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Working Paper

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GLO Discussion Paper, No. 512

Provided in Cooperation with:

Global Labor Organization (GLO)

Suggested Citation: Lu, Haiyang; Nie, Peng; Qian, Long (2020) : Do Quarantine Experiences and Attitudes Towards COVID-19 Affect the Distribution of Psychological Outcomes in China? A Quantile Regression Analysis, GLO Discussion Paper, No. 512, Global Labor Organization (GLO), Essen

This Version is available at:

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Do Quarantine Experiences and Attitudes Towards COVID-19 Affect the Distribution of Psychological Outcomes in China? A Quantile Regression Analysis

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April, 2020

Abstract

While quarantine has become a widely used control measure during the outbreak of the 2019 novel coronavirus disease (COVID-19), empirical research on whether and to what extent quarantine and attitudes towards COVID-19 influence psychological outcomes is scant. Using a cross-sectional online survey, this paper is the first to investigate the heterogeneous impact of quarantine experiences and attitudes towards COVID-19 on the whole distribution of psychological well-being in China. We find that credibility of real-time updates and confidence in the epidemic control are associated with a decline in depression but an increase in happiness. Such effects are stronger in the upper distribution of depression and the median of happiness. We also discern that individuals with severe depressive symptoms (or lower levels of happiness) are more susceptible to the severity of the pandemic. Moreover, home self-quarantine is associated a decrease in depression but an increase in happiness, by contrast, community-level quarantine discourages happiness, especially in the lower distribution of happiness.

JEL Classification: I10, I31

Keywords: Quarantine, Attitudes, Quantile regression, Psychological well-being

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“This storm will pass, but the choices we make now could change our lives for years to come.” — Yuval Noah Harari

1 Introduction

Since December 2019, the outbreak of a novel coronavirus disease (COVID-19), which was first reported in Wuhan, Hubei province, China, has become a global concern. On March 11, 2020, WHO Director-General characterized COVID-19 as a pandemic because of its alarming levels of spread and severity (WHO, [2020a](#)). By April 6, there were 8,3005 confirmed cases of COVID-19 in China and 3,340 people were dead due to infection; Globally, the number of COVID-19 cases has surged, with 1,214,973 confirmed cases in 205 countries/areas (WHO, [2020b](#)). Public health efforts to curb the rapid transmission of COVID-19 have led to infection control measures dominating hospital procedures and policies in China. Governments at all levels have implemented a range of containment measures, including early detection and isolation of suspected and confirmed cases, establishment of Fangcang shelter hospitals (Chen et al., [2020](#)), travel restrictions, dissemination of diagnostic kit and widespread quarantines (Xiang et al., [2020](#)).

The outbreak of COVID-19 has sparked a renewed research interest in psychological challenges this epidemic poses to health professionals, patients, and the public. As highlighted by Jalloh et al. ([2018](#)), individuals generally face mental health problems such as anxiety, stress, depression, insomnia, and anger in the fight against epidemics such as SARS and Ebola. In response to public mental health concerns in

China, the National Health Commission of China (2020) has issued guidelines to local authorities to promote psychological crisis intervention against COVID-19. In addition, many psychological counseling centers have set up special hotlines to provide psychological counseling services to those in need (Bao et al., 2020).

Although some prior work, including Kang et al. (2020) and Liu et al. (2020), underscore the psychological impact of COVID-19, empirical evidence is quite limited so far, possibly due primarily to a lack of data. One exception is the work by Huang & Zhao (2020), which studies the mental health burden of Chinese people during the outbreak of COVID-19 based on a web-based survey. They document that age, occupation, and attention to COVID-19 are significant predictors of generalized anxiety and sleep quality. Just based on this background, we aim to explore the role of quarantine experiences and attitudes towards COVID-19 in influencing the whole distribution of psychological well-being (PWB) among adults in China.

Our work complements the existing literature in the psychological impact of disease outbreaks in the following ways. First, unlike most previous studies focusing on negative domains of PWB such as psychiatric morbidity (Chong et al., 2004), depressive symptoms (Liu et al., 2012), and psychological distress (Lee et al., 2018), we combine both positive and negative metrics of PWB – depressive symptoms and happiness – in the context of the COVID-19 outbreak in China. This combination could allow researchers to gain a fuller picture of the psychological impacts of COVID-19. As Kang et al. (2020) have emphasized, the severe situation can not only cause mental health problems but also have a lasting effect on the PWB of the population.

Second, we use a quantile regression approach to analyze the potential asymmetry in the impact of quarantine experiences and attitudes towards COVID-19 on the whole distribution of PWB. To our knowledge, all previous work regarding the psychological outcomes of either quarantine experiences or other epidemic-related factors focus on mean impacts, that is, the average change in psychological outcome variables. However, since the PWB distribution is empirically quite skewed (Binder & Coad, 2011), it is reasonable to assume that impact of quarantine experiences and attitudes towards COVID-19 may differ at different quantiles of the PWB distribution.

It is also novel that we explore these associations in China, where the disease first emerged and is now under effective control, and therefore has important implications for other countries affected by the pandemic.

Our results reveal that home self-quarantine during the COVID-19 pandemic is associated with increased happiness and reduced depressive symptoms. While community-level quarantine is negatively associated with happiness, people who had quarantine experiences during the 2003 SARS are more likely to report symptoms of depression. In terms of attitudinal measures, people with a high degree of confidence in COVID-19 control have significantly higher levels of happiness and milder symptoms of depression, while negative attitude to the pandemic severity is likely to exert a detrimental impact on PWB. We also find that attitude towards the credibility of real-time updates play a role in improving happiness during the COVID-19 pandemic. Moreover, the results show that the effects of quarantine experiences and attitudes towards COVID-19 vary substantially across quantiles of the PWB distribution.

