in aggression. In contrast, being older and having good physical health condition were negatively related to the increase in aggression.

The model explained 1.7% variance of the changes in substance use with 0.1% variance ($p = .519$) being explained by the between-level. The results showed that having higher education was positively related to the increase in substance use. In contrast, being female and having good physical health condition were negatively related to the increase in substance use.

The model explained 5.0% variance of the changes in mobile phone use with 0.7% variance ($p = .017$) being explained by the between-level. The results showed that being female, having higher education and perceiving the virus to be more severe were positively related to the increase in mobile phone use. In contrast, being younger and having better physical health condition were negatively related to the increase in mobile phone use.

The model explained 7.5% variance of social participation with 1.1% variance ($p = .033$) being explained by the between-level. The results showed that being older, having better physical health condition, having higher education, perceiving the virus to be more severe, and having more knowledge about the virus were positively related to more social participation.

The model explained 19.3% variance of precautionary behaviour, with 1.2% variance (p = .001) being explained by the between-level. The results showed that being female, having better physical health condition, having higher education, perceiving the virus to be more severe and controllable, and having more knowledge about the virus were positively related to more precautionary behaviour. In contrast, being younger and being with history of chronic physical diseases were negatively related to precautionary behaviour.

Discussion

The public's emotional and behavioural reactions, social participation, and precautionary behaviour during the outbreak of the COVID-19

A central goal of this research is to provide early evidence to the understanding of public's emotional and behavioural outcomes during the outbreak of the COVID-19. In this study, we examined three related outcomes, including the changes in the frequencies of the public's emotional and behavioural reactions towards the COVID-19, the public's participation in social events regarding the COVID-19, and the public's engagement in precautionary behaviour. Regarding the changes in the frequencies of the public's emotional and behavioural reactions, participants reported very slight changes in the frequencies of experiencing negative emotion, positive emotion and using mobile phone before and after the outbreak of the COVID-19, as the mean score of these dimensions were higher than 3 (coded *as more or less the same before and after the outbreak of the COVID-19*) but less than 4 (coded *higher compared to the days before the outbreak*). Interestingly, compared to the days before the outbreak of the COVID-19, the public reported slightly fewer sleep problem, aggression or substance use after the outbreak. These finding suggest that the outbreak of the COVID-19 does not necessarily bring intensive negative emotional or behavioural responses among the public; on the contrary, it may also bring slight benefit, such as less aggression, drinking and smoking, and sleeping problems. In addition, the low levels of social participation and the high levels of precautionary behaviour suggest that the public did not show too much interest in participating in social events about the COVID-19 but that they developed a good habit of behaviour that prevent the virus.

These reactions could be due to several reasons. First, they may be related to the measures the Chinese government has adopted since the outbreak in controlling the transmission of the COVID-19, including urging the public to maximally stay at home and reduce mobility, suspending most public facilities and venues that could be crowded (e.g., bars, cinema, restaurants, etc.), strengthening the monitoring of physical health whenever the citizen entering the public venue (e.g., supermarkets, ones' residential building), issuing precautionary guidance to maintain good mental and physical health, and strongly urging the public to keep personal hygiene. Such strong measures and the transparency of the media may increase the public's mental resource to maintain their mental and physical health, which thus restrains the increase of negative emotional and behavioural responses and increases healthy habits. However, staying at home for a long time could also increase the frequency of using mobile phone to maintain social connection, work from home, and reduce boredom. Second, the low levels of social participation could be because the government did not strongly require the public to do so and thus most participants just lived their lives and limited the extent to which they engaged in social events. Another reason might be because most of the participants in this study were students and they had limited capacity to actually contribute to the control of the COVID-19. Third, the timing when the COVID-19 outbroke might also matter. Actually, the outbreak of the COVID-19 was reported just right before the Chinese New Year holiday, a time for most citizens to get back home and gather around with family. This allows most citizens to stay with family and support each other; and strong social support is crucial resource to alleviate stress caused by natural disaster or induced by experimental manipulation and maintain physical and mental health [24, 25].

