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COVID-19 and Mental Health in China: The Effects of Personality

Xiao Zhang

University of Glasgow

Michele Battisti

University of Glasgow, IZA, CESifo

Eugenio Proto

University of Glasgow, CEPR, IZA, CESifo

(Corresponding author: Eugenio Proto, eugenio.proto@glasgow.ac.uk)

Abstract

Background China was the first country affected by the COVID-19 virus, and it is a very important case to study the effects of the virus and the consequent restrictions. However, national representative studies of how the COVID-19 pandemic affects mental health in China are still limited.

Methods Using two waves of the China Family Panel Studies (CFPS), we follow the same individuals before and during the pandemic. We compare weighted means using 95% confidence intervals to explore mental health deterioration, and we perform several linear regressions with the OLS estimator to identify individuals most affected by the COVID-19 pandemic.

Results The prevalence of severe cases of depression, measured using an eight-item version of the common CES-D scale, increased from 6.68% in 2018 to 7.86% in 2020; quantifiable as around a 18% increase. This deterioration is higher for individuals subject to strict lockdowns, about 0.4 symptoms more on average, and it is stronger among those who already reported symptoms of depression in the 2018 wave of data. Individuals with more open personalities tend to experience more severe deterioration: a one-standard-deviation change in the openness trait corresponds to 0.05 more symptoms. On the other hand, more neurotic individuals seem less negatively affected.

Conclusion We find clear evidence of a moderate level of mental health deterioration between 2018 and 2020. These effects are larger for individuals subject to stricter lockdowns and for individuals with more open personalities.

Key Messages:

What is already known on this topic: Mental health in China deteriorated during the pandemic, with less education and less income generally experience more severe mental health deterioration; male respondents seem more affected than female respondents.

What this study adds: This deterioration is higher for individuals subject to strict lockdowns, and it is stronger among those who already reported symptoms of depression. Individuals with more open personalities tend to experience more severe deterioration. On the other hand, more neurotic individuals seem less negatively affected.

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3 **How this study might affect research, practice or policy:** First, this can lead to identification of at-risk groups, as
4 well as more personalized psychological or psychiatric treatments. Second, understanding how different personalities
5 are affected in China, and comparing this reaction with individuals in other countries, may improve our
6 understanding of how extreme situations affect mental health and the link between personality and mental health.
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9 10 **Introduction**

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13 The effects of the COVID-19 pandemic on mental health in China, particularly regarding
14 the stringent procedures put in place to control the spread of the virus, have received
15 relatively little attention. A recent *Lancet* editorial emphasizes that mental health in China
16 is a particularly compelling issue “because it plays out against the wider backdrop of
17 mental health disorders in China, which remain largely unaddressed” [1].
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24 Therefore, given the size of the country and the potential extent of the problem,
25 there are several reasons it is crucial to identify how individuals with different
26 personalities may have experienced mental health effects associated with the pandemic.
27 First, this can lead to identification of at-risk groups, as well as more personalized
28 psychological or psychiatric treatments, especially for the post-COVID period [2].
29 Second, understanding how different personalities are affected in China, and comparing
30 this reaction with individuals in other countries, may improve our understanding of how
31 extreme situations affect mental health and the link between personality and mental
32 health.
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41 We analyze mental health deterioration in China during the first part of the
42 pandemic thanks to the availability of a national representative dataset, the China Family
43 Panel Studies (hereinafter CFPS). The panel structure of the CFPS dataset allows us to
44 compare the same individuals over time (i.e., before and during the pandemic). Our
45 analysis shows clear evidence of an increase in the prevalence of serious cases of
46 depression between 2018 and 2020.
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52 The CFPS dataset includes a set of standard personality questions derived from
53 the “Big Five” model [3], which gives us the opportunity to test how personality interacts
54 with the pandemic to affect mental health. We find that openness is associated with more
55 severe negative effects from the pandemic. Our findings are roughly in line with the
56 previous analyses of the pandemic’s effect on mental health, based on very different
57 contexts and environments but with some interesting differences, as we discuss in the last
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3 section. We also provide further insights into the large amount of literature analyzing the
4 link between personality and mental health (e.g., [4] for a comprehensive meta-analysis).
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8 Moreover, using information on the province of residence at the time of the
9 pandemic, we find that individuals that have been subject to strict lockdowns report a
10 higher level of mental health deterioration; the observed deterioration during lockdown
11 is largely due to changes among individuals who reported some depression symptoms
12 before the pandemic rather than among individuals who did not report any symptoms in
13 the prepandemic wave from 2018.
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19 To the best of our knowledge, there are only two country-representative studies
20 on how the COVID-19 pandemic affects wellbeing in China. [5] compare emotional
21 wellbeing from before the pandemic to the pandemic period and find that the beginning
22 of the pandemic led to a 74% drop in overall emotional well-being. [6] use the CFPS
23 dataset to examine how COVID-19 affects the mental health of individuals in different
24 provinces. Their results are fully consistent with ours, although [6] do not analyze how
25 personality affects mental health deterioration.
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32 There are few country-representative contributions analyzing the mediating role
33 of personality during the pandemic. [7], like our paper, focus on how personality affects
34 mental health deterioration, but in the UK; [8] use the CFPS dataset to measure how
35 COVID-19 pandemic restrictions affect smoking and how personality mediates this
36 behavior. [9] find that attitudes and, arguably, personality mediate how the restrictions
37 affect mental health. In the last section, we discuss how the existing contributions on
38 personality and restrictions during the pandemic relate to this study.
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45 Focusing on specific groups of individuals, several studies find some mental
46 health deterioration in China during the pandemic. However, these studies are limited by
47 nonrepresentative data ([10] [11] [12] [13] [14] [15] [16], among others). Finally, this
48 study belongs to the large and growing amount of literature that uses data from several
49 countries to investigate the effects of the pandemic on mental health (see e.g. [7] [9] [17]
50 [18] [19] [20] [21] [22] [23] [24] [25] among others).
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57 **Materials and Methods**

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Data

The China Family Panel Studies (CFPS)

This study primarily uses the 2018 and 2020 waves of the CFPS (we report mental health data from the 2016 wave in only one figure). The CFPS collected data for respondents of the 2018 wave from June 2018 to May 2019, and it collected data for respondents of the 2020 wave from July to December 2020. Though the data from the 2018 wave is collected across 12 months, more than 97% respondents (17626 observations out of 18127 observations) were interviewed between July and December 2018. We present the details of the cross-sectional and longitudinal dimensions in Table S1, while in Tables S2, S3, S4, S5 and S6 of the Supplementary Information (SI henceforth) we present the descriptive statistics of the variables used.

We only consider respondents appearing in both waves (there are 18,127 of them) in all our analysis, and we use the appropriate weights from the 2020 panel as the CFPS recommends. Among individuals interviewed in 2018 for whom we have information on the CES-D and weights, 60.1% were reinterviewed in 2020. Although an attrition rate of around 40% is substantial, it compares favorably with previous work on the topic (e.g., [26]). To cope in part with the attrition, we use the suggested weights when using both waves. In Table S7 of the SI, we perform a simple attrition analysis showing that using data from the 2020 wave results in a younger sample. This is to be expected because older respondents from 2018 are less likely to appear in the 2020 wave. The average symptoms of depression slightly decrease in a consistent manner (the difference is nonsignificant at the 5% level). Average education and household income are also slightly higher, which is consistent with the age differences in this context.

China imposed two lockdowns at the province level in 2020. The first one was in the Hubei province from January 23 to April 8, 2020; the second one was in the Xinjiang province in July and August 2020. All residents in the Hubei and Xinjiang provinces were required to stay indoors and prohibited from leaving the region. All schools in Wuhan closed and switched to online teaching; only authorized public service providers were permitted to leave home for work. Other provinces in China were less strict, and normal daily work and life continued as much as possible, but the residents of these provinces were still required to follow a series of containment measures that were inconvenient in many aspects [27].

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3 There are two groups of respondents who experienced the strict lockdown. The
4 first group includes respondents in the Hubei province for the entire 2020 wave, who
5 experienced lockdown before the interview; the second group includes respondents in the
6 Xinjiang province in lockdown during the interview, in July and August 2020. Due to the
7 small sample size of the second lockdown, we group both lockdowns together in our
8 analysis.
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13 **The Eight-Item Center for Epidemiologic Studies Depression Scale**

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15 To identify changes in mental health in the 2018 and 2020 waves, we use two measures
16 based on the eight-item Center for Epidemiologic Studies Depression Scale, or CES-D
17 scale. The eight-item CES-D scale is derived from the original 20-item scale, which is a
18 commonly used self-rating scale to measure depressive symptomatology [28] and is
19 widely considered a valid instrument for screening for depression in older adults [28].
20 The reduced eight-item scale is also a valid and reliable instrument to detect depression
21 [29].
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30 Following common practice, we use a measure based on a binary indicator of risk
31 of presenting with mental health problems (CES-D “caseness” score). In the 20-item
32 questionnaire, each answer is coded between 0 (no symptoms) and 3 (frequent
33 symptoms); the sum of the coded responses results in a score that falls between 0 and 60.
34 If the total score is 28 or above, the subject is considered likely to have severe depression
35 [30] [31]. Accordingly, in the eight-item version (with a score ranging from 0 to 24) we
36 classify an individual with a score of 12 and above (calculated using the 28/60 ratio from
37 the 20-item version) as severely depressed. In the SI we will also show results considering
38 a score of 8 or above, classified as mild depression. This corresponds to 20 in the 20 item
39 questionnaire (this follows [32] suggesting that using 20 points as cutoff is better than 16
40 points, originally classified as mild depression [30]).
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49 To measure the level of mental deterioration between the two waves, for each
50 respondent we calculate the difference in symptoms between waves, where a symptom is
51 present every time a respondent feels a specific way either occasionally (three or four
52 days in a week) or often (five-seven days in a week) as described in the questionnaire.
53 We assume that the total number of symptoms is a cardinal measure, therefore we use a
54 simple linear OLS regression. The mental health data, the other variables and further
55 description of the data are in section S1 of the SI (Tables S2, S3, and S4).
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Big Five Personality Traits and Cognitive Skills

The 2018 wave of the CFPS dataset includes a set of standard personality questions derived from the most widely used taxonomy of personality, the “Big Five” model as measured by the Revised NEO Personality Inventory (NEO-PI-R) [3]. Instead of using the origin NEO-PI-R with 60 items (12 items per domain), the CFPS measures relevant data with a shorter, 15-item questionnaire (three for each of the Big Five traits), as it is customary in large surveys. Scale-development studies show that it is possible to assess the Big Five personality traits reliably using fewer items and the 15-item version in particular ([33], [34] and [35]). See Tables S5 and S6 of the SI for the relevant descriptive statistics.

