Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Change in psychological distress in response to changes in reduced mobility during the early 2020 COVID-19 pandemic: Evidence of modest effects from the U.S.

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ABSTRACT

Rationale: During the early 2020 COVID-19 pandemic, several US states had implemented stay-in-place orders (SIPOs) with varying degrees of stringency which resulted in inter-state differences in mobility (i.e., longer presence at home). We test whether the inter-state differences in mobility influenced changes in reported psychological distress. Our study is not on the surge in COVID-19 in the later part of 2020.
Objective: To identify whether the change in state-level mobility is associated with the change in individuals' reported psychological distress during the early COVID-19 pandemic and whether the intensity of the association varies by older individuals, females, and nonwhites.
Methods: We use differences in state-level mobility and change in reported psychological distress between the two dates of interviews of 5,132 individuals who participated in March and April 2020 waves of Understanding America Study (UAS).
Results: We find support for modest effects, i.e., a one standard deviation decline in mobility was associated with a 3.02% higher psychological distress [95% CI: 0.4%–5.64%], and the effects are robust to controlling for reported changes in exercise intensity, alcohol consumption, cannabis use, recreational drug use, and meditation intensity. We also find support for a stronger association for females, but not for older individuals or non-whites. Further, we do not find support for the mediation effects from change in chance of running out of money or change in chance of getting COVID-19.
Conclusion: Our findings show that reduced mobility from lockdowns during the early COVID-19 wave in the US is associated with a modest increase in reported psychological distress, especially for females. However, these conclusions should not be construed as a small increase in psychological distress in general, as a variety of non-mobility related factors associated with COVID-19 could have exacerbated psychological distress during the early COVID-19 wave in the US.

1. Introduction

In the U.S., mid-March was the start of a significant uptick in COVID-19 cases, with the cases peaking around mid-July 2020. However, in the so-called 'second' wave, there has been a significant increase in the number of cases. As of December 6, 2020, there were 14.7 million cases and 281,000 deaths in the U.S. During the early stage, states enacted a variety of non-pharmaceutical interventions to curb the pandemic. Our study focuses on the effects of these early-stage policies aimed at curbing the pandemic. The human and economic toll of the pandemic is staggering, and the reduced mobility from lockdowns may also, directly and indirectly, impact mental well-being. Studies have focused on the effects of COVID-19 on psychological distress in China (Qiu et al., 2020), Italy (Mazza et al., 2020), Spain (Losada-Baltar et al., 2020), among others.

Extending these country-level studies, our study focuses on the intra-country variation in mobility on changes in reported psychological distress during the early COVID-19 wave in the U.S. Though reduced mobility helps control the spread of COVID-19, according to Douglas et al. (2020), several groups are especially vulnerable to poorer health due to economic deterioration, social isolation, stress on family relationships, poor health, and essential services and the general social malaise, especially, as coping capacity may be limited in the face of

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sudden onset of the pandemic. The confluence of these factors could have increased the levels of psychological distress during the early COVID-19 wave in the U.S.

Though most countries initiated national lockdowns during the early COVID-19 wave, the U.S. presents an interesting case for studying the effects of variations in strictness of lock-downs that drive variations in mobility on psychological distress during this period. In the U.S., the lockdown policy was mostly initiated by the state governors and there was no national lockdown policy. Variations in lockdown policies across U.S. states starting mid-March 2020 resulted in substantial variation in mobility across states (Alvarez et al., 2020). Extending prior claims that lockdown may increase the incidence of suicide (Gunnell et al., 2020), increase stress and anxiety (Wang et al., 2020), and trigger a variety of mental conditions (Yao et al., 2020), we focus on the association between changes in mobility on the changes in reported psychological distress during the early COVID-19 wave in the U.S. The mobility restrictions have negative implications on distress, as evident in a study by Arendt et al. (2020) who find an increase in calls to crisis hotlines and reopening led to a decrease in the number of calls.

Based on stress process theory (Attell et al., 2017; Pearlin and Bierman, 2013; Thoits, 2010), we elaborate the theoretical reasons for the following hypotheses, below: The decline in mobility at the state-level during the early COVID-19 wave in the U.S. is positively associated with the changes in psychological distress; and this association is stronger for older individuals, females, or non-whites. We further explore possible mediation mechanisms as auxiliary analyses by testing whether lower mobility drives an increase in psychological distress through two channels — perceived changes in the chance of running out of money or perceived changes in chances of getting COVID-19 between two waves of the interview. We use a two-wave individual-level longitudinal survey and assess changes in mobility in a state between the two interview dates, and the changes in reported psychological distress. Mobility is measured using Google's data on Android users, where increased stay at home (measured as residential mobility) would imply reduced movement outside the home. Our effect sizes are small relative to a more recent UK based study by Niedzwiedz et al. (2020) who found that psychological distress increased one month into lockdown with the prevalence rising from 19.4% in 2017–2019 to 30.6% in April 2020, mostly affecting women, young adults, people from an Asian background and more educated. Our effect sizes are much smaller, however, we also note that we do not have pre-COVID-19 data of the respondents, and a variety of non-mobility related factors may affect reports of changes in psychological distress. We do not find support for the mediation effect through perceived changes in the chance of running out of money or perceived changes in chances of getting COVID-19.