The rest of the paper proceeds as follows. Section 2 reviews the relevant literature. Section 3 describes data and methods. Section 4 presents and discusses empirical results, and Section 5 concludes.

2. Prior literature

2.1 Quarantine and psychological outcomes

The concept of “quarantine”, which is fundamentally rooted in local and global health cultures and practices, has received much attention during disease outbreaks that can be detected or actually occur (Gensini et al., 2004). In the health literature, quarantine is commonly defined as the separation or restriction of the activities of individuals who may have been exposed to infectious diseases to reduce their risk of infecting others (Brooks et al., 2020). Conceptually, “quarantine” is often used interchangeably with “isolation”, and both terms share the same meaning of infection prevention. However, there is also a clear distinction between the two terms: the former applies to individuals who are asymptomatic or are not yet ill, whilst the latter is for patients who are symptomatic or known to have a contagious disease (Barbisch et al., 2015).

Although quarantine is to protect individuals’ health from infectious diseases, it is widely regarded as an unpleasant experience that may trigger various psychological problems such as depression, anxiety, fear, loneliness, resentment, and perplexity (Lin et al., 2010). For instance, using data from a survey in South Korea during the Middle East Respiratory Syndrome (MERS) epidemic, Jeong et al. (2016) find that approximately 16.6% and 7.6% of respondents reported anger and symptoms of anxiety

during quarantine, respectively. Sprang & Silman (2013) document that disease-containment measures such as quarantine and isolation have a detrimental impact on children and their parents, manifested in symptoms of post-traumatic stress disorder (PTSD). This result is in line with Hawryluck et al. (2004), who document that longer duration of quarantine is a significant factor behind an increased prevalence of PTSD symptoms.

There are several reasons why quarantine is likely to have a detrimental impact on PWB. First, those who are quarantined may face difficulties getting food and other daily necessities (DiGiovanni et al., 2004). Lack of access to basic supplies could, in turn, give rise to feelings of tension, frustration, and anxiety (Maynard et al., 2019; Shernoff et al., 2011). Second, quarantined individuals are likely to be discriminated against and ostracized by their neighbors and other groups, suggesting that stigma is common among people with quarantine experiences (Cava et al., 2005; Karamouzian & Hategekimana, 2015). For example, after the lockdown in Wuhan, the stigma of people from Hubei province has been widely spread on social medias such as *WeChat*. Such stigma may further result in increased stress and deterioration of mental health among those who were under quarantine (Robertson et al., 2004). Moreover, quarantine may cause financial loss, inadequate information, and boredom (Brooks et al., 2020), thereby contributing to psychological disorders.

Although there is some evidence from various disciplines that quarantine experiences are negatively associated with psychological outcomes (Reynolds et al., 2008; Taylor et al., 2008), quarantine may also have beneficial psychological impacts,

mainly because it can effectively reduce an individual's risk of being infected, thereby alleviating the infectious pressure on them (Locke et al., 2019). It is worth pointing out that the psychological impact of quarantine depends largely on the characteristics of participants and the quarantine variables selected. As documented by Reynolds et al. (2008), while longer quarantine and compliance with quarantine requirements are significant factors behind a higher level of PTSD, healthcare workers are more likely than the public to be affected.

2.2 The role of attitudes in PWB

The unique role of attitudes in predicting emotional functioning has been extensively documented in the PWB literature (Amato & Rogers, 1999; Ayers et al., 2010; Iyer & Muncy, 2016). Using data from a 9-year follow-up survey, the work by Halvorsen et al. (2010) provides evidence that dysfunctional attitudes are closely related to depression severity. Aghababaei et al. (2016), using a sample of college students in Iran, find that both religious and scientific attitudes are positively associated with life satisfaction, happiness, and self-esteem.

Closer to our interest is a small but growing body of research on the nexus between attitudes towards disease and PWB. One branch of the literature looks at the impact of attitude to disease severity on the PWB of patients (e.g., Moss Morris et al., 1996; Zhang et al., 2016). Using a sample of heart failure patients from Ireland, Morgan et al. (2014) document that illness perceptions are correlated with PWB, and suggest that control-related attitudes could have a protective role in health-related outcomes. This finding is in line with the work by Callus et al. (2014), showing that attitude towards

severity of cardiac disease is associated with the patients' pre-operative psychological state. Our study is also related to Boyes et al. (2006), who find that attitude towards real-time feedback of health information improves patients' symptom control, but has no significant impact on their PWB.

Overall, favorable attitudes are found to predict successful adaptation to adverse circumstances, due to their protective function against illness, disability, and depression (Kato et al., 2016). As emphasized by Shallcross et al. (2010), embracing negative experiences may protect individuals from negative emotions and prevent depression. In a similar vein, a systematic review by Ayers et al. (2010) indicates that women who hold a more negative attitude towards menopause report more symptoms during the menopause transition.

Given our research aim, it is important to highlight three aspects of previous research: First, although quarantine experiences and attitudes towards disease are closely linked to psychological outcomes, little research has been done on whether these relationships exist in the context of China. We argue that China offers a novel and important case for investigating psychological impacts of quarantine and attitudinal factors, mainly because it is the first country in the world to experience the COVID-19 outbreak, with a huge number of infection cases. Second, most existing research focuses on a single indicator of quarantine and attitude, ignoring that both quarantine and attitude towards disease are multifaceted and that different aspects may lead to different psychological consequences. Third, no empirical work has explored the impact of quarantine and attitude towards disease on the whole distribution of psychological

outcomes. These three points highlight the contributions of our work: not only is it the first study to investigate the potential impacts of quarantine and public attitudes toward the COVID-19 pandemic in China, it also explores their heterogeneous effects on the whole distribution of PWB.