Regression Analysis

The main empirical model we use in this study is a simple OLS regression of this form:

$$\Delta y_i = \alpha + \beta \textit{lockdowns} + \boldsymbol{\pi} \mathbf{X}_i + \boldsymbol{\rho} \mathbf{Z}_i + e_i$$

where Δy_i is the change in the number of symptoms individual i reports using the CES-D as defined, between the 2018 and 2020 waves; *lockdowns* is a dummy that equals 1 if the respondent has experienced lockdown before the interview or is interviewed during a lockdown; \mathbf{X}_i is a vector of demographic variables, and \mathbf{Z}_i is an employment status indicator in 2018. Finally, e_i is the error term of the regression. All regressions are estimated using 2020 weights and heteroskedasticity-robust standard errors.

Results

The left-hand panel of Figure 1 shows a significant increase in the prevalence of serious depression symptoms between the prepandemic years (2016 and 2018) and the first pandemic year (2020). We will refer to this difference as mental health deterioration. The prevalence of severe depression over our weighted sample is 7.86% (95% CI 7.44, 8.29) in 2020, which is a significant increase compared to 6.68% (95% CI 6.28, 7.07) in 2018 and to 6.74% (95% CI 6.30, 7.18) in 2016.

The right-hand panel of Figure 1 investigates differences in the average symptoms of depression, which are measured using the eight-item CES-D scale. They rise from 1.09

(95% CI 1.07, 1.12) in 2016 and 1.16 (95% CI 1.13, 1.18) in 2018 to 1.22 (95% CI 1.19, 1.24) in 2020. This implies a significant difference of 0.060 (95% CI 0.034, 0.086) between 2020 and 2018.

The fact that the prevalence of serious depression is significantly higher in the pandemic year than in the previous two waves of data seems to rule out the possibility that these differences are because individuals are older in 2020. We nevertheless address this concern by estimating the effect of the COVID-19 pandemic on our mental health indicators (serious depression and symptoms) by controlling for *Age* and *Age Squared* for the 2018 and 2020 waves. The result is in Figure 2 (the full regression estimation is in Table S8 of the SI). From the top panel we note that the difference of effect before and after controlling for age is quite small (from 1.2% to 0.9%). From the bottom panel, we note a more substantial difference in terms of symptoms (from 0.061 to 0.038) that becomes nonsignificant at the 95% confidence interval (p -value = 0.065). Therefore, these results suggest that age has a larger effect on symptom reporting in the extensive margin (i.e., respondents with symptoms report more of them) than in the intensive margin (i.e., respondents report symptoms for the first time), but the opposite is true in the COVID-19 period. Hence, respondents who do not report symptoms previously begin to report them significantly more in the COVID-19 period, independently from their ages.

As a robustness checks: we consider a smaller cut-off point to define depression (which we define mild depression), and we report these results in the SI (Figure S1 and Table S9), where we can see that the pandemic year features an equally significant increase using this different cut-off; we also restricted all observation to the the same set of months (July-December), as we can observe from Figure S2 in the SI, the outcome is almost identical.

[Figures 1 and 2 HERE]

Mental Health Deterioration and Personality Traits

Next, we analyze whether individuals experience mental health deterioration more acutely if they have certain personality traits. Before delving into the mental health deterioration analysis, we estimate the correlations between mental health symptoms and personality traits in the 2018 wave (the only wave reporting personality data) using a simple linear cross-sectional regression, with and without other control variables. The results are in Table S10 of the SI. The effects are quite natural and in line with what is observed in other analyses (see, e.g., [4] for an exhaustive meta-analysis). Neuroticism is

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3 a strong predictor of poor mental health (one standard deviation more predict 0.371 more
4 symptoms of depression).
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6 In Figure 3, we present the results of the estimation of how personality traits affect
7 mental health deterioration (i.e., changes in mental health between 2018 and 2020) using
8 a multivariable econometric model as outlined earlier with and without control variables
9 for demographic factors (the full regressions are in Table S11 of the SI). From both
10 regressions we note a strong effect of openness (see left panel of Figure 3, corresponding
11 to column 1 of Table S11 of the SI), where a one-standard-deviation change in Openness
12 corresponds to about 0.08 more symptoms (with and without control variables).
13 Neuroticism is the other significant coefficient, negative and equal to -0.087, which may
14 look surprising but is roughly in line with other studies analyzing how different
15 personalities react to the pandemic, as argued in [7] and in the final section of this article.
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25 *[Figure 3, Here]*
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29 **Mental Health Deterioration and Lockdowns**

30 We analyze whether respondents subject to stricter lockdown measures experience mental
31 health deterioration more acutely by estimating a multiple linear regression model. Figure
32 4 reports the estimated coefficients of the regression presented in our Materials and
33 Methods section. It includes the 95% confidence intervals (see Table S12 in the SI for
34 more detail).
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39 On the left panel, we note that individuals under lockdown measures report over
40 0.4 more symptoms (hence, more than 1 in 2.5 individuals). By comparing the central and
41 the right panels of Figure 4, we note that individuals already reporting symptoms in the
42 2018 wave are more affected. Figure 4 also presents some correlations between mental
43 health deterioration and basic demographics. We find that individuals with less education
44 and less income generally experience more severe mental health deterioration; male
45 respondents seem more affected than female respondents. These findings are consistent
46 with other studies that are based on the Chinese population (e.g., [5] [6] [16] [36] [37]) .
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53 We describe these results in section S2 of the SI.
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56 **Discussion**

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3 Our analysis shows that cases of serious depression in China increase by about 0.9
4 percentage points (an increase of over 10%) after controlling for age. It is difficult to
5 compare this to Europe and the United States, which use other scales. To provide an idea
6 of the possible differences, we calculate an index of mild depression, defined as scoring
7 8 or more in the CES-D scale. This demonstrates a significant increase of about 1.3
8 percentage points (reported in Figure S1 and Table S9 of the SI). If we compare this figure
9 with [24], who find an increase of about 13.5 percentage points in the UK in April 2020,
10 it is possible to argue that the increase in mental health problems in the UK seems much
11 higher than in China.
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19 People with more open personalities seem significantly worse off, consistent with
20 the view that certain personalities may be more likely to suffer from limitations on
21 personal contacts and social life due to COVID-19. [7] and [38] find similar results in the
22 UK population and among Canadian students, respectively. On the other hand,
23 neuroticism does not predict more deterioration in mental health. As argued in [7],
24 individuals with highly neurotic personalities normally experience several negative
25 shocks during their lives; hence, there might be a sort of habituation effect at play. The
26 pandemic's mental health effects on people with different personalities are remarkably
27 consistent with the rest of the literature on the subject, and we refer to [7] for a detailed
28 discussion of this small but growing literature.
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36 Conscientiousness does not appear to have a significant effect; this is different
37 from [7]. It would be natural to expect conscientiousness to have a negative effect on
38 mental health deterioration given that conscientiousness implies more controlled
39 behavior, which [9] show is conducive to less depression during the pandemic. In fact,
40 [8], using our same dataset, find that this significantly mediates a decrease in smoking.
41 We do not find an effect of extraversion, but [9] and [7] find a negative effect. This lack
42 of effect of conscientiousness and extraversion on mental health deterioration is an
43 interesting difference in personality traits in the UK and in China, and it deserves further
44 investigation.
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51 Overall, the effects that different personality traits have on mental health across
52 different cultures during the pandemic can contribute to the analysis of the universality
53 of personality traits ([39] [40]).
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58 **Data Availability Statement**

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This paper uses data from China Family Panel Studies (wave 2018 and wave 2020), which are available to researchers upon request. The datasets generated and/or analyzed during the current study are available in the [CFPS Data Platform] repository, [<http://www.issp.pku.edu.cn/cfps/download>]. Please contact the China Family Panel Studies project team for data access. Their mailing address is Office of China Family Panel Studies, Science Building #5, Peking University, 5 Yiheyuan Road, Haidian District, Beijing, P.R. China; Postal Code : 100871; email: issp.cfps@pku.edu.cn. The authors will make replication files (Stata do file) available.