Overall, provides early intra-country evidence on the effect of lower mobility on change in psychological distress, a key public health outcome of interest for policymakers, mental health practitioners, and individuals alike. Although our results only provide a snapshot of the relationship between reduced mobility during the COVID-19 pandemic and psychological distress during the early COVID-19 wave in the U.S., they contribute to the ongoing research on the effects of COVID-19 on the mental well-being of individuals.

2. Theoretical background and hypotheses

2.1. Psychological distress during the early stages of COVID-19 pandemic

The nature of psychological distress is unique for a pandemic. Health and economic uncertainty take a visible physical and mental toll on the population. At the same time, in the U.S., during the early COVID-19 wave varying state and federal narratives on containment and seriousness of the pandemic have further added to variegation in the mobility of individuals. Though stay-in-place orders (SIPO) are central to the containment of spread (Courtemanche et al., 2020; Dave et al., 2020), not all states in the U.S. enacted stringent SIPO laws to contain the virus. By mid-July 2020, it was evident that states with the most stringent SIPOs and those that delayed relaxation of SIPO laws (e.g., New Jersey, New York, Pennsylvania, and others) had seen a steady decline in cases, whereas states with less stringent laws and aggressive re-opening plans had seen a surge of cases. Public compliance was equally important, for example, in California despite the stringent SIPO during early stages, excessive congregations in public places may have contributed to the resurgence of cases.

Although a combination of factors may help 'flatten the curve,' the differences in government mandate of SIPO were elemental in explaining variations in curbing COVID-19 spread (Courtemanche et al., 2020). In Appendix Table A, we list the SIPO law variations by the state during the early COVID-19 wave. Though studies have focused on the effect of national lockdowns on psychological distress (Mazza et al., 2020; Qiu et al., 2020), the variations in mobility across states are a unique context. Figure A (Appendix) presents the variations in the degree of mobility across states between two waves of our study period. Higher differences imply higher presence at home, in other words, lower mobility.

Our theoretical basis is mainly rooted in stress process theory, which links stressors to adverse mental health outcomes (Thoits, 2010). Prior empirical studies show an association between exposure to stressors and worsening mental health (Attell et al., 2017). Coping with the demands of childcare, income uncertainty, reduced socialization, and general malaise are strong stressors that could increase psychological distress. The general sense of isolation from lower mobility can increase the levels of depression and anxiety (Torales, O'Higgins, Castaldelli-Maia and Ventriglio, 2020).

Because COVID-19 was a recent phenomenon during the early COVID-19 wave in the U.S., we lack sufficient theoretical background on psychological distress specific to COVID-19. Thus, we rely on the literature on the psychological effects of past pandemics such as SARS, H1N1, Ebola, among others. Studies have shown that those quarantined, relative to those who are not quarantined, reported higher levels of psychological distress (Brooks et al., 2020). Quarantined individuals are prone to higher levels of post-traumatic stress disorder (PTSD) and depression (Hawryluck et al., 2004; Holmes et al., 2020; Jeong et al., 2016). According to a recent study on COVID-19, about 54.8% of respondents reported moderate or severe impact from the outbreak, with 16.5% of respondents reporting moderate to severe depressive symptoms (Wang et al., 2020). In a related study, about 35% of the 52,730 participants reported psychological distress (Qiu et al., 2020). There is also mounting evidence that isolation based on lockdowns has increased psychological distress (Torales et al., 2020). We hypothesize that:

H1. The decline in mobility during the COVID-19 pandemic is positively associated with an increase in reported psychological distress.

Next, we theorized about heterogeneity in the association proposed in H1.