3. Data and methods

3.1 Study design and sample

The rapid transmission of COVID-19 has hampered traditional face-to-face surveys. In contrast, with the rapid development and diffusion of the mobile Internet in China, online surveys are more secure and feasible. As such, we conducted an anonymous, mobile Internet-based, cross-sectional survey entitled “*Social Attitudes and Psychological Health during the COVID-19 Pandemic*” between March 6, 2020 and March 12, 2020. This cross-sectional study was conducted in accordance with the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) statement. The online questionnaire was designed using *WenJuan*, a popular Internet survey platform in China (For more information, please see: <https://www.wenjuan.com/>), and was taken voluntarily after clicking on a survey solicitation link. Using a snowballing sampling technique, our survey collected a total of 1,951 respondents from all 31 mainland provinces/municipalities/autonomous regions. In this paper, we focus on respondents aged between 16 and 65, and exclude from the sample those who lacked information on core variables (including depression, happiness, quarantine, and attitudes toward COVID-19). As a result, 1,849 observations remain after data cleaning.

3.2 Outcome variables

To generate a more differentiated picture of the quarantine-PWB nexus, we introduce both depressive symptoms and happiness. Based on the Center for Epidemiological Studies Depression (CES-D) scale developed by Radloff (1977), we use a 9-item scale to measure the depressive symptoms of participants during the COVID-19 pandemic. More specifically, on a 5-point frequency scale from “1 = never or rarely” to “5 = most or all the time”, the respondents were asked how often they had experienced the following feelings during the past week: (i) loss of appetite, (ii) upset, (iii) hopelessness in the future, (iv) meaningless life, (v) poor sleep, (vi) inability to concentrate, (vii) sadness, (viii) afraid, and (ix) difficulty doing anything. A composite indicator for depressive symptoms is generated summing all responses, with a total score ranging from 9 to 45, and higher scores indicate more severe depressive symptoms (Cronbach’s alpha = 0.91).

Following Arampatzi et al. (2018) and Ugur (2019), we use the question “*All things considered, how happy are you with your life as a whole?*” (a 10-point scale ranging from “1 = totally unhappy” to “10 = totally happy”) to measure individual happiness. As shown in Figs. 1 and 2, the distribution of depression is skewed to the left with a long right tail, while the distribution of happiness is skewed slightly to the right.

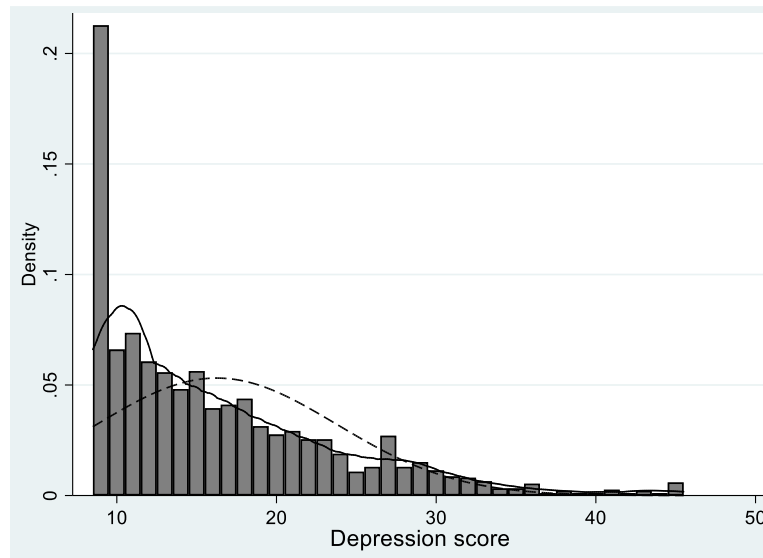


Fig. 1. Histogram for depressive symptoms, overlaid with a kernel density and a normal density

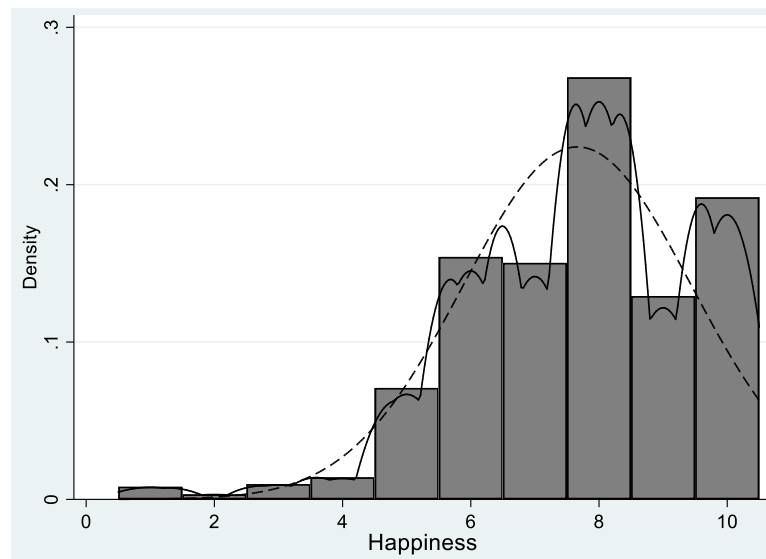


Fig. 2. Histogram for happiness, overlaid with a kernel density and a normal density

3.3 Key independent variables

As stated before, the attitude one holds is multifaceted. For the purpose of our work, three metrics are used to measure the attitudes towards COVID-19. One attitude will be labeled *severity perception*, which refers to an individual's perception of *COVID-19* severity, coded as 1 if the respondent believes that the negative impact of the pandemic on him/her will last for at least three months, and 0 otherwise. A second

attitude will be labeled *credibility of real-time data*, capturing whether an individual has a very high level of trust in the real-time updates of COVID-19 cases (1 = yes, 0 = otherwise). The third attitude measure will be labeled *pandemic control* and will reflect an individual's confidence in the control of COVID-19 (1 = very or fairly confident, 0 = otherwise).