Ethical Approval Statement

This paper uses data from China Family Panel Studies (2018 and 2020 waves), which is collected by the Institute of Social Science Survey (ISSS) at Peking University in China. The China Family Panel Studies project team submitted an application for ethical approval to the Peking University Biomedical Ethics Committee and conducted the corresponding data collection after the ethical approval or review was received. The unique ethical review batch number of the China Family Panel Studies project is IRB00001052-14010.

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Acknowledgments

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56
57 This paper uses data from China Family Panel Studies (2018 and 2020 waves). The
58 CFPS was launched in 2010 by the Institute of Social Science Survey of Peking
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6 **Author contributions**

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9 Conceptualization: MB, EP

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11 Data analysis: MB, EP, XZ

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13 Writing - original draft: MB, EP, XZ

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15 Writing - review and editing: MB, EP, XZ
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20 **Competing Interests Statement**

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22 The author(s) declare no competing interests.
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Captions of Figures from the Main Text

Figure 1: **Depression before and during the pandemic.** In the left panel, serious depression occurs when respondents score 12 or more in the CES-D questionnaire. The right panel reports the average number of symptoms reported. The bars represent the 95% confidence intervals. Statistics are weighted using the survey sample weights. Data source: CFPS dataset, 2016, 2018, and 2020 waves. All statistics are produced using a weighted sample.

Figure 2: **Estimated differences in depression before and during the pandemic, controlling by age.** The table reports the OLS coefficients of the COVID wave dummy in four separate regressions. In the top panels, the dependent variable is serious depression. In the bottom panels, the dependent variable is the symptoms reported. Data source: CFPS dataset 2018 and 2020 waves. The regressions in the right panels include the variables Age and Age Squared (unreported in the table); the regressions in the left panels do not include the variables. The complete estimation of the two regressions is in table S8 of the SI. The bars represent 95% confidence intervals with robust standard errors clustered at the individual levels. The four regressions include the same respondents, and the data sample is weighted to generate a population-representative estimation.

Figure 3: **Mental health deterioration for individuals with different personalities.** This table reports the OLS coefficients of the two regressions where the dependent variable is the difference between the number of symptoms in 2018 and 2020. The personality trait measures are standardized. The bars represent 95% confidence intervals with robust standard errors. Data are weighted to generate a population-representative estimation. Gender, age group, urban residence, family size, and months of the interview are included in the regression related to the right panel but omitted in the figure. The complete estimation of the two regressions is in table S11 of the SI.

Figure 4: **Mental health deterioration among different groups.** The table reports the OLS coefficients of the three regressions where the dependent variable is the difference between number of symptoms in 2018 and 2020. The bars represent the 95% confidence intervals with robust standard errors. Data is weighted to generate a population-representative estimation. Marriage status and months of the interview are included in the regression but omitted in the figure. The complete estimation of the three regressions is presented in Table S12 of the SI.

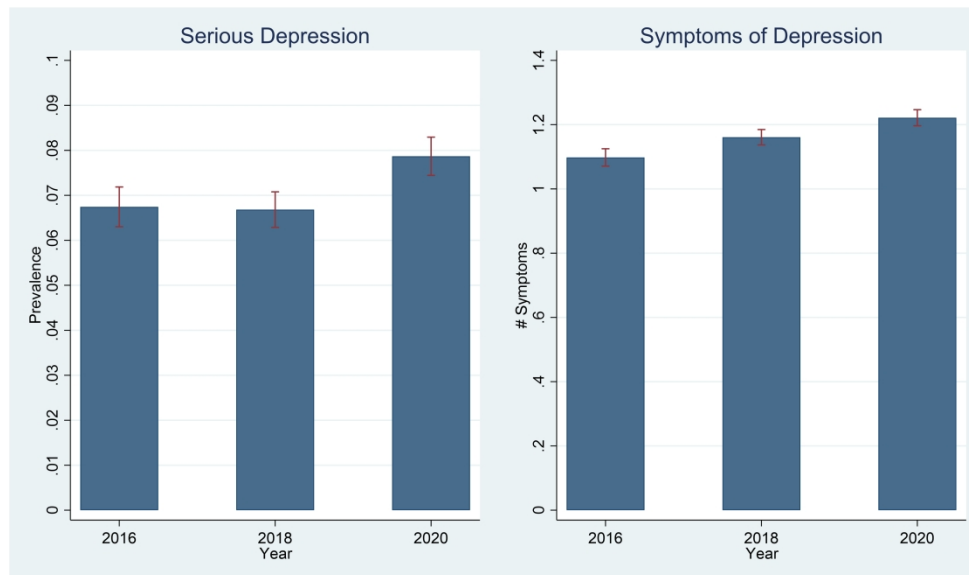


Figure 1: Depression before and during the pandemic. In the left panel, serious depression occurs when respondents score 12 or more in the CES-D questionnaire. The right panel reports the average number of symptoms reported. The bars represent the 95% confidence intervals. Statistics are weighted using the survey sample weights. Data source: CFPS dataset, 2016, 2018, and 2020 waves. All statistics are produced using a weighted sample.

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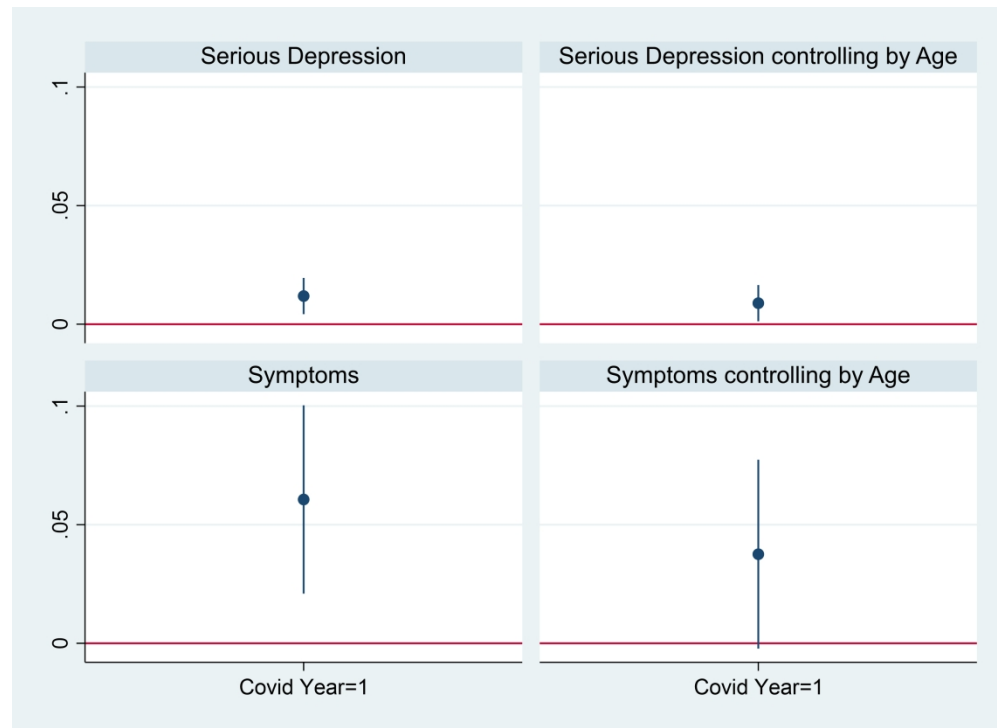


Figure 2: Estimated differences in depression before and during the pandemic, controlling by age. The table reports the OLS coefficients of the COVID wave dummy in four separate regressions. In the top panels, the dependent variable is serious depression. In the bottom panels, the dependent variable is the symptoms reported. Data source: CFPS dataset 2018 and 2020 waves. The regressions in the right panels include the variables Age and Age Squared (unreported in the table); the regressions in the left panels do not include the variables. The complete estimation of the two regressions is in table S8 of the supplementary information. The bars represent 95% confidence intervals with robust standard errors clustered at the individual levels. The four regressions include the same respondents, and the data sample is weighted to generate a population-representative estimation.

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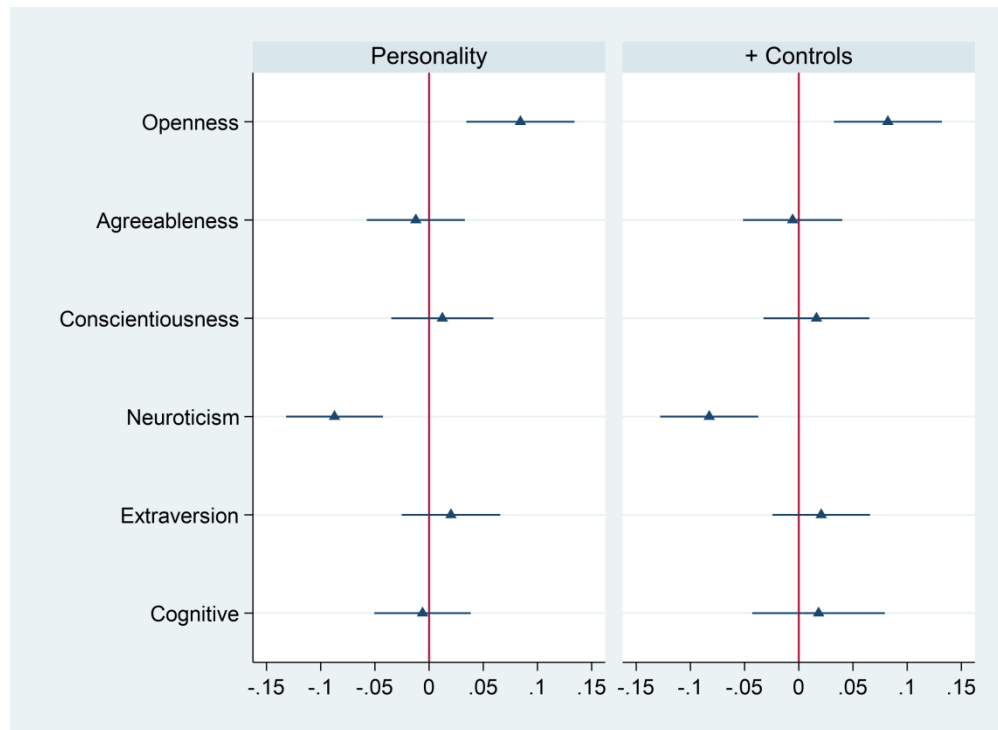


Figure 3: Mental health deterioration for individuals with different personalities. This table reports the OLS coefficients of the two regressions where the dependent variable is the difference between the number of symptoms in 2018 and 2020. The personality trait measures are standardized. The bars represent 95% confidence intervals with robust standard errors. Data are weighted to generate a population-representative estimation. Gender, age group, urban residence, family size, and months of the interview are included in the regression related to the right panel but omitted in the figure. The complete estimation of the two regressions is in table S11 of the supplementary information.