The role of cognitive appraisal in the emotional and behavioural reactions towards the outbreak of the COVID-19

Three cognitive appraisals were examined. The results suggested that the public had differential evaluation of these appraisals. These findings align with prior researches that reveal the differences in the levels of various cognitive appraisals in mental health and well-being domains [3, 12, 13, 17]. Besides the differences in the mean levels, these appraisals were associated with the outcomes differentially. Among the three appraisals, perceived severity was the risk factor that most widely associated with emotional and behavioural problems while perceived controllability was the protective factor against the increase in emotional problems. However, knowledge about the COVID-19 was not related to any emotional and behavioural changes before and after the outbreak of the COVID-19. This may be because evaluation of severity is more closely about whether and how much an individual's health and well-being is at stake compared to the other two types of appraisals. This suggests that different cognitive appraisals are differentially related to emotional and behavioural outcomes, as found in previous studies [13, 26, 27].

Moreover, all the three appraisals were positively related to more social participation (except for perceived controllability) and precautionary behaviour. These findings are consistent with previous studies that cognitive appraisal (e.g., having more knowledge and perceived risk, threat and danger) were related to more precautionary behaviour during the outbreak of SARS [3, 17, 28]. In addition, these findings suggest that although perceived severity of the COVID-19 is related to more emotional and behavioural problems, it paradoxically increases the public's social participation and precautionary behaviour ---- actions that help control the epidemics [5]. In this sense, perceived severity can be regarded as a double-edge sword, being both risk and asset, in the encounter of medical catastrophe.

Implications

This study has several theoretical and practical implications. Theoretically, the findings deepen our understanding of the important role of cognitive appraisal in the emotional and behavioural outcomes during the outbreak of the COVID-19. Specifically, the findings contribute to the literature that some cognitive appraisals (e.g., know more information and perceived controllability of the event) may serve as protective factors for some emotional and behavioural outcomes. Moreover, some commonly believed risk factor such as perceived severity may actually entail beneficial effect to some extent, such as associating with more behaviour (e.g., social participation and precautionary behaviour) that help control the epidemic. Taken together, these findings highlight the utility of cognitive appraisal in the explanation of the public's emotional and behavioural responses towards emergent public health concern.

Practically, the findings bear several implications for policy-makers and frontline practitioners. First, we identified some groups that are generally vulnerable to various emotional and behavioural problems, such as being female, having physical health problems concurrently, and having higher education level. Therefore, these groups may be in higher need of mental care. Second, the public's cognitive appraisals are related to different outcomes. This suggests that practitioners may address different emotional and behavioural problems by intervening with relevant cognitive appraisals. Third, policy-makers and governments should publicize scientific information about the virus to the public as thorough as possible, since this could enhance the public's motivation engaging in social events (i.e., social participation) and developing healthy behaviour (i.e., precautionary behaviour).

Limitations

This study has several limitations we must acknowledge. First, this study relied on self-report data and cross-sectional design, and thus common method bias could not be excluded. However, this is not without precedent when examining the public's emotion and behaviour during the outbreak of virus/disease [3, 4, 17]. As a preliminary study, the findings provide early understanding of the public's cognitive appraisals of the COVID-19 and their association with a number of emotional and behavioural outcomes. Nevertheless, future study may utilize more sophisticated design and multiple-informant to achieve even more robust results. Second, although hierarchical sampling method was used, the sample size varied greatly across different provinces. The unbalanced sample size may cause bias in the results, especially the estimation of the variance in the outcome variables at the between-level. It is desirable for future research to balance the sample size across clusters if condition permits. Third, females, participants with high education, and participants residing in Guangdong Province were over-representative in the sample, which makes the findings not entirely generalizable to other populations. Finally, it should be noted that the model explained only small amount of variance in many outcome variables, suggesting that relying on cognitive appraisal to understand the public's emotional and behavioural outcomes are not enough and future research should investigate other relevant predictors as well.

Conclusions

China now is working with enormous efforts to control the COVID-19. To this end, intellectual input from multiple disciplines is required, including the understanding of the public's emotion and behaviour and their antecedents from the psychological perspectives. This study provides early evidence to this issue. Our results reveal that the public' emotional and behavioural problems before and after the outbreak of the COVID-19 do not change too much. The public have limited participation in social events regarding the COVID-19 but they actively engage in precautionary behaviour. Moreover, the public's appraisals (i.e., knowledge, perceived severity and perceived controllability) of the COVID-19 are differentially related to their emotional and behavioural outcomes. We believe that these findings bear important theoretical and practical implications in understanding the public's emotion and behaviour during the encounter of emergent public health concerns.