Regarding quarantine experiences, we take into account both micro and macro levels of quarantine. The former is home-based quarantine, captured by the question “*How often did you go out during the COVID 19 outbreak?*” and measured on a 4-point scale (1 = never, 2 = once or twice a week, 3 = three or four times a week and 4 = everyday). To facilitate the analysis, we rescale it as a dichotomous measure, equaling to 1 if the respondent has never been out, and 0 otherwise. The latter, labelled *community-level quarantine*, is also a binary variable that equals to 1 if the community/village where the respondent resides is blocked, 0 otherwise. It should be noted that communities are at the frontline of COVID-19 pandemic control. Moreover, since quarantine was also used as a control measure during the 2003 SARS outbreak in China, it is interesting to explore the scarring effect of such quarantine experience on current PWB. This variable is measured by asking the respondent if he or she has experienced home quarantine during the 2003 SARS (1=yes, 0=otherwise).

3.4 Covariates

To reduce omitted variable bias, we also introduce a range of covariates that may be linked to PWB. Based on previous work (Binder & Coad, 2011; Zhang et al., 2015), we control for gender (1 = male, 0 = female), age, self-reported health (1 = good, 0 =

others), household registration type (*hukou*) (1 = rural, 0 = urban), education attainment (1 = primary school, 2 = junior middle school, 3 = senior middle school, 4 = college or above), household economic status (1 = poor family, 0 = others), marital status (1 = married, 0 = others), religiosity (1 = religious believer, 0 = others), COVID-19 confirmed cases among relatives/friends (1 = yes, 0 = no), food/water shortage (1 = yes, 0 = no), family contacts (1 = close contact with family members, 0 = other), perceived fairness (1 = high, 0 = other), generalized trust (1 = high, 0 = other), and provincial dummies.

3.5 Empirical Strategy

Due to the great diversity of individual characteristics, psychological outcomes may exert a pattern of heterogeneity. As highlighted by Binder & Coad (2011), the determinants of happiness vary across different quantiles of the happiness distribution. In our work, due to the non-normal distribution of dependent variables, the impacts of quarantine and attitudinal factors may differ across the distributions of depressive symptoms and perceived happiness. As such, in addition to the most commonly used OLS method, we also report the estimates from quantile regressions (QR). The QR method, developed by Koenker & Bassett (1978), allows us to investigate the predictors at different intervals throughout the whole distributions of PWB.

The quantile estimators can be obtained by tackling the following optimization problem:

$$\min_{\beta \in R^k} \left[\sum_{i \in \{i: y_i \geq x_i' \beta\}} \theta |y_i - x_i' \beta| + \sum_{i \in \{i: y_i < x_i' \beta\}} (1 - \theta) |y_i - x_i' \beta| \right] \quad (1)$$

for the θ th quantile ($0 < \theta < 1$), y_i is psychological outcomes in terms of depressive symptoms or perceived happiness, x_i is a vector of explanatory variables including quarantine experiences, attitudes towards COVID-19, and other covariates.

4. Results

4.1 Descriptive statistics and pairwise correlations

Table 1 provides an overview of the descriptive statistics. Female respondents account for 63% of our sample. The average age of the respondents is about 31 years old, and the female sample is much younger than the male one (30 versus 32, $p < 0.01$). In general, relative to males, females are more likely to hold favorable attitudes towards COVID-19 in terms of severity perception (0.34 versus 0.43, $p < 0.01$) and confidence in pandemic control (0.92 versus 0.90, $p < 0.05$). Interestingly, although males had more quarantine experiences than females during the 2003 SARS, females are more likely to be quarantined at home than males during the COVID-19 pandemic.

Table 1 Descriptive statistics

Variables	Mean	Min	Max	25th	50th	75th	Females	Males
Depressive symptoms	16.26 (7.51)	9	45	10	14	20	16.24	16.26
Happiness	7.66 (1.78)	1	10	6	8	9	7.46	7.78***
Severity perception	0.37 (0.48)	0	1	0	0	1	0.34	0.43***
Credibility of real-time data	0.11 (0.31)	0	1	0	0	0	0.11	0.12
Pandemic control	0.91 (0.28)	0	1	1	1	1	0.92	0.90**
SARS quarantine experience	0.28 (0.45)	0	1	0	0	1	0.26	0.33***
Community-level quarantine	0.93 (0.26)	0	1	1	1	1	0.93	0.92
Home quarantine	0.46 (0.50)	0	1	0	0	1	0.50	0.39***
Gender	0.37 (0.48)	0	1	0	0	1	–	–
Age	30.62 (9.44)	16	65	24	28	36	29.76	32.07***
Self-reported health	0.69 (0.46)	0	1	0	1	1	0.71	0.67**
Rural <i>hukou</i>	0.38 (0.48)	0	1	0	0	1	0.38	0.37
Primary school	0.01 (0.10)	0	1	0	0	0	0.01	0.01
Junior middle school	0.06 (0.24)	0	1	0	0	0	0.06	0.06
Senior middle school	0.10 (0.30)	0	1	0	0	0	0.10	0.10