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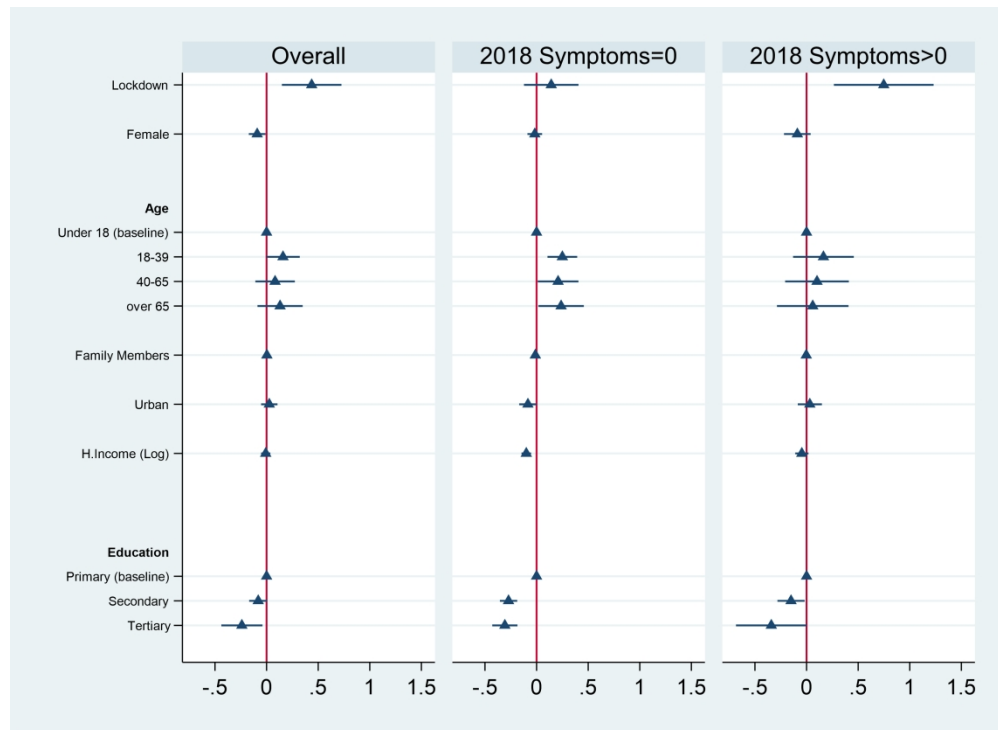


Figure 4: Mental health deterioration among different groups. The table reports the OLS coefficients of the three regressions where the dependent variable is the difference between number of symptoms in 2018 and 2020. The bars represent the 95% confidence intervals with robust standard errors. Data is weighted to generate a population-representative estimation. Marriage status and months of the interview are included in the regression but omitted in the figure. The complete estimation of the three regressions is presented in Table S12 of the supplementary information.

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Supplementary Information

S1 Materials and Methods

S1.1 The China Family Panel Studies (CFPS)

The CFPS is a large panel dataset representative of the Chinese population. In our analysis we use sampling weights as suggested by the data collectors. We use robust standard errors in all our regression analyses.

The formal version of the 2016, 2018, and 2020 waves of the China Family Panel Studies (CFPS) data is publicly available. The relevant datasets are available in the CFPS data platform repository, [<http://www.issp.pku.edu.cn/cfps/download>]. The study uses open research data from the China Family Panel Studies (CFPS). CFPS obtained informed consent from all subjects in the studies.

The 2018 wave had 37,354 total individual respondents; the 2020 wave had 28,590. After removing individual data with missing mental health information on the CES-D questionnaire (9,160 in total) and those who were part of the survey in 2018 but not in 2020 for various reasons, we have 18,127 respondents in both waves as reported in table S1 of the supplementary information.

S1.2 Big 5 Personality Traits and Cognitive Skills

The five personality traits in the “Big Five” model are neuroticism (or emotional stability), extraversion, conscientiousness, agreeableness, and openness. These are usually self-reported based on the so-called NEO Five-Factor Inventory, which originally had 60 items (12 items per domain). The relevant data from the China Family Panel Studies (CFPS) are measured with a short 15-item questionnaire (three for each of the Big Five traits) as is customary in large surveys (as [1] argues). The 2018 wave includes two measures of cognitive skills (a math test and verbal test). We average the two scores to have a unique measure of cognitive skills.

In table S5 of SI, we present the descriptive statistics of personality and cognitive variables, and in table S6 we present the correlation matrix between each single personality trait and the measure of cognitive skills. The correlation among personality traits is the expected 1, with *Openness*, *Conscientiousness*, *Extraversion*, and *Agreeableness* correlating positively, *Neuroticism* correlates negatively.

S1.3 The Eight-Item Center for Epidemiologic Studies Depression Scale

The eight-item Center for Epidemiologic Studies Depression Scale CES-D is a well-known instrument for evaluating mental health, where the respondent reports the extent to which each of the eight symptoms is present in the few weeks before the survey takes place. The respondent can pick from a few possibilities for each of these symptoms, based on weekly frequencies: rarely (less than 1 day), a little (one or two days), occasionally (three or four days), or often (five-seven days).

To measure the mental deterioration between the two waves, we count the differences in symptoms between waves for each respondent appearing in both waves, coding it a “symptom” every time the respondent feels a specific way occasionally (three or four days) or often (five-seven days). We assume the total number of symptoms is a cardinal measure and therefore the level of deterioration (or the difference between the sum of symptoms in the pre-pandemic and pandemic waves) is a cardinal measure, as we can use a simple linear OLS estimator for the regression.

Table S1. Cross-Sectional and Longitudinal Dimensions

Wave	Individual is observed twice		Total
	No	Yes	
2018	11,708	18,127	29,835
2020	6,398	18,127	24,525
Total	18,106	36,254	54,360

Source: CFPS (waves 2018 and 2020). The data are from China Family Panel Studies (CFPS), funded by Peking University and the National Natural Science Foundation of China. The CFPS is maintained by the Institute of Social Science Survey of Peking University.

Table S2: Descriptive Demographic Statistics, Year 2018 (Prepandemic)

Variable	Obs.	Mean	Std. err.	[95% conf.	interval]
Mental Health					
Deterioration	18,127	0.0620621	0.0122091	0.0381312	0.0859931
Mental Health Symptoms					
Symptoms	18,127	1.192365	0.0112286	1.170356	1.214374
Mental Health Caseness					
Female	18,127	0.4919181	0.0037133	0.4846397	0.4991966
Male	18,127	0.5080819	0.0037133	0.5008034	0.5153603
Urban	17,965	0.4991372	0.0037305	0.4918251	0.5064494
Income	18,127	14096.09	214.4266	13675.79	14516.38
Primary Edu. Group	18,127	0.4341038	0.0036814	0.4268879	0.4413197
Secondary Edu. Group	18,127	0.4539085	0.003698	0.4466601	0.4611569
Tertiary Edu. Group	18,127	0.1119876	0.0023423	0.1073965	0.1165788
Age Group					
Under 18 Years Old	18,127	0.109781	0.002322	0.1052297	0.1143323
18-39 Years Old	18,127	0.2972362	0.0033947	0.2905822	0.3038901
40-65 Years Old	18,127	0.4834225	0.0037118	0.4761471	0.4906979
Over 65 Years Old	18,127	0.1095603	0.0023199	0.105013	0.1141076
Job Status					
Agricultural Business	17,446	0.2801788	0.0034001	0.2735143	0.2868434
Other Private Business	17,446	0.0734266	0.0019748	0.0695557	0.0772974
Agricultural Job	17,446	0.0154763	0.0009346	0.0136445	0.0173082
Waged Job	17,446	0.2942222	0.0034501	0.2874596	0.3009848
Unemployed	17,446	0.0107761	0.0007817	0.0092439	0.0123083
Student	17,446	0.1513241	0.0027132	0.1460058	0.1566423
Retired	17,446	0.0887883	0.0021535	0.0845671	0.0930094
Housework	17,446	0.0513012	0.0016703	0.0480272	0.0545751
Disable	17,446	0.0237877	0.0011538	0.0215262	0.0260492
Other Reason	17,446	0.0107188	0.0007796	0.0091906	0.012247