2.2. COVID-19 psychological distress and demographic factors during the early COVID-19 wave in the U.S

COVID-19 studies during the early COVID-19 wave have focused on the effect of demographic and social factors on individual reactions to quarantine and effects on psychological outcomes (Mazza et al., 2020). The stress process theory is particularly salient in the current context. Stress process theory posits that health outcomes are distributed according to one's social status and exposure to stress (Aneshensel, 1992), such that those in more marginalized groups in the society are prone to greater stress (Attell et al., 2017). In the stress process theory, stressors are "*the broad array of problematic conditions and experiences that can challenge the adaptive capacities of people*" (Pearlin, 2010, page 208). During the early stages, COVID-19 created factors that not only impacted individuals in general but more marginal populations were also more severely affected. We focus on three vulnerable groups—older

individuals, females, and non-Whites. The three groups we focus on are linked to systematic differences in socio-economic status. Clouston, Nataleb, and Link (2020) find that earlier incidence of index cases was concentrated in higher socio-economic status counties, but with higher social distancing incidence and fatality, rates declined, indicating lower socioeconomic status groups bore a disproportionate burden during the early stages of a pandemic.

The extensive set of studies on the early COVID-19 wave document that older individuals are more vulnerable to COVID-19, females are more prone to COVID-19 stress, and finally, non-Whites, have disproportionately been affected by COVID-19 (Bhala et al., 2020). Older individuals are reported to have a negative susceptibility to COVID-19 (Girdhar et al., 2020). Combining the stress process theory with the stereotype embodiment theory we expect that negative stereotypes are harbored towards older individuals. Higher susceptibility to COVID-19, lower sensitivity among younger individuals towards the spread of COVID-19 to older individuals (Ayalon et al., 2020), and the general "age walling" (Hagestad and Uhlenberg, 2005) have contributed to higher stress among the elderly. Ageism, higher mortality rates, and the general malaise among the elderly in emotional response to COVID-19 may increase their psychological distress levels. Bu, Steptoe, and Fancourt (2020), using a sample of 38,217 UK adults in the UCL COVID-19 Social Study (23/03/2020–10/05/2020) identified four latent groups on loneliness levels, where during the first few weeks of lockdown, loneliness levels increased in the highest loneliness group, remained constant in the middle two groups and declined in the lowest loneliness group. Younger adults, women, those in the lower income group, and those with mental health conditions were more likely to be in the highest loneliness class.

Females were perhaps also more prone to psychological distress during the early wave of COVID-19 (Qiu et al., 2020; Wang et al., 2020), and both younger adults (ages 18–30) and the elderly (those older than 60 years) are more likely to report psychological distress. In a nationally representative study, Qiu et al. (2020) found that during the early wave of the COVID-19 pandemic, in China, females were more prone to psychological distress, perhaps due to higher experiences of PTSD among females (Tang et al., 2020). Though PTSD is an extreme outcome, a higher expected psychological distress among females in the U.S. may likely result from variations in gender roles and gender inequality. The psychological distress for females could increase through two channels—the greater burden of housework and labor force inequality. Higher demands at home, employment in more customer-facing occupations, lower pay relative to males are some of the factors that could explain why females may experience higher psychological distress during the early wave of the COVID-19 pandemic in the U.S. These multipronged demands at home and work under reduced mobility could significantly increase psychological distress among females for two possible reasons. Indirectly, related to greater stress among females, pregnant females reported higher stress levels that could influence maternal mental and physical health, perinatal outcomes (Preis et al., 2020).

First, females bear a higher burden of household work and childcare (Stone, 2008). Collins, Landivar, Ruppanner, and Scarborough (2020) find that during the COVID-19 pandemic, in the U.S., mothers with young children reduced their work hours, indicating a growing gender gap in work hours by 20–50 percent. The evidence of a greater reduction in work and higher household responsibilities under lower mobility during the early wave of the COVID-19 pandemic could exacerbate psychological distress among females. Females may bear greater responsibility for taking care of children, those sick, and even the educational responsibility of school-aged children at home. For example, Pierce et al. (2020) using a sample of 17,452 participants in Waves 6–9 of the UK Household Longitudinal Study (UKHLS) panel (with COVID-19 web surveys conducted in Waves 8 or 9) found that mental distress rose from 18.9% in 2018–19 to 27.3% (26.3–28.2) in April 2020; a month after the start of UK lockdown and working women with younger children had higher distress levels.

Second, females tend to work in service sectors (Polachek et al., 2015; Rendall, 2018) that tend to be more customer facing and therefore leading to higher concerns for exposure. Furthermore, it is a foregone conclusion that females make less money than males, and with greater economic insecurity gripping the U.S. during the COVID-19 pandemic, females may feel more economically vulnerable, especially during the early onset of the pandemic. Mounting unemployment rates, continuing or increasing workloads, and higher representation in lower-paying jobs are the additional reasons why we expect females to experience higher psychological distress under lower mobility during the early wave of the COVID-19 pandemic in the U.S. In a review by Connor et al. (2020) female caregivers had higher exposure to the virus, exacerbates multifactorial stress for females, and called for gender-informed policies to combat higher stress among females.