College or above	0.83 (0.37)	0	1	1	1	1	0.83	0.83
Poor family	0.17 (0.38)	0	1	0	0	0	0.15	0.20***
Married	0.43 (0.50)	0	1	0	0	1	0.39	0.49***
Religious believer	0.08 (0.28)	0	1	0	0	0	0.08	0.08
COVID-19 cases	0.02 (0.12)	0	1	0	0	0	0.01	0.02
Food/water shortage	0.10 (0.29)	0	1	0	0	0	0.10	0.10
Family contacts	0.63 (0.48)	0	1	0	1	1	0.64	0.60**
Perceived fairness	0.41 (0.49)	0	1	0	0	1	0.41	0.41
Generalized trust	0.50 (0.50)	0	1	0	1	1	0.51	0.48

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Significance levels are obtained from t -tests. Standard deviations are shown in parentheses.

Although the gender difference in mean depression is insignificant, the mean happiness score for females is significantly higher than that for males. To get a more complete picture of PWB during the COVID-19 pandemic, we also investigate several other types of emotions. As illustrated in Fig. 3, more than 58% of respondents report anxiety, around 35%, 17.1% and 16.6% report panic, anger, and helplessness, respectively. In contrast, very few report numbness (9.6%) and desperation (3.7%), separately. In addition, gender difference is also discernable. Specifically, females are more likely show anxiety and panic, but males are more prone to feel depressed and compelled.

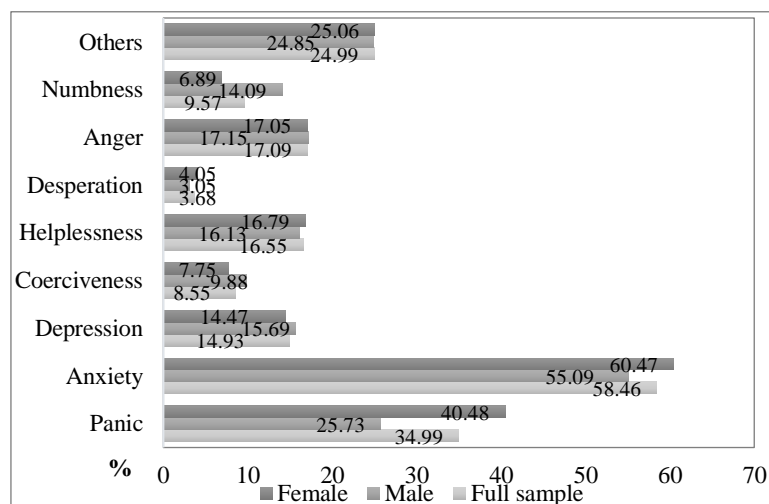


Fig. 3. The prevalence of negative emotions

Table 2 presents pairwise correlations between our main variables of interest. We find a significantly negative correlation between depression and happiness ($r = -0.32$, $p < 0.01$). The correlation matrix also reveals that all three attitudinal metrics are significantly correlated with depressive symptoms and perceived happiness. More specifically, we find that severity perception is positively correlated with depressive symptoms ($r = 0.17$, $p < 0.01$), but is negatively correlated with happiness ($r = -0.11$, $p < 0.01$). Similarly, both credibility of real-time data and pandemic control are negatively correlated with depressive symptoms ($r = -0.08$, $p < 0.01$ versus $r = -0.17$, $p < 0.01$), but are positively correlated with happiness ($r = 0.12$, $p < 0.01$ versus $r = 0.18$, $p < 0.01$). Regarding quarantine measures, SARS quarantine experience is positively correlated with depressive symptoms ($r = 0.06$, $p < 0.05$), while home quarantine is positively correlated with happiness ($r = 0.05$, $p < 0.05$). However, those results should be explained with much caution without controlling for demographic and socioeconomic characteristics.

Table 2 Intercorrelations among main variables of interest

Variables	1	2	3	4	5	6	7	8
1. Depressive symptoms	–							
2. Happiness	-0.32***	–						
3. Severity perception	0.17***	-0.11***	–					
4. Credibility of real-time data	-0.08***	0.12***	-0.07***	–				
5. Pandemic control	-0.17***	0.18***	-0.12***	0.06***	–			
6. SARS quarantine experience	0.06**	-0.01	0.01	0.01	0.01	–		
7. Community-level quarantine	0.03	-0.01	-0.01	-0.03	0.07***	0.10***	–	
8. Home quarantine	-0.00	0.05**	-0.06**	0.03	0.04	0.01	0.10***	–

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2 Multivariate regression analysis

Table 3 shows estimation results for the impact of quarantine and attitudes towards COVID-19 on depressive symptoms. We start by exploring the correlates of depressive symptoms based on the OLS regression (column 1). After controlling for other covariates, severity perception is still associated with an increase in depressive symptoms, whilst pandemic control exerts a significantly negative impact on depressive symptoms. These results may suggest that individual who are pessimistic about COVID-19 severity and the pandemic control are more likely to feel depressed. Regarding the impact of quarantine experiences, we find that home quarantine plays a role in reducing depression, while SARS quarantine experience is found to have a deleterious impact on depression, implying that, in the short term, home quarantine is conducive to PWB mainly because of its potential role in reducing risk of infection, but has a scarring effect on individual PWB.