Table S3: Descriptive Demographic Statistics, Year 2020 (Pandemic)

Variable	Obs.	Mean	Std. err.	[95% conf.	interval]
Mental Health					
Symptoms	18,127	1.254427	0.0117985	1.231301	1.277553
Mental Health Caseness	18,127	0.0818117	0.0020357	0.0778214	0.0858019
Lockdown	18,127	0.0157776	0.0009256	0.0139633	0.0175918
Hubei Lockdown	18,127	0.0136261	0.0008611	0.0119382	0.0153139
Xinjiang Lockdown	18,127	0.0021515	0.0003442	0.0014769	0.0028261

Table S4: Descriptive Demographic Statistics, Year 2016

Variable	Obs.	Mean	Std. err.	[95% conf.	interval]
Mental Health					
Symptoms	14,537	1.151544	0.0126048	1.126837	1.176251
Mental Health Caseness	14,537	0.0668639	0.0020718	0.0628029	0.0709248

Table S5: Descriptive Personality Statistics, Year 2018 (Prepandemic)

Variable	Obs.	Mean	Std. dev.	Min	Max
Openness	16,420	3.182562	0.8524371	1	5
Conscientiousness	16,544	3.850137	0.6532633	1	5
Extraversion	16,495	3.349884	0.7033113	1	5
Agreeableness	16,540	3.832648	0.6016804	1	5
Neuroticism	16,530	2.968381	0.7356712	1	5
Cognitive	12,894	16.5686	5.998624	1	29

Table S6: Personality Traits and Cognitive Skill Correlation Matrix, Year 2018 (Prepandemic)

	Openness	Conscienti- ousness	Extraversi- -on	Agreeable- -ness	Neuroticis- -m	Cognitive
Openness	1					
Conscientiousness	0.1874	1				
Extraversion	0.2194	0.1726	1			
Agreeableness	0.0956	0.123	0.0634	1		
Neuroticism	0.0034	-0.1058	-0.1487	-0.1053	1	
Cognitive	0.0785	-0.1492	-0.0689	-0.0135	-0.0783	1

Table S7: Attrition Analysis

	(1)		(2)		(3)		(4)		(5)		(6)	
	Mean/ SD	Count	Mean/ SD	Count	Mean/ SD	Count	(1) vs. (2) b/se	<i>p-value</i>	(1) vs. (3) b/se	<i>p-value</i>	(2) vs. (3) b/se	<i>p-value</i>
Depression	1.243	32598	1.243	32598	1.184	19550	0.000	1.000	0.059	0.000	0.059	0.000
Symptoms	(1.561)		(1.561)		(1.505)		(0.012)		(0.014)		(0.014)	
(in 2020)	(0.125)		(0.124)		(0.125)		(0.001)		(0.001)		(0.001)	
Female	0.500	33097	0.500	32598	0.501	19550	0.000	0.984	-0.001	0.811	-0.001	0.798
	(0.500)		(0.500)		(0.500)		(0.004)		(0.005)		(0.005)	
Age	44.791	37352	44.026	32598	42.531	19550	0.765	0.000	2.260	0.000	1.495	0.000
	(19.366)		(18.588)		(17.745)		(0.144)		(0.166)		(0.165)	
Urban	0.496	35133	0.500	32295	0.504	19366	-0.005	0.242	-0.008	0.063	-0.004	0.401
	(0.500)		(0.500)		(0.500)		(0.004)		(0.004)		(0.005)	
Family Members	4.170	20924	4.179	19895	4.180	19529	-0.009	0.644	-0.011	0.604	-0.001	0.954
	(2.066)		(2.058)		(2.053)		(0.020)		(0.020)		(0.021)	
Education	1.648	37354	1.654	32598	1.704	19550	0.006	0.231	-0.044	0.000	-0.051	0.000
	(0.677)		(0.669)		(0.672)		(0.005)		(0.006)		(0.006)	
Household	9.634	36683	9.672	32266	9.705	19425	-0.037	0.000	-0.070	0.000	-0.033	0.000
Income (~)	(0.998)		(0.990)		(0.980)		(0.008)		(0.009)		(0.009)	
Marital Status:	0.168	19807	0.163	18799	0.164	18435	0.005	0.186	0.004	0.340	-0.001	0.721
Never Married	(0.374)		(0.369)		(0.370)		(0.004)		(0.004)		(0.004)	
Marital Status:	0.770	19807	0.776	18799	0.776	18435	-0.006	0.182	-0.006	0.141	-0.001	0.887
Married	(0.421)		(0.417)		(0.417)		(0.004)		(0.004)		(0.004)	
Marital Status:	0.003	19807	0.003	18799	0.003	18435	-0.000	0.921	-0.000	0.988	0.000	0.934
Cohabiting	(0.055)		(0.055)		(0.055)		(0.001)		(0.001)		(0.001)	
Marital Status:	0.018	19807	0.018	18799	0.018	18435	-0.000	0.987	0.000	0.939	0.000	0.927
Divorced	(0.134)		(0.134)		(0.134)		(0.001)		(0.001)		(0.001)	
Marital Status:	0.041	19807	0.040	18799	0.039	18435	0.001	0.702	0.003	0.199	0.002	0.371

1													
2	Widowed	(0.199)		(0.197)		(0.193)		(0.002)		(0.002)		(0.002)	
3	Job Status:	0.228	37354	0.259	32598	0.260	19550	-0.033	0.000	-0.034	0.000	-0.001	0.721
4	Agricultural Business												
5													
6		(0.420)		(0.438)		(0.439)		(0.003)		(0.004)		(0.004)	
7	Job Status:	0.061	37354	0.069	32598	0.071	19550	-0.009	0.000	-0.011	0.000	-0.003	0.271
8	Private Business	(0.239)		(0.253)		(0.258)		(0.002)		(0.002)		(0.002)	
9	Job Status:	0.013	37354	0.014	32598	0.015	19550	-0.002	0.047	-0.002	0.045	-0.000	0.379
10	Agricultural Job	(0.112)		(0.119)		(0.120)		(0.001)		(0.001)		(0.001)	
11	Job Status:	0.245	37354	0.277	32598	0.295	19550	-0.034	0.000	-0.052	0.000	-0.018	0.000
12	Wage Job	(0.430)		(0.447)		(0.456)		(0.003)		(0.004)		(0.004)	
13	Job Status:	0.010	37354	0.011	32598	0.011	19550	-0.001	0.129	-0.001	0.348	0.000	0.722
14	Unemployed	(0.099)		(0.104)		(0.102)		(0.001)		(0.001)		(0.001)	
15	Job Status:	0.119	37354	0.126	32598	0.137	19550	-0.008	0.001	-0.019	0.000	-0.011	0.000
16	Student	(0.323)		(0.331)		(0.344)		(0.002)		(0.003)		(0.003)	
17	Job Status:	0.092	37354	0.103	32598	0.082	19550	-0.012	0.000	-0.009	0.000	0.021	0.000
18	Retiree	(0.289)		(0.304)		(0.274)		(0.002)		(0.002)		(0.003)	
19	Job Status:	0.050	37354	0.057	32598	0.058	19550	-0.007	0.000	-0.008	0.000	-0.001	0.629
20	Housework	(0.219)		(0.232)		(0.234)		(0.002)		(0.002)		(0.002)	
21	Job Status:	0.025	37354	0.028	32598	0.022	19550	-0.003	0.017	0.003	0.020	0.006	0.000
22	Disabled	(0.157)		(0.165)		(0.146)		(0.001)		(0.001)		(0.001)	
23	Job Status:	0.011	37354	0.013	32598	0.011	19550	-0.001	0.084	0.001	0.491	0.002	0.036
24	Other	(0.106)		(0.112)		(0.102)		(0.001)		(0.001)		(0.001)	

Table S7: The first column provides basic statistical information about the observations for the whole sample from the raw CFPS dataset. The second column provides basic statistical information about the observations for the sample after dropping the missing values of the depression symptoms. The third column provides basic statistical information about the observations for the sample after dropping the observations that were in the 2018 CFPS survey but not in the 2020 CFPS survey. The fourth, fifth, and sixth columns compare the statistics indexes between the first and the second column, the first and the third column, and the second and the third column, respectively. This table demonstrates whether the attrition caused by missing observations affects the national representation of the sample used for analysis.