Continuing from the stress process theory, COVID-19 has also disproportionately affected racial minorities. Already subject to systemic discrimination (Reskin, 2012), greater likelihood of being employed in front-line jobs (Cubrich, 2020), and facing higher income uncertainty (Hardy, 2017), studies have highlighted significant stressors faced by racial minorities (Chowkwanyun and Reed Jr, 2020; Hooper et al., 2020). Racial minorities in the U.S. also have greater co-morbidities than whites (Metcalfe et al., 2018), live in more congested urban settings, and low pay higher COVID-19 exposure occupational settings may further strengthen psychological strain from lower mobility.

To summarize, COVID-19 studies on the early wave of the pandemic have focused on the effect of demographic and social factors on individual reactions to quarantine and effects on psychological outcomes (Mazza et al., 2020). Females are more prone to psychological distress (Qiu et al., 2020; Wang et al., 2020), and both younger adults (ages 18–30) and the elderly (those older than 60 years) are also more likely to report psychological distress (Mazza et al., 2020). The effects based on education are mixed, with individuals of both high and low education reporting higher psychological distress (Qiu et al., 2020; Wang et al., 2020). Others have focused on more behavioral traits, including personality, that influence reaction to quarantine, and the subsequent depression and anxiety outcomes (Ioannou et al., 2004).

Based on the above discussion we propose the following hypotheses on the heterogeneity in the changes in mobility and psychological distress by older individuals, females, and non-whites.

H2. The decline in mobility during the COVID-19 pandemic is more strongly associated with an increase in reported psychological distress for older individuals.

H3. The decline in mobility during the COVID-19 pandemic is more strongly associated with an increase in reported psychological distress for females.

H4. The decline in mobility during the COVID-19 pandemic is more strongly associated with an increase in reported psychological distress for non-whites.

3. Methods

3.1. Understanding America Study (UAS) survey data during the early COVID-19 wave in the U.S

Though pre-COVID-19 mental well-being data of individuals is generally unavailable in the U.S. studies (except for large scale studies such as Health and Retirement Study, National Longitudinal Survey of Youth who are planning for assessments in the latter part of 2020), we exploit the effect of change in mobility and change in reported psychological distress from the same individuals during peak months of the early wave of COVID-19. Our data relies on a two-wave longitudinal national survey – The Understanding America Study (UAS) COVID-19

survey conducted by the University of Southern California via an online survey (Kapteyn et al., 2020). The sample consists of members of the Center for Economic and Social Research's UAS probability-based internet panel that started in 2014. This nationally representative panel of American households was randomly recruited from the United States Postal Service delivery sequence files. The members were individuals age 18 and older who could respond to the survey online. The participants had a choice to complete the online survey in English/-Spanish by using their computer, mobile device, or tablet, any day/time during the study period. For those households without online access, an internet-connected tablet was provided.

A total of 8815-panel members were invited to participate in the first wave of the COVID-19 survey. The first wave of the COVID-19 survey was held from March 10th, 2020 to March 31st, 2020. The members were randomly assigned a particular day of the week to complete the survey during the 14 days. The respondents were compensated for their participation and an additional incentive was provided if they responded on their assigned day. The participation rate was about 82%, with 7145 adult U.S. residents participating in the survey. The margin of sampling error was ± 2 percentage points for Wave 1. UAS administrators computed the survey weights based on the base weights that account for probabilities of selecting into the sample and also by post-stratification weights aligning with benchmark distributions from U.S. Census Current Population Surveys. The final sample released by UAS after curating the data was 6930. For detailed methodology, weighting methods, and sample selection, please refer to https://uasdata.usc.edu/index.php.

Wave 2 of the COVID-19 survey was administered from April 1st, 2020 to April 28th, 2020. The survey was sent to a total of 9063 panel members, 154 individuals had not completed the Wave 1 survey, and 1606 individuals from the Wave 1 survey respondents did not participate in the Wave 2 survey. After removing observations with missing covariates, our final sample consists of 5,132 individuals who were surveyed for both the UAS waves. Appendix Figure B shows the flowchart for our sample selection. Appendix Figure C shows the distribution of our sample across all U.S. states. A higher share of the sample is located in highly populated states in the U.S.