Table 3 The OLS and quantile regression estimates (dependent variable: depressive symptoms)

	(1)	(2)	(3)	(4)
	OLS	25th	50th	75th
Severity perception	1.977*** (0.361)	0.547* (0.285)	1.529*** (0.357)	2.752*** (0.658)
Credibility of real-time data	-0.268 (0.509)	-0.168 (0.311)	-0.492 (0.350)	-1.459* (0.749)
Pandemic control	-2.565*** (0.706)	-0.776 (0.741)	-2.078** (0.884)	-3.084*** (1.163)
SARS quarantine experience	0.810** (0.385)	0.479 (0.315)	1.197*** (0.399)	0.780 (0.701)
Community-level quarantine	0.690 (0.656)	0.452 (0.450)	0.204 (0.510)	0.914 (1.238)
Home quarantine	-0.660* (0.346)	-0.517** (0.212)	-0.806* (0.418)	-1.003* (0.558)
Gender	-0.329 (0.348)	-0.459* (0.274)	-0.388 (0.408)	-0.791* (0.466)
Age	0.008 (0.027)	0.014 (0.026)	-0.011 (0.044)	-0.006 (0.040)
Self-reported health	-3.243*** (0.392)	-1.825*** (0.44)	-3.389*** (0.642)	-4.643*** (0.700)
Rural <i>hukou</i>	0.223 (0.400)	0.247 (0.224)	0.075 (0.373)	0.482 (0.617)
Junior middle school	1.684 (1.668)	-0.111 (1.138)	-1.163 (2.456)	0.789 (2.841)
Senior middle school	1.487 (1.581)	0.786 (1.213)	-0.872 (2.187)	0.942 (2.597)
College or above	1.848 (1.550)	1.069 (1.193)	-0.296 (2.235)	1.031 (2.579)
Poor family	0.913* (0.514)	0.278 (0.434)	0.459 (0.681)	1.292 (0.802)
Married	-1.646*** (0.484)	-0.651 (0.425)	-1.507** (0.686)	-2.535*** (0.920)
Religious believer	0.688 (0.637)	0.501 (0.478)	0.119 (0.784)	0.306 (0.843)

COVID-19 cases	1.375 (1.512)	1.305 (1.921)	0.905 (1.513)	3.764 (3.204)
Food/water shortage	3.026*** (0.656)	2.379** (1.073)	4.038*** (0.730)	2.896*** (0.889)
Family contacts	0.439 (0.351)	0.351 (0.298)	0.550 (0.411)	0.802 (0.361)
Perceived fairness	-1.571*** (0.348)	-0.809*** (0.235)	-2.171*** (0.487)	-2.239*** (0.768)
Generalized trust	-0.642* (0.372)	-0.466 (0.308)	-0.511 (0.498)	-1.205 (0.944)
Constant	18.737*** (2.209)	11.034*** (1.668)	19.583*** (2.989)	25.593*** (3.392)
Provincial dummies	Yes	Yes	Yes	Yes
Observations	1,847	1,847	1,847	1,847

Note: * $p < 0.1$, ** $p < 0.05$, *** p value < 0.01 .

Columns 1-4 of Table 3 report the estimated effects for the 25th, 50th, and 75th quantiles of the distribution of depressive symptoms. The quantile regression suggests that the mean effect derived from the OLS estimates masks considerable heterogeneities (see Fig. 4). While the impact of severity perception is significant in all three quantiles, this impact rises nearly monotonically from 0.547 in the 25th percentile to 2.752 in the 75th percentile, indicating that people with more severe depressive symptoms are more vulnerable. Notably, although the impact of real-time data credibility is not significant in the OLS estimation, it becomes significant at the 75th quantile. In addition, the effect of pandemic control is only significant at the quantiles of 0.50th and 0.75th (-2.078 versus -3.084). Overall, these results indicate that, conditional on other covariates, those in the upper distribution of depression benefit more from favorable attitudes towards COVID-19. Similarly, the beneficial impact of home quarantine on reducing depression is much stronger in the upper distribution of depression.