Figure S1: Mild or Serious Depression in the Prepandemic and Pandemic Waves

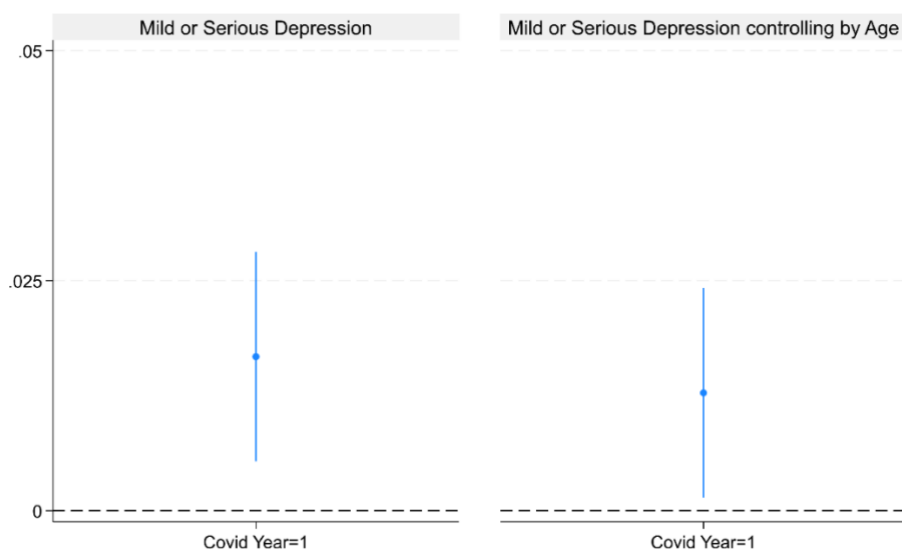


Figure S1: Mild or serious depression in the prepandemic and then pandemic waves. Mild and serious depression occur when respondents report eight or more symptoms in the CES-D questionnaire. The two panels report the coefficient of the regression with and without age. The bars represent the 95% confidence intervals. Statistics are weighted using the survey sample weights. Robust standard errors are clustered at the individual levels.

Figure S2: Mild or Serious Depression in the Prepandemic and Pandemic Waves (July-December Interviewees only)

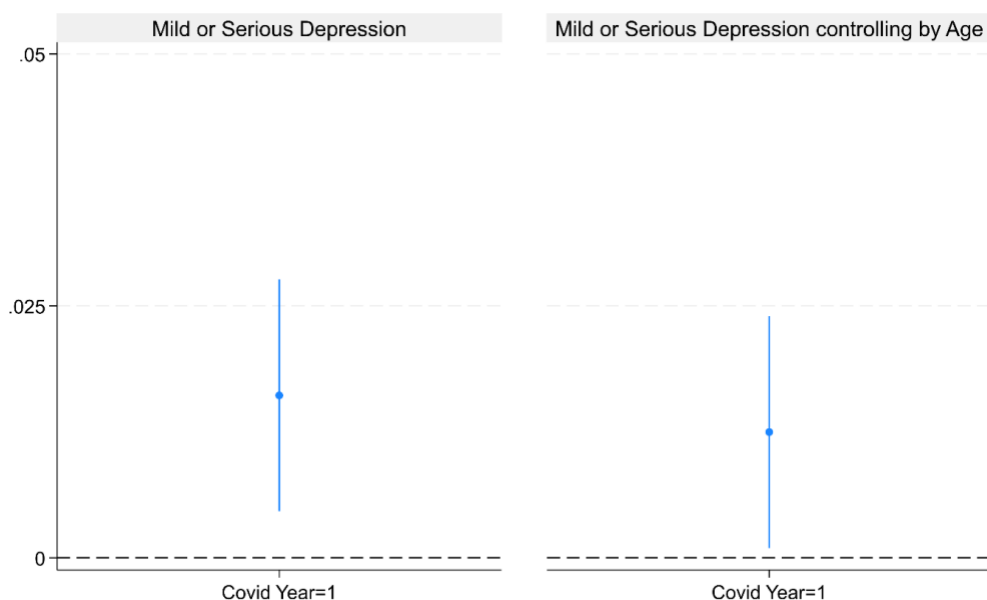


Figure S2: Mild or Serious Depression in the Prepandemic and Pandemic Waves (July-December Interviewees only). Figure S2 presents the same information as Figure S1 but restricts the respondents from the 2018 wave and the 2020 wave to the same set of months (July to December). Mild and serious depression occur when respondents report eight or more symptoms in the CES-D questionnaire. The two panels report the coefficient of the regression with and without age. The bars represent the 95% confidence intervals. Statistics are weighted using the survey sample weights. Robust standard errors are clustered at the individual levels.

Table S8: Mental Health in the Pandemic Year with and without Age Effects

VARIABLES	(1) Caseness	(2) Caseness	(3) Symptoms	(4) Symptoms
Age		0.002*** (0.001)		0.027*** (0.004)
Age Squared		-0.000 (0.000)		-0.000*** (0.000)
Year 2020	0.012*** (0.004)	0.009** (0.004)	0.061*** (0.020)	0.038* (0.020)
Constant	0.067*** (0.003)	-0.004 (0.011)	1.161*** (0.019)	0.361*** (0.073)
Observations	30,772	30,772	30,772	30,772

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, *p<0.1

Table S9: Mild and Serious Depression Prevalence in the Pandemic Year with and without Age Effect

VARIABLES	(1) Caseness	(2) Caseness
Age		0.008*** (0.001)
Age Squared		-0.000*** (0.000)
Year 2020	0.017*** (0.006)	0.013** (0.006)
Constant	0.252*** (0.005)	0.044** (0.020)
Observations	30,772	30,772

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table S9: Mild and serious depression caseness occurs when respondents report eight or more symptoms in the CES-D questionnaire. Statistics are weighted using the survey sample weights. Robust standard errors are clustered at the individual levels.

Table S10: Mental Health and Personality Traits

VARIABLES	(1) Personality	(2) + Basic Demographics	(3) + Income and Education
Female		0.047 (0.037)	0.056 (0.037)
18-39 Years Old		0.260*** (0.072)	0.223*** (0.072)
40-65 Years Old		0.443*** (0.076)	0.419*** (0.078)
Over 65 Years Old		0.520*** (0.091)	0.447*** (0.094)
Urban			-0.049 (0.038)
Family Size			-0.047*** (0.010)
Secondary Education Group			-0.033 (0.049)
Tertiary Education Group			0.222*** (0.079)
log Household Income			-0.129*** (0.023)
Openness	-0.073*** (0.022)	-0.062*** (0.022)	-0.067*** (0.022)
Agreeableness	-0.032 (0.021)	-0.043** (0.021)	-0.044** (0.021)
Conscientiousness	-0.085*** (0.021)	-0.106*** (0.022)	-0.100*** (0.022)
Neuroticism	0.371*** (0.020)	0.371*** (0.020)	0.367*** (0.020)
Extraversion	-0.113*** (0.020)	-0.114*** (0.020)	-0.111*** (0.020)
Cognitive	-0.254*** (0.019)	-0.202*** (0.022)	-0.191*** (0.027)
Constant	1.076*** (0.217)	0.714*** (0.230)	2.154*** (0.322)
Observations	11,469	11,469	11,374

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table S11: Mental Health Deterioration and Personality Traits, with Reported Coefficients on Control Variables

VARIABLES	(1) Personality	(2) + Basic Demographics	(3) + Income and Education
Female		-0.058 (0.043)	-0.070 (0.044)
18-39 Years Old		-0.042 (0.105)	-0.022 (0.109)
40-65 Years Old		-0.087 (0.110)	-0.071 (0.113)
Over 65 Years Old		-0.116 (0.123)	-0.120 (0.127)
Urban			0.053 (0.046)
Family Size			-0.001 (0.011)
Secondary Education Group			-0.113** (0.056)
Tertiary Education Group			-0.181** (0.092)
log Household Income			-0.016 (0.025)
Openness	0.084*** (0.025)	0.079*** (0.025)	0.082*** (0.025)
Agreeableness	-0.012 (0.023)	-0.007 (0.023)	-0.006 (0.023)
Conscientiousness	0.012 (0.024)	0.017 (0.025)	0.016 (0.025)
Neuroticism	-0.087*** (0.023)	-0.083*** (0.023)	-0.083*** (0.023)
Extraversion	0.020 (0.023)	0.021 (0.023)	0.021 (0.023)
Cognitive	-0.006 (0.023)	-0.018 (0.027)	0.018 (0.031)
Constant	-0.056 (0.220)	0.050 (0.248)	0.262 (0.336)
Observations	10,047	10,047	10,001

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

S2 Mental health deterioration in lockdown and effect of basic demographic variables

In Figure 4 in the main text, and Table S12 in this supplementary information section, we note that females seem to experience less deterioration (about 0.09 fewer symptoms). Individuals with tertiary education report significantly less deterioration than individuals with only primary education (more than 0.2 symptoms fewer), and that deterioration increases among those with less education. This finding is perfectly in line with [2], using the same set of data we do. Younger adults between 18 and 39 constitute the most affected age group. In particular, the central panel of figure 4 shows that mental health deterioration tends to decline with age among subjects over 18, especially among those that did not report any symptoms in 2018 (about 0.24 symptoms). This effect, however, can be due at least in part to a normal increase in mental health problems when individuals in this cohort age.

Finally, column 4 of table S12 presents differences with respect to job status. Individuals unemployed and employed in the agrarian sector report significantly smaller increases in symptoms than the baseline group (i.e., those employed in the industry and in the other nonagricultural sectors). Column 5 of the same table in the supplementary information outlines no significant differences arising from provincial GDP per capita, provincial public expenditures, or provincial population density.