3.2. Mobility data

We obtain the mobility data from Google's COVID-19 community mobility reports (published at https://www.google.com/covid19/mobility/). The daily mobility reports provide public health officials and researchers with estimates of changes in mobility patterns due to the COVID-19 pandemic and also to test the effectiveness of policies that are implemented to flatten the curve. The daily mobility patterns data show changes in trends at places such as residences, workplaces, retail/recreational venues, parks groceries/pharmacies, and transit centers. The anonymized and aggregated data capture location from Google users across the nation who had opted to turn on their location history settings. To protect user privacy and improve the accuracy of the aggregated data, random noise is added by Google's research team to each metric.

We use the changes in mobility data at the place of residence to proxy for reduced mobility in our analysis (in other words, an increase in mobility at residence implies reduced overall mobility). For each day, the signals such as relative frequency, time, and duration of visits combined with the average amount of time spent at home (in hours) are used to compute residential data (Aktay et al., 2020). The mobility changes are compared to a baseline (median) value for a particular day of the week between January 3rd and February 6th, 2020. Additional information on Google mobility trends and the associated calculations are available at https://www.google.com/covid19/mobility/data_documentation.html?hl=en. The ratio between each day's metric and baseline are then published as a percentage. Due to the addition of noise for privacy, the margin measurement errors are ± 2.5%. Further, when the percentage chance of residential metrics has a 5% chance of being wrong, then such geographic data is not reported.

We then merge the daily state-level mobility trends provided by Google based on the date of the UAS interview to estimate the changes in reduced mobility between the two waves of interviews in the state where the individual resides.

3.3. COVID-19 incidence proportion

We obtain state-level cumulative COVID-19 incidence data from USAFacts, an organization that aggregates confirmed COVID-19 data released by U.S. Center for Disease Control and Prevention (CDC), and confirmed by referencing state- and local-level public health agencies. The cumulative positive COVID-19 cases and death data are collected and updated each day from public health websites. They are presented both at the state- and county-level. Conforming to CDC's reporting methodology, USAFacts counts presumptive positive cases as confirmed cases and assign location based on where individuals were diagnosed. We then divide the cumulative COVID-19 incidence by 100,000 population to express the data as the incidence proportion.

We then merged the daily state-level COVID-19 incidence proportion data with the date of the UAS interview across both the waves. We use this data to estimate the changes in incidence proportions between two waves of the survey to measure the exposure of COVID-19 in the individuals' residence state.

3.4. Empirical specification

Our model approach allows U.S. to account for state-level changes related to the propensity to follow lockdown orders by staying home (that is, higher reduced mobility), and also control for the individual characteristics in reporting and managing reactions to COVID-19. To estimate the impact of reduced mobility on psychological distress, we use the following specification:

$$\Delta Y_{ist} = \alpha_0 + \alpha_1(\Delta\ Reduced\ mobility)_{ist} + \alpha_c \Delta C_{st} + \alpha_m \Delta M_{it} + \alpha_x X_i + \mu_{is} \quad (1)$$

Where i is the individual located in state s in wave t.

Our outcome measure (ΔY_{ist}) in both methods is the change in psychological distress between the two waves. We use the psychological distress scale from the Generalized Anxiety Disorder seven-item scale (Spitzer et al., 2006) and is used as a proxy for short-term psychological distress (Vasiliadis et al., 2015), including in recent COVID-19 research (Zhang et al., 2020). Our psychological distress measure is the average of four-point Likert scale (1: Not at all; 2: Several days; 3: More than half the days; 4: Nearly every day) of four variables asking the respondent "Over the last two weeks, how often have you been bothered by any of the following problems?": 1) Feeling nervous, anxious, or on edge; 2) not being able to stop or control worrying; 3) Feeling down, depressed, or hopeless; and 4) Little interest or pleasure in doing things. The Cronbach's α for the psychological distress measure for Wave 1 was = 0.89. The Cronbach's α for Wave 2 was 0.88.

The coefficient, α_1, in equation (1) provides an estimate of the impact of change in reduced mobility between Wave 2 and Wave 1 of the UAS survey on change in reported psychological distress. The reduced mobility implies that individuals are staying home and therefore a positive coefficient implies a higher increase in distress.