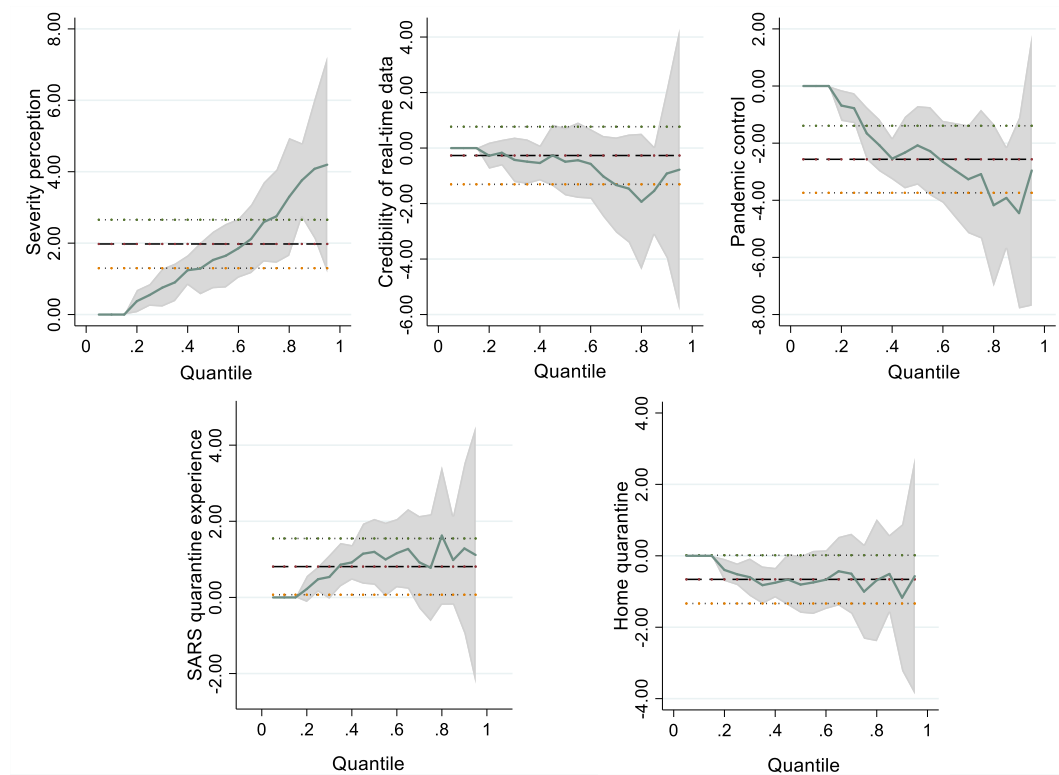


Fig. 4. Distributional effects on depressive symptoms

We further look at the impact of quarantine and attitudes towards COVID-19 on happiness (Table 4). In column 1, we find that the impact of severity perception is negative, while the impacts of credibility of real-time data and pandemic control are positive, underscoring the importance of favorable attitudes in promoting PWB. It is worth noting that although home quarantine is positively associated with happiness, community-level quarantine is likely to exert a negative impact on happiness. This may be because community-level quarantine means that the pandemic is severe or beyond the control, inevitably creating a climate of panic and coercion. Also, quarantine at the macro level will cause a lot of inconveniences to people's daily life. By contrast, home quarantine is more likely to be a rational choice for self-protection, which can reduce the fear of infection and thus help increase happiness.

Table 4 The OLS and QR estimates (dependent variable: happiness)

	(1)	(2)	(3)	(4)
	OLS	25th	50th	75th
Severity perception	-0.146* (0.081)	-0.246** (0.121)	-0.227** (0.093)	0.001 (0.140)
Credibility of real-time data	0.275** (0.124)	0.290** (0.148)	0.498** (0.193)	0.361** (0.181)
Pandemic control	0.571*** (0.160)	0.396 (0.279)	0.545** (0.234)	0.493** (0.196)
SARS quarantine experience	0.039 (0.090)	0.091 (0.158)	-0.095 (0.116)	0.110 (0.112)
Community-level quarantine	-0.266** (0.134)	-0.346** (0.176)	-0.214 (0.183)	-0.022 (0.188)
Home quarantine	0.160* (0.083)	0.028 (0.120)	0.159** (0.071)	0.255*** (0.096)
Gender	-0.173** (0.082)	-0.149 (0.126)	-0.123 (0.118)	-0.172 (0.114)
Age	-0.019** (0.007)	-0.018* (0.010)	-0.029*** (0.010)	-0.021** (0.008)
Self-reported health	0.824*** (0.092)	0.969*** (0.091)	0.933*** (0.126)	0.807*** (0.112)
Rural <i>hukou</i>	-0.211** (0.090)	-0.278* (0.158)	-0.297** (0.132)	-0.136 (0.107)
Junior middle school	0.415 (0.580)	0.000 (0.794)	0.603 (0.635)	0.386 (0.912)
Senior middle school	-0.079 (0.580)	-0.363 (0.677)	-0.014 (0.656)	-0.105 (0.837)
College or above	-0.090 (0.571)	0.054 (0.663)	-0.001 (0.549)	-0.491 (0.837)
Poor family	-0.397*** (0.125)	-0.319* (0.176)	-0.360* (0.187)	-0.145 (0.147)
Married	0.300*** (0.113)	0.299* (0.168)	0.454*** (0.129)	0.507*** (0.108)
Religious believer	0.117 (0.158)	-0.081 (0.242)	0.242 (0.226)	0.339* (0.201)
COVID-19 cases	0.326 (0.260)	0.187 (0.351)	0.228 (0.389)	0.431 (0.451)
Food/water shortage	-0.241* (0.140)	-0.449** (0.220)	-0.278 (0.199)	-0.057 (0.130)
Family contacts	0.310*** (0.080)	0.245* (0.144)	0.314*** (0.094)	0.206* (0.126)
Perceived fairness	0.410*** (0.082)	0.444** (0.174)	0.431*** (0.096)	0.313** (0.150)
Generalized trust	0.503*** (0.085)	0.638*** (0.104)	0.409*** (0.106)	0.416*** (0.142)
Constant	6.823*** (0.691)	5.956*** (1.022)	7.260*** (0.779)	8.238*** (0.985)
Provincial dummies	Yes	Yes	Yes	Yes
Observations	1,849	1,849	1,849	1,849

Note: * $p < 0.1$, ** $p < 0.05$, *** p value < 0.01 .

Columns 2-4 of Table 4 report the coefficients for quantile regression estimates for happiness. Fig. 5 provides additional details on these results by plotting the heterogeneous impacts of quarantine and attitudinal metrics. Three main findings are worth noting: First, people at the lower distribution of happiness are more affected by their perceptions of pandemic severity, while those who are happy are more susceptible to the pandemic control. Second, the impact of community-level quarantine varies widely across the happiness distribution, dropping substantially from -0.346 in the 25th

percentile to -0.022 in the 75th percentile, and is only significant at lower quantiles. Third, the effect of home quarantine is not significant at the bottom end of the happiness distribution, but it is positive and significant at the median and upper distribution (50th = 0.159; 75th = 0.255). This finding may imply that happier people care more about the risk of infection and therefore benefit more from home quarantine.