Abbreviations

CFI: Comparative Fit Index; COVID-19: Coronavirus Disease-19; ICCs: Intraclass Correlation; RMSEA: Root-Mean-Square Error of Approximation; SARS: Severe Acute Respiratory Syndrome; TLI: Tucker-Lewis Index.

Declarations

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Authors' contributions

LJB and DK: Study conceptualisation and design, data analysis, manuscript drafting and revision. DK, LJB, ZMC, and LXQ: Data collection and data entry. YA and WLX: Data analysis, reviewed, and edited the manuscript. The authors read and approved the final manuscript.

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Availability of data and materials

The questionnaire and datasets used and/or analyzed during the current study are available from the corresponding authors upon reasonable request.

Ethics approval and consent to participate

The study received ethical approval from the Ethics Review Committee of Education School, Guangzhou University [GZHU2020001] and all participants provided online informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1
Summary of demographic variables

	N	%
Biological sex		
Male	1265	27.5%
Female	3342	72.5%
Educational level		
Junior middle school and below	79	1.7%
High school degree	343	7.4%
College degree	810	17.6%
Bachelor degree	3129	67.9%
Master degree	217	4.7%
Doctoral degree	29	.6%
Current residential provinces		
Anhui Province	152	3.3%
Beijing	33	.7%
Chongqing	28	.6%
Fujian Province	223	4.8%
Gansu Province	31	.7%
Guangdong Province	1386	30.1%
Guangxi Zhuang Autonomous Region	74	1.6%
Guizhou Province	110	2.4%
Hainan Province	20	.4%
Hebei Province	58	1.3%
Henan Province	108	2.3%
Heilongjiang Province	40	.9%
Hong Kong Special Administrative Region	82	1.8%
Hubei Province	45	1.0%
Hunan Province	383	8.3%
Inner Mongolia Autonomous Region	18	.4%
Jilin Province	30	.7%
Jiangsu Province	124	2.7%
Jiangxi Province	1005	21.8%
Liaoning Province	28	.6%
Ningxia Hui Autonomous Region	16	.3%
Qinghai Province	92	2.0%
Shandong Province	101	2.2%
Shanxi Province	57	1.2%
Shaanxi Province	35	.8%
Shanghai	50	1.1%
Sichuan Province	62	1.3%
Tianjin	42	.9%
Xinjiang Uygur Autonomous region	42	.9%
Yunnan Province	50	1.1%
Zhejiang Province	82	1.8%
Self-reported current physical health condition		
Very poor	5	.1%
Poor	46	1.0%
Average	997	21.6%
Good	2160	46.9%
Very good	1399	30.4%
Self-reported history of chronic physical diseases		
Yes	251	5.4%
No	4356	94.6%
Self-reported history of psychiatric / psychological disorder		
Yes	39	.8%
No	4568	99.2%
Relationship with COVID-19		
Healthy (not infected)	4499	97.7%
Other	108	2.3%
Total	4607	100%

Table 2

Descriptive Statistics of knowledge about the COVID-19, perceived severity, perceived controllability, emotional and behavioral reactions, social participation, and precautionary behavior

	Number of Items	*Possible range*	*M*	*SD*	*α*
1. Knowledge about the COVID-19	11	1-5	3.56	.61	.91
2. Perceived severity	5	1-5	4.09	.59	.84
3. Perceived controllability	9	1-5	3.25	.72	.91
4. Emotional and behavioral reactions					
Negative emotion	8	1-5	3.33	.67	.91
Positive emotion	3	1-5	3.68	.83	.97
Sleep problem	4	1-5	2.79	.76	.91
Aggression	2	1-5	2.70	.78	.90
Substance use	2	1-5	2.61	.80	.91
Mobile phone use	1	1-5	3.77	.97	-
5. Social participation	5	0-4	1.75	.77	.79
6. Precautionary behavior	19	0-4	3.33	.66	.92

Table 3

Bivariate Correlations of knowledge about the COVID-19, perceived severity, perceived controllability, emotional and behavioral reactions, social participation, and precautionary behavior

	Neg.	Pos.	Sleep.	Agg.	SU	MPU	Soc. P.	Pre. B
Know	.00	-.02	.00	-.01	.00	.03	$.24^{***}$	$.30^{***}$
PerS	$.24^{***}$	$.15^{***}$	$.06^{***}$	.01	-.03	$.20^{***}$	$.09^{***}$	$.27^{***}$
PerC	$-.10^{***}$	$-.09^{***}$	$-.04^{**}$	-.02	.00	$-.04^{*}$	$.10^{***}$	$.15^{***}$

Note. Know = knowledge about the COVID-19; PerS = perceived severity; PerC = perceived controllability. Neg. = negative emotion; Pos. = positive emotion; Sleep = sleep problems; Agg. = aggression; SU = substance use; MPU = mobile phone use; Soc. P. = social participation; Pre.B = precautionary behavior.