We control for a series of contextual and demographic confounds that may influence the reporting of psychological distress. Related to contextual confounds, due to daily changes in local COVD-19 conditions, we control for the change in state-level COVID-19 incidence proportions (ΔC_{st}) on the day of the interview from the previous day. Related to personal experience of COVID-19 on the household economic situation that could increase reporting of distress, we control for the change in reported chance of running out of money (range of 1–100) and change in reported chance of getting COVID-19 (range 1–100) between

two waves (i.e., ΔM_{it} in equation (1)). Older individuals are more likely to report distress (Schieman et al., 2001), and experiences of distress vary by gender (Cook, 1990) and by race (Kessler and Neighbors, 1986). Furthermore, those with higher education are likely to hold better-paying jobs (Brännlund and Hammarström, 2014) and those with a partner can have necessary emotional support (Hope et al., 1999) to lower reporting of distress. We also note that the effects based on education are mixed, with individuals of both high and low education reporting higher psychological distress (Qiu et al., 2020; Wang et al., 2020). Similarly, immigrants may face higher distress (Ritsner and Ponizovsky, 1999), and those with a lower household income may further higher distress due to greater economic uncertainty from COVID-19 (Matthews et al., 2001). Therefore, related to demographic confounds, we control for age, gender, whether the respondent identifies as White, education status, marital status, employment status, immigrant status, and household income. Further, we cluster our standard errors by state.

As a robustness test, we also perform a first difference model to capture all of the time-invariant factors between two waves. The first difference model is a modification of equation (1) and takes the following form:

$$\Delta Y_{ist} = \beta_1(\Delta\ Reduced\ mobility)_{ist} + \beta_c \Delta C_{st} + \beta_m \Delta M_{it} + \Delta\varphi_{ist} \quad (2)$$

where $\Delta\varphi_{ist}$ are the changes in idiosyncratic error and β_1 is the first-difference estimator of reduced mobility.

Table 1 presents the descriptive statistics of our sample. Appendix Table B shows the detailed questions and scale used in UAS survey variables.

4. Results

4.1. State-level preliminary evidence of SIPO on mobility

We first test whether the changes in SIPO order had any effect on changes in mobility at a state-level. For our predictor variable, we compute the changes in SIPO order between April 14th (Wave 1) and March 20th, 2020 (Wave 2). We measure the outcome variable as changes in state-level mobility between those two dates. Our control variables include the log of the state population in 2018, the log of gross state product, the unemployment rate in 2018, and the state minimum wage in 2018. Appendix Table C shows the descriptive statistics of the state-level variables used in this analysis. Our results are shown in Appendix Table D, where we find that the SIPO had reduced overall mobility (implying an increase in residential presence).

4.2. Main results on the effects of reduced mobility on psychological distress

Table 2 shows the results of our model specifications. Estimates in Models 1 through 5 are based on OLS; Model 5 estimates are based on the first-difference specification. Model 1 is the base model without controls. In Model 2 we add individual characteristics as controls. In Model 3 we add state-level changes to COVID-19 incidence proportions between the two waves. In Model 4, our preferred model, we include the mediators – change in chance of running out of money and change in chance of getting COVID-19 between two waves. In Model 5, we add state dummies to the previous model. Model (6) shows the results of our first difference specification.

We find that across all models, the changes in reduced mobility increases psychological distress, however, with modest effect sizes. Using our preferred model, we find that one standard deviation decline in mobility is associated with an increase in reported psychological distress by 3.02% [95% CI: 0.4%–5.64%]. The estimates were computed as follows: The average decline in mobility is 15.1105 (SD = 6.8376), and OLS Coefficient is 0.00441 [95% CI: 0.00059 to 0.00825] from Model 5.

Table 1
Summary statistics (N = 5,132 individuals).