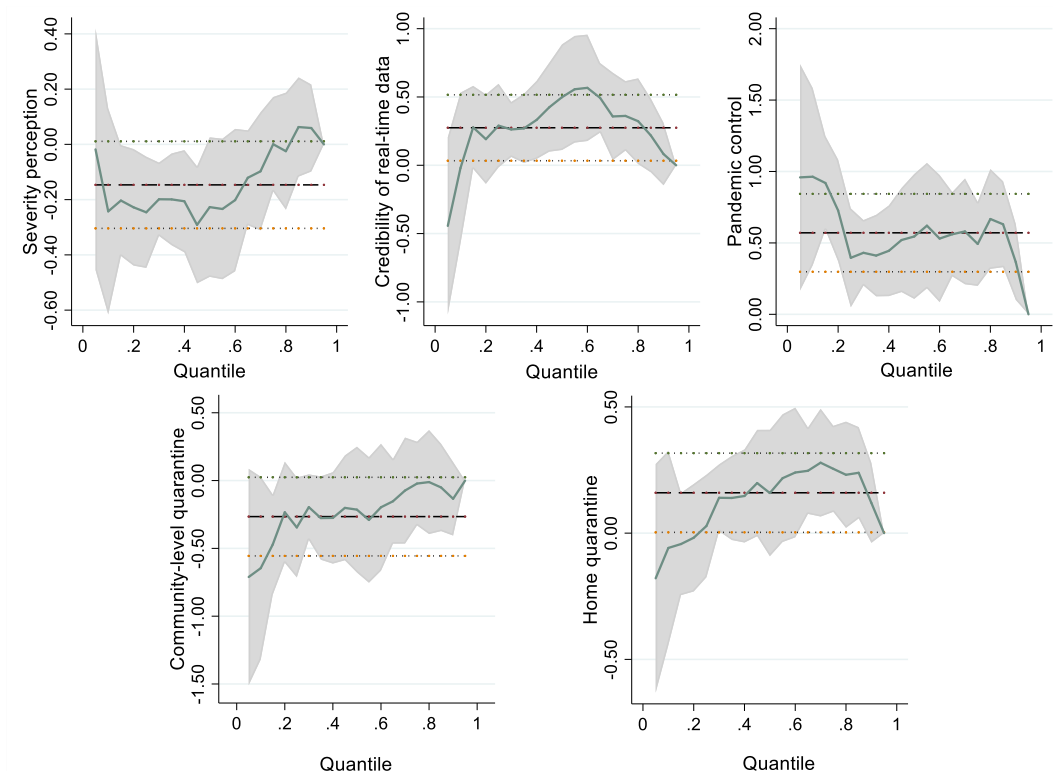


Fig. 5. Distributional effects on happiness

Regarding other covariates, two key findings are worth emphasizing: First, family contacts are positively related to happiness, underscoring the importance of family support during the COVID-19 pandemic. Second, perceived fairness and general trust play an important role in promoting happiness and reducing depression. One possible explanation is that people living in a society with high levels of fairness and trust may have a strong sense of belonging (Knack & Keefer, 1997), thereby leading to greater

social cohesion and cooperation (Alesina et al., 2004), all of which may help them overcome the difficulties during the pandemic.

5. Conclusions

The outbreak of COVID-19 pandemic poses a severe challenge to the normal functioning of societies and human health. Quarantine has become a widely used measure by most governments to contain the transmission of epidemics. Despite ample evidence on the psychological consequences of quarantine, virtually no empirical studies have explored this topic in the context of COVID-19 pandemic. Also, there is little agreement about how attitude towards the epidemics affects PWB.

In this paper, we explore the psychological outcomes (measured by depressive symptoms and happiness) of quarantine experiences and attitudes towards COVID-19 in China. A key novelty lies in our focus on the heterogeneous effects across the whole distribution of psychological outcomes. Ours is the first paper, of which we are aware, to explore the impact of quarantine experiences and attitudes towards COVID-19 on the PWB distribution.

We provide evidence that positive attitude towards COVID-19 (including severity perception, credibility of real-time updates, and confidence in pandemic control) helps reduce depressive symptoms and improve happiness. Our quantile regression analysis further shows that although people with severe depressive symptoms or lower levels of happiness are more concerned about COVID-19 severity, those with milder depression or higher levels of happiness care more about the credibility of real-time updates and the pandemic control.

As Brooks et al. (2020) have posited, quarantine could have lasting, widespread and substantial psychological effects. We demonstrate that home quarantine during the COVID-19 pandemic is closely related to a decrease in depression and an increase in happiness, perhaps due primarily to its role in reducing the risk of infection. Conversely, community-level quarantine and quarantine experience during the 2003 SARS have deleterious psychological impacts. These results appear to call into question the appropriateness of controlling the spread of COVID-19 or other novel infectious diseases via macro-mandatory quarantine.

Overall, our findings have some important implications for improving the PWB of the public especially during the COVID-19 pandemic: First, successful containment measures should take the psychological costs of quarantine into account. In China social mobilization is easy to achieve and often effective, more detailed assessments on macro-level segregation are needed because restricting the activities of individuals may cause inconveniences, panic, and also be detrimental to the economy. Second, the rapid and real-time authoritative dissemination of pandemic information is crucial to alleviating negative public sentiment. A lack of authoritative information could lead the public to ignore the epidemic, exacerbating the outbreak and increasing follow-up costs (Gong et al. 2020). As Harari (2020) have recently emphasized: “A *self-motivated and well-informed population is usually far more powerful and effective than a policed, ignorant population.*” Third, given the importance of social cohesion and trust, close cooperation among governments at all levels should be strengthened to reduce stigma and employment discrimination against migrants resulting from quarantine or

lockdown.

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