Table S12: Mental Health and Some Demographic Characteristics, with Reported Coefficients on Control Variables

VARIABLES	(1)	(2)	(3)	(4)	(5)
	Overall	2018 Symptoms=0	2018 Symptoms>0	Overall with Job Class	Plus Aggregate Variables
Lockdown	0.437*** (0.147)	0.142 (0.135)	0.748*** (0.246)	0.426*** (0.147)	0.393*** (0.149)
Female	-0.091** (0.042)	-0.017 (0.036)	-0.089 (0.066)	-0.120*** (0.044)	-0.122*** (0.044)
18-39 Years Old	0.159* (0.083)	0.250*** (0.073)	0.164 (0.150)	0.218** (0.091)	0.226** (0.092)
40-65 Years Old	0.082 (0.098)	0.209** (0.101)	0.101 (0.157)	0.137 (0.112)	0.144 (0.113)
Over 65 Years Old	0.131 (0.112)	0.238** (0.112)	0.060 (0.177)	0.190 (0.130)	0.187 (0.131)
Urban	0.026 (0.041)	-0.084* (0.043)	0.032 (0.060)	0.036 (0.043)	0.033 (0.043)
Family Size	0.003 (0.010)	-0.012 (0.011)	-0.003 (0.014)	0.001 (0.010)	-0.001 (0.010)
Secondary Education Group	-0.081* (0.045)	-0.272*** (0.043)	-0.150** (0.067)	-0.081* (0.047)	-0.084* (0.047)
Tertiary Education Group	-0.240** (0.102)	-0.307*** (0.062)	-0.342* (0.175)	-0.237** (0.103)	-0.240** (0.100)
log Household Income	-0.008 (0.023)	-0.099*** (0.024)	-0.046 (0.033)	0.005 (0.024)	0.006 (0.025)
Married	-0.103 (0.072)	0.038 (0.078)	-0.036 (0.114)	-0.036 (0.090)	-0.039 (0.090)
Cohabitation	0.213 (0.475)	0.643 (0.600)	0.428 (0.605)	0.408 (0.532)	0.422 (0.540)
Divorced	0.053 (0.251)	0.696 (0.454)	0.070 (0.277)	0.056 (0.253)	0.052 (0.253)
Widowed	-0.111 (0.140)	0.277* (0.166)	-0.001 (0.189)	-0.027 (0.152)	-0.030 (0.152)
Agricultural Business				0.074 (0.064)	0.076 (0.065)
Other Private Business				-0.083 (0.088)	-0.082 (0.089)
Agricultural Job				-0.307** (0.134)	-0.310** (0.134)

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2	Unemployed			-0.468***		-0.458***
3				(0.173)		(0.174)
4	Student			0.147		0.150
5				(0.099)		(0.099)
6	Retired or Old			0.024		0.034
7				(0.086)		(0.087)
8	Housework			0.109		0.109
9				(0.099)		(0.099)
10	Disable			-0.178		-0.176
11				(0.137)		(0.138)
12	Other Reason Out			-0.031		-0.024
13				(0.188)		(0.189)
14	Log GDP per					
15	Capita					0.095
16						(0.086)
17	Density					0.017
18						(0.022)
19	log Fiscal					
20	Expenditure per					
21	Capita					-0.172*
22						(0.095)
23	Constant	0.268	1.767***	-0.044	0.004	-1.055
24		(0.257)	(0.269)	(0.378)	(0.290)	(0.909)
25	Observations	14,204	6,371	7,833	13,683	13,645

26 Robust standard errors
 27 in parentheses
 28 *** p<0.01, ** p<0.05,
 29 * p<0.1

References

1. Kotov, R., et al., *Linking "big" personality traits to anxiety, depressive, and substance use disorders: A meta-analysis*. Psychological Bulletin, 2010. **136**(5): p. 768.
2. Zhou, Y., W. Cai, and L. Xie, *The impact of the COVID-19 pandemic on depressive symptoms in China: A longitudinal, population-based study*. International Journal of Public Health, 2022. **67**: p. 1604919.

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3 Reviewer: 1
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6 Comments to the Author
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8
9 This study analyses how the impact of COVID-19 on mental health in china was mediated by
10 personality and demographic characteristics. Using 2 waves of the China Family Panel Study
11 they show that mental health deteriorated with larger effects among those with more open
12 personalities, and among men.
13

14 This is an interesting study replicating in the Chinese context previous evidence from Proto
15 et al. (2021) on the UK. I have minor comments.
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20 **Thanks for these insightful comments, we are very glad you find our study interesting.**
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23 1) The introduction could clarify that while other studies have looked at the role of
24 personality, openness, and routines disruptions on mental health in other contexts, this is
25 the first study examining these relationships in the Chinese context using panel data. On
26 page 3, the authors clarify their contribute to other studies on China, but it may be worth
27 adding a couple of lines on how this study contributes to the extant literature on COVID-19
28 and mental health in other regions, and in particular to those studies analyzing the impact
29 of personality traits, habits etc.
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34 **We now refer to additional studies on the impact of personality and attitudes toward**
35 **different behaviours in the introduction and discuss some of them on the last section. In**
36 **particular, we have added this paragraph (Page 3, 2nd Paragraph):**
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40 *“There are a few country-representative contributions analyzing the mediating role of*
41 *personality during the pandemic. [7], like our paper, focus on how personality affects mental*
42 *health deterioration, but in the UK; [8] use the CFPS dataset to measure how COVID-19*
43 *pandemic restrictions affect smoking and how personality mediates this behavior. [9] find that*
44 *attitudes and, arguably, personality mediate how the restrictions affect mental health. In the*
45 *last section, we discuss how the existing contributions on personality and restrictions during*
46 *the pandemic relate to this study.”*
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51 2) Clinical depression is usually defined as a CESD score of 15 or higher on the 20-item
52 version of the scale. Why are the authors using 12 when using an 8-scale?
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55 **In this version of the paper, we are trying to be more precise about this important point**
56 **you raise. In the paragraph below we describe the depression scale we now illustrate the**
57 **logic of this cutoff choice (page 5, 1st paragraph):**
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3 *“Following common practice, we use a measure based on a binary indicator of risk of*
4 *presenting with mental health problems (CES-D “caseness” score). In the 20-item*
5 *questionnaire, each answer is coded between 0 (no symptoms) and 3 (frequent symptoms);*
6 *the sum of the coded responses results in a score that falls between 0 and 60. If the total score*
7 *is 28 or above, the subject is considered likely to have severe depression [33] [34]. Accordingly,*
8 *in the eight-item version (with a score ranging from 0 to 24) we classify an individual with a*
9 *score of 12 and above (calculated using the 28/60 ratio from the 20-item version) as severely*
10 *depressed.”*

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16 How sensitive are the results to this choice?

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19 **In the supplementary information (figure S1), we now show results using a lower cutoff as**
20 **you suggest, the results are consistent with a deterioration of mental health also in this**
21 **analysis. And, in the main text, we have now added:**

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24 *“In the supplementary information we will also show results considering a score of 8 or above,*
25 *classified as mild depression. This corresponds to 20 in the 20 item questionnaire (which*
26 *follows [35] suggesting that using 20 points as cutoff is better than 16 points, originally*
27 *classified as mild depression [33]).”*

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31 3) Is the effect on severe depression among individuals younger than 18 driven by a
32 particular subset of symptoms? Given there are less significant differences when looking at
33 the number of symptoms across age groups, it would be interesting to provide more insights
34 on what specific symptoms may be affecting this vulnerable group of the population.

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38 **This is a very interesting point. However, as you might have already noticed, Reviewer 2**
39 **suggested to focus more on personality and less on demographics because the last results**
40 **are generally known, on top of that, Reviewer 2 argued that disentangling the normal age**
41 **effect from the covid pandemic effect on mental health might be challenging. For this**
42 **reason, we did not insist on the demographic effect. We nevertheless run some empirical**
43 **test over this subsample, and we could not find any clear pattern. This is possibly due to the**
44 **relatively low number of existing observations for responders aged 18 and below.**

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49 4) It would be important to specify in the main text when the data were collected in
50 2018/2020. What months were covered in 2018/2020?

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54 **We have added the corresponding information in the 1st paragraph of our ‘Material and**
55 **Methods’ section:**

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"... Though the data from the 2018 wave is collected across 12 months, more than 97% respondents (17626 observations out of 18127 observations) were interviewed between July and December 2018"

What happens if restricting 2018 and 2020 to the same set of months (July-December)?

Given the small number of observations outside this time range, there is not much change. We nevertheless add figure S2 in the supplementary information showing that, and added the following sentence at page 7 (2nd paragraph).

"... we also restricted all observation to the the same set of months (July-December), as we can observe from figure S2 in the supplementary information, the outcome is almost identical."

5) Are the main figures restricting the sample to subjects for which information was collected in both waves?

Yes, as we now clarify in the data section (2nd paragraph of the Data section, beginning of page 4):

"We only consider respondents appearing in both waves (there are 18,127 of them) in all our analysis"

6) The attrition is substantial and may deserve more attention in the main text. Attrition seems to be selective with respect to age, household income, job status. These characteristics are likely correlated with mental health. The authors should discuss the extent to which this may bias their results or at least acknowledge this limitation.

We agree this issue needs some attention, thus -- although we are severely constrained by the 3,000 words limit-- we added a short discussion over the attrition in the main text (2nd paragraph of the material and methods) as it follows:

"... Among individuals interviewed in 2018 for whom we have information on the CES-D and weights, 60.1% were reinterviewed in 2020. Although an attrition rate of around 40% is substantial, it compares favorably with previous work on the topic (e.g., [18] [29]). To cope in part with the attrition, we use the suggested weights when using both waves. In table S7 of the supplementary information, we perform a simple attrition analysis showing that using data from the 2020 wave results in a younger sample. This is to be expected because older respondents from 2018 are less likely to appear in the 2020 wave. The average symptoms of depression slightly decrease in a consistent manner (the difference is nonsignificant at the

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5% level). Average education and household income are also slightly higher, which is consistent with the age differences in this context”

Confidential: For Review Only

Responses to Reviewer 2

Comments to the Author

This study aims to examine how personality and demographics affects the association between the COVID-19 and mental health in China. It's innovative to consider the role of personality here. The authors conduct several empirical tests and find evidence consistent with previous studies. However, I still have some concerns both on the research design and the presentation of this study. I suggest the authors to make major revisions on their manuscript if they have the chance of resubmission.