Variable	Description of variables	Mean	Std.
Change in distress	Change in an individual's response to reported psychological distress measure between wave 2 and wave 1	0.1662	0.6426
Change in reduced mobility	Percent change in state-level reduced mobility (mobility trends for places of residence) between individuals wave 2 and wave 1 interview dates compared to a baseline (median) value for the day of the week from Jan 3rd to Feb 6th, 2020.	15.1105	6.8376
Change in COVID-19 state incidence proportion	Change in state-level COVID-19 incidence proportion [i.e., number of COVID-19 reported cases per 100,000 population of the individuals' state of residence] between individuals wave 2 and wave 1 interview dates	91.9754	141.7473
Change in the chance of running out of money (0–100)	Change in individual's response on the chance of running out of money between wave 2 and wave 1	5.4809	26.7272
Change in the chance of getting COVID-19 (0–100)	Change in individual's response on the chance of getting COVID-19 between wave 2 and wave 1	6.7023	23.5559
Age	Age of individual at the time of the survey	51.2132	16.1412
Male	Gender is male (=1); otherwise (=0)	0.4281	0.4949
White	The individual is White race (=1); otherwise (=0)	0.8447	0.3622
High school graduate	The individual is a High school graduate education (=1); otherwise (0)	0.1633	0.3697
Some college	The individual has attended Some college (=1); otherwise (0)	0.3693	0.4826
Bachelor's degree or more	The individual has a Bachelor's degree or more (=1); otherwise (0)	0.4213	0.4938
Married (spouse not there)	The individual is married (but spouse lives elsewhere) (=1); otherwise (0)	0.0134	0.1152
Separated	The individual is Separated (=1); otherwise (0)	0.0160	0.1254
Divorced	The individual is Divorced (=1); otherwise (0)	0.1430	0.3501
Widowed	The individual is Widowed (=1); otherwise (0)	0.0493	0.2165
Never married	The individual is Never married (=1); otherwise (0)	0.2235	0.4166
Employed	The individual is employed at the time of the survey (=1); otherwise (0)	0.4943	0.5000
First-generation immigrant	The individual is a First-generation immigrant (=1); otherwise (0)	0.1009	0.3013
Second-generation immigrant	The individual is a Second-generation immigrant (=1); otherwise (0)	0.1401	0.3471
Third generation immigrant	The individual is a Third-generation immigrant (=1); otherwise (0)	0.1884	0.3911
Unknown immigrant status	Individual's immigrant status is unknown (=1); otherwise (0)	0.0281	0.1652
HH income $5 k to $7499	Household income is $5 k to $7499 (=1); otherwise (0)	0.0117	0.1075
HH income $7.5 k to $9999	Household income is $7.5 k to $9999 (=1); otherwise (0)	0.0133	0.1144
HH income $10 k to $12,499	Household income is $10 k to $12,499 (=1); otherwise (0)	0.0265	0.1606
HH income $12.5 k to $14,499	Household income is $12.5 k to $14,499 (=1); otherwise (0)	0.0226	0.1486

(continued on next page)

Table 1 (*continued*)

Variable	Description of variables	Mean	Std.
HH income $15 k to $19,999	Household income is $15 k to $19,999 (=1); otherwise (0)	0.0357	0.1855
HH income $20 k to $24,999	Household income is $20 k to $24,999 (=1); otherwise (0)	0.0435	0.2039
HH income $25 k to $29,999	Household income is $25 k to $29,999 (=1); otherwise (0)	0.0456	0.2086
HH income $30 k to $34,999	Household income is $30 k to $34,999 (=1); otherwise (0)	0.0472	0.2120
HH income $35 k to $39,999	Household income is $35 k to $39,999 (=1); otherwise (0)	0.0458	0.2091
HH income $40 k to $49,999	Household income is $40 k to $49,999 (=1); otherwise (0)	0.0735	0.2609
HH income $50 k to $59,999	Household income is $50 k to $59,999 (=1); otherwise (0)	0.0883	0.2837
HH income $60 k to $74,999	Household income is $60 k to $74,999 (=1); otherwise (0)	0.1085	0.3111
HH income $75 k to $99,999	Household income is $75 k to $99,999 (=1); otherwise (0)	0.1442	0.3513
HH income $100 k to $149,999	Household income is $100 k to $149,999 (=1); otherwise (0)	0.1419	0.3489
HH income $150 k or more	Household income is $150 k or more (=1); otherwise (0)	0.1208	0.3259

The average change in distress variable is 0.1662 (SD = 0.6426); a one standard deviation increase in reduced mobility is associated with increased distress by 3.02 percent (i.e., 6.8376 × 0.00441).

4.3. Heterogeneity by age, gender, and race

We test our hypotheses — H2, H3, and H4, on whether or not the effects of reduced mobility on psychological distress varies by age, gender, and race. Table 3 presents the results of this heterogeneity. We do not find statistical evidence of reduced mobility among older individuals or by race on distress. Though reduced mobility increases psychological distress overall, we find that a stronger association for females than for males. One standard deviation decline in mobility increases reported psychological distress among females by 6.61% relative to males, again with modest effect sizes.

5. Robustness tests

5.1. Changes in behavior

It is plausible that individuals could have changed their behavior between two waves when their mobility is restricted outside their residence and that may influence reported psychological distress. To test for that possibility, we also include changes to self-reported exercise intensity, alcohol consumption, cannabis use, recreational drug use, and meditation intensity to our preferred specification. These changes in activities were calculated from the change in an individual's response to the number of days the respondent did each of the above activities in the past week of the survey between Wave 2 and Wave 1. Table 4 shows the results of our analysis controlling for changes in behavior. We find that our original results of reduced mobility impacting higher psychological distress remain consistent.

5.2. Alternate measures of mobility

We perform a counterfactual placebo analysis by replacing reduced mobility with workplace mobility [mobility trends across places of work], as both are conversely related. Additionally, we also test for changes to retail and recreation mobility [which include mobility trends across food establishments, shopping malls, theme parks, museums, libraries, and movie theaters] on psychological distress. Appendix Table E shows that higher workplace mobility (or retail/recreation mobility) leads to lower psychological distress.