*$p < .05$; ** $p < .01$; *** $p < .001$

Table 4

Multilevel analysis of the association between knowledge, perceived severity, perceived controllability about the COVID-19 and emotional and behavioral reactions, social participation, and precautionary behavior

	Neg.		Pos.		Sleep.		Agg.		SU		MPU		Soc. P.		Pre. B	
	B	*S.E.*	*B*	*S.E.*	*B*	*S.E.*	*B*	*S.E.*	*B*	*S.E.*	*B*	*S.E.*	*B*	*S.E.*	*B*	*S.E.*
Sex	0.07^{***}	0.02	0.06^{***}	0.02	-0.02	0.02	-0.01	0.03	-0.05^{*}	0.03	0.09^{*}	0.04	0.00	0.03	0.17^{***}	0.02
Age	0.00	0.00	0.00^{*}	0.00	0.00	0.00	-0.00^{*}	0.00	-0.00	0.00	-0.01^{**}	0.00	0.01^{**}	0.00	-0.01^{***}	0.00
Phy.history	-0.01	0.04	-0.01	0.04	-0.01	0.05	-0.09	0.06	-0.02	0.05	-0.13	0.09	0.00	0.04	-0.09^{*}	0.04
Psy.history	0.07	0.10	0.08	0.14	-0.36^{**}	0.12	-0.06	0.14	-0.06	0.10	0.03	0.16	-0.08	0.12	0.13	0.11
Health con.	-0.12^{***}	0.01	0.01	0.03	-0.14^{***}	0.02	-0.11^{***}	0.02	-0.07^{***}	0.02	-0.10^{***}	0.02	0.07^{***}	0.02	0.11^{***}	0.01
Education	0.07^{***}	0.02	-0.05^{***}	0.01	0.08^{***}	0.01	0.12^{***}	0.01	0.11^{***}	0.01	0.08^{***}	0.02	0.10^{***}	0.02	0.09^{***}	0.01
Rel. w. COVID-19	0.03	0.08	0.03	0.06	-0.05	0.08	-0.00	0.08	-0.08	0.07	0.08	0.11	-0.02	0.05	-0.05	0.07
PerS	0.25^{***}	0.02	0.19^{***}	0.02	0.06^{***}	0.02	0.02	0.02	-0.02	0.02	0.29^{***}	0.03	0.09^{***}	0.02	0.29^{***}	0.03
PerC	-0.06^{*}	0.02	-0.07^{***}	0.02	-0.03	0.02	-0.01	0.02	-0.00	0.01	-0.01	0.02	0.02	0.01	0.08^{***}	0.01
Know	0.01	0.02	-0.02	0.02	0.03	0.03	0.00	0.02	0.00	0.02	0.02	0.03	0.27^{***}	0.03	0.22^{***}	0.02
ICC	0.032		0.013		0.008		0.014		0.014		0.016		0.020		0.031	
Level-2 variance	$.007^{*}$		.005		.001		.000		.001		$.007^{*}$		$.011^{*}$		$.012^{**}$	
R^2	8.5%		2.9%		3.0%		2.8%		1.7%		5.0%		7.5%		19.3%	

Note. Phy.history = self-reported history of chronic physical diseases; Psy.history = self-reported history of psychiatric / psychological disorder; Health con. = self-reported current physical health condition; Rel. w. COVID-19 = relationship with the COVID-19; PerS = perceived severity; PerC = perceived controllability; Know = knowledge about the COVID-19; ICC = intraclass correlation. Neg. = negative emotion; Pos. = positive emotion; Sleep = sleep problems; Agg. = aggression; SU = substance use; MPU = mobile phone use; Soc. P. = social participation; Pre.B = precautionary behavior. *$p < .05$; ** $p < .01$; *** $p < .001$