We are glad you find our study innovative. Thank you for reading the manuscript and for your insightful comments that we think to have addressed to the best our possibility. Please see our answers below in bold after your comments.

Here are my comments:

1. At first, I don't think it's a wise strategy to focus on two different domains (personality and demographics) in such a short article. Especially, the part of "demographics" just show the same findings in previous literature and don't provide us new information. For example, if Zhou et al., (2022) has shown less-educated people experienced severer mental health deterioration with the exactly same dataset, what is the authors' contribution to explore the effect of education? The authors discuss their findings on educational backgrounds with a long paragraph and several new references on page 9 but not explain how their findings contribute to the existing literature. I suggest the authors to just focus on the effect of personality and use more space to discuss about potential mechanisms behind the role of personality.

This is a very useful comment, and we followed this suggestion. The paper is now focused on the effect of personalities only. The title has also been changed to reflect this. As you suggest, this change allowed us to have more space to address other comments and provide more discussion. For demographic effects we refer to other studies and we now only briefly mention demographics in the 2nd paragraph of page 8:

"... Figure 4 also presents some correlations between mental health deterioration and basic demographics. We find that individuals with less education and less income generally experience more severe mental health deterioration; male respondents seem more affected than female respondents. These findings are consistent with other studies that are based on the Chinese population"

2. On page 4, the authors are struggling with the role of age as a confounder (also see Figure 2). Let's consider the following scenario: age indeed has no impact on depression, and the magnitude of COVID-19 induced mental health deterioration is the same for all age groups. In

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3 this case, we will observe a strong positive association between age and depression, and age
4 might explain a significantly large proportion of mental health deterioration from 2018 to
5 2020. The theory is statistically mechanical: everyone gets two years older, and on average
6 people are more depressed than before. To distinguish the impact of COVID-19 from the life-
7 cycle transition of mental health, the authors need to use more waves of CFPS data. For
8 example, if population mental health didn't deteriorate from 2016 to 2018, then we should
9 not observe the association between age and depression.
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14 **We added the mental health data related to the 2016 wave to Figure 1. The figure shows**
15 **how age differences are unlikely to represent a confounding in the increase of mental health**
16 **problems during the pandemic. It is perhaps worth noticing that Figure 2 (a well as Figure**
17 **S1 in the SI), where we used the residuals after controlling for age and age squared, could**
18 **lead to a similar conclusion. We now illustrate this point from the 3rd paragraph of page 6**
19 **(result section) onward:**
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24 *“The fact that the prevalence of serious depression is significantly higher in the pandemic*
25 *year than in the previous two waves of data seems to rule out the possibility that these*
26 *differences are because individuals are older in 2020. We nevertheless address this concern*
27 *by estimating the effect of the COVID-19 pandemic on our mental health indicators (serious*
28 *depression and symptoms) by controlling for Age and Age Squared for the 2018 and 2020*
29 *waves...”*
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36 3. I checked the personality module of CFPS 2018 questionnaire and found it used a 15-
37 question test, which is much shorter than the standard ones. If possible, the authors need to
38 find some literature supporting the validity of the short Big-5 test.
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40

41 **In this revised version, we have added some additional information regarding the Big Five**
42 **Inventory and cited the literature that evaluated the validity and reliability of the shorter**
43 **15-items Big Five Inventory as requested. The additional text is from the 3rd subsection of**
44 **our Material and Methods section (page 5):**
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48 *“The 2018 wave of the CFPS dataset includes a set of standard personality questions derived*
49 *from the most widely used taxonomy of personality, the “Big Five” model as measured by the*
50 *Revised NEO Personality Inventory (NEO-PI-R) [3]. Instead of using the origin NEO-PI-R with 60*
51 *items (12 items per domain), the CFPS measures relevant data with a shorter, 15-item*
52 *questionnaire (three for each of the Big Five traits), as it is customary in large surveys. Scale-*
53 *development studies show that it is possible to assess the Big Five personality traits reliably*
54 *using fewer items and the 15-item version in particular ([36], [37] and [38])”*
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3 They also need to cite more references (e.g., Cai and Zhou, 2022) that also use the Big-5
4 module of CFPS to study how personalities affect people's responses to the COVID-19
5 pandemic.
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9 **Thanks for pointing this out. We now refer to some additional studies on the impact of**
10 **personality and attitudes toward different behaviours on the introduction and discuss some**
11 **of them on the last section. In particular, in the 7th paragraph of the introduction (page 3),**
12 **we write:**
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16 *"There are few country-representative contributions analyzing the mediating role of*
17 *personality during the pandemic. [7], like our paper, focus on how personality affects mental*
18 *health deterioration, but in the UK; [8] use the CFPS dataset to measure how COVID-19*
19 *pandemic restrictions affect smoking and how personality mediates this behavior. [9] find that*
20 *attitudes and, arguably, personality mediate how the restrictions affect mental health. In the*
21 *last section, we discuss how the existing contributions on personality and restrictions during*
22 *the pandemic relate to this study..."*
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28 4. The authors introduce dataset, the measurement of depression, and the measurement of
29 Big 5 until the "Materials and methods" section, after the "results" section. They also
30 introduce the econometric model, which generates the estimates in some figures, only in
31 the supplementary section. Such a structure is not friendly for readers to understand what
32 the patterns in the figures mean and how the statistical analyses were performed. I suggest
33 the authors to introduce data and methods before showing the results.
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38 **We moved the paragraphs illustrating the econometric model in the main body of the**
39 **paper and moved the "Material and Methods" section before the results, following your**
40 **suggestion.**
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44 5. The authors should describe more about the background of COVID-19 in China, which is
45 supposed to be quite different from other countries in many dimensions. Otherwise, readers
46 from countries other than China might have difficulties to understand some information in
47 this article.
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51 **We have added more information regarding China's Covid-19-related containment**
52 **measures (although we had to consider the journal's 3,000-word limit). In particular in the**
53 **3rd Paragraph of the Data section (page 4), we write:**
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57 *"China imposed two lockdowns at the province level in 2020. The first one was in the*
58 *Hubei province from January 23 to April 8, 2020; the second one was in the Xinjiang province*
59 *in July and August 2020. All residents in the Hubei and Xinjiang provinces were required to stay*
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3 *indoors and prohibited from leaving the region. All schools in Wuhan closed and switched to*
4 *online teaching; only authorized public service providers were permitted to leave home for*
5 *work. Other provinces in China were less strict, and normal daily work and life continued as*
6 *much as possible, but the residents of these provinces were still required to follow a series of*
7 *containment measures that were inconvenient in many aspects [30]."*
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13 6. I have strong interests in the variable "Lockdown" and believe it might help us understand
14 potential mechanisms behind the effects. However, the authors didn't give a clear
15 introduction about how such a variable is constructed.
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19 **We have now tried to be clearer about how our "Lockdown" variable is constructed. Below**
20 **the information in the paragraph pasted above, we also add:**
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23 *"We could identify two groups of respondents based on whether they experienced lockdown*
24 *before the interview or were in lockdown during the interview. The first group includes*
25 *respondents in the Hubei province for the entire 2020 wave; the second group includes*
26 *respondents in the Xinjiang province in July and August 2020. Due to the small sample size of*
27 *the second lockdown, we group both lockdowns together in our analysis"*
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31 7. Why the authors use 12-point as the cutoff of severe cases of depression, is this a widely-
32 accepted clinical standard?
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35 **We clarify this important point in the subsection describing the depression scale (Page 5,**
36 **1st paragraph), where we now illustrate the logic behind our choice of cutoff:**
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40 *"Following common practice, we use a measure based on a binary indicator of risk of*
41 *presenting with mental health problems (CES-D "caseness" score). In the 20-item*
42 *questionnaire, each answer is coded between 0 (no symptoms) and 3 (frequent symptoms);*
43 *the sum of the coded responses results in a score that falls between 0 and 60. If the total score*
44 *is 28 or above, the subject is considered likely to have severe depression [33] [34]. Accordingly,*
45 *in the eight-item version (with a score ranging from 0 to 24) we classify an individual with a*
46 *score of 12 and above (calculated using the 28/60 ratio from the 20-item version) as severely*
47 *depressed."*
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52 Are the findings robust to the choice of cutoff?
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55 **In the supplementary information, we show results using a lower cutoff (figure S1). The**
56 **results are consistent with deterioration of mental health due to Covid-19 restrictions, also**
57 **in this analysis. In the main text, we write (subsection of Material and Methods describing**
58 **the depression scale: page 5, 1st paragraph):**
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5 *“In the supplementary information we will also show results considering a score of 8 or above,*
6 *classified as mild depression. This corresponds to 20 in the 20 item questionnaire (which*
7 *follows [35] suggesting that using 20 points as cutoff is better than 16 points, originally*
8 *classified as mild depression [33]).”*
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13 8. There are many typos and grammatical mistakes in this article. For example, the reference
14 list in the last page seems to be incomplete. I suggest the authors proofread the manuscript
15 more carefully.
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19 **The manuscript and the supplementary information document have been proof-read by a**
20 **professional copyeditor.**
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