5.3. Mediation effects

At an individual level, we assess whether changes in reduced mobility affect the reported changes in the chance of running out of money (or, the chance of getting COVID), which in turn increases psychological distress. We estimate this relationship using a structural equation model (SEM) as shown in Appendix Figure D. Appendix Table F presents the estimates of the structural equation model (SEM). We find that the changes to reduced mobility increase the reported change in chances of running out of money (Panel A) and the reported change in chances of getting COVID-19 (Panel B), in turn, increases psychological distress, however, the effect size is negligible. Our estimates show that the mediation effects are negligible, suggesting that psychopathology of distress is not strongly influenced by perceived chances of running out of money or chances of getting COVID-19. Perhaps reporting of small changes in psychological distress seems to be driven by individual-specific factors and less likely to be driven by broader socio-epidemiological trends of COVID-19.

5.4. Heterogeneity by other characteristics

We further test whether reduced mobility differentially impacts individuals based on their education status, marital status, employment status, immigrant status, and household income. Appendix Table G shows the results of this test and we find no statistical evidence to show that there is heterogeneity across most of these individual characteristics. With reduced mobility, an increase in psychological distress among first-generation immigrants relative to non-immigrants.

5.5. Alternate measure for the COVID-19 incidence proportion

It is plausible that testing for COVID-19 may have varied substantially across states based on each state's approach to the pandemic. We test whether the changes in incidence proportions between two waves as controls could be biasing our results. As a sensitivity check, we include changes in COVID-19 death rates between two waves as an alternate measure of incidence proportions in our model. Appendix Table H shows the results of our analysis and we find that our original results of reduced mobility impacting higher psychological distress are consistent.

5.6. Diagnostic cut-off of distress

The psychological distress scale in the UAS includes four scale items with responses ranging from 1 to 4. The traditional diagnostic cutoffs for high psychological distress are not feasible with the scale in UAS as it has fewer scale items. We first take the sum of all responses to the four scale items. We then create a dummy variable with a diagnostic cut-off of 6 (median value of total distress score for the Wave 2 survey) or 7 (average of the total distress score for the Wave 2 survey). We then estimate the change in the psychological distress at the diagnostic cut-off dummy between two waves as the outcome variable. Appendix Table I shows the results of our analysis and we find that reduced mobility increases psychological distress across the two diagnostic cut-offs.

5.7. Test with alternate standard errors

In addition to the standard errors clustered at the state-level in the main specification, we also test our results using Huber-White robust standard errors, clustering by date of survey, and state by date of survey clustering (Appendix Table J Models 1 to 5). We find that our results are robust to these alternate standard errors.

5.8. The intensity of incidence proportions

We test whether our results are consistent across lower and higher COVID-19 incidence proportions. We first create quartiles of changes to

Table 2
Main effects on change in psychological distress.

	Model 1:	Model 2:	Model 3:	Model 4:	Model 5:	Model 6:
VARIABLES	Change in psychological distress	Change in psychological distress	Change in psychological distress	Change in psychological distress	Change in psychological distress	Change in psychological distress
Model estimation	OLS	OLS	OLS	OLS	OLS	First difference
State dummies included in model	No	No	No	No	Yes	No
Change in reduced mobility	0.00570***	0.00576***	0.00573***	0.00441**	0.00448**	0.00820***
	(0.00193)	(0.00197)	(0.00206)	(0.00191)	(0.00203)	(0.000874)
Change in COVID-19 state incidence proportion			7.38e-06	2.02e-05	0.000184	4.99e-05
			(4.41e-05)	(4.13e-05)	(0.000160)	(3.78e-05)
Change in the chance of running out of money				0.00172[a]	0.00160**	0.00131**
				(0.000627)	(0.000631)	(0.000574)
Change in the chance of getting COVID-19				0.00164**	0.00181[a]	0.00167**
				(0.000642)	(0.000666)	(0.000634)
Age		−0.00125	−0.00125	−0.00104	−0.00137	
		(0.000987)	(0.000987)	(0.00103)	(0.00106)	
Male		−0.0663**	−0.0663**	−0.0650**	−0.0649**	
		(0.0251)	(0.0251)	(0.0252)	(0.0253)	
White		0.0237	0.0237	0.0259	0.00313	
		(0.0347)	(0.0348)	(0.0337)	(0.0337)	
High school graduate		−0.157**	−0.156**	−0.160**	−0.171**	
		(0.0729)	(0.0725)	(0.0730)	(0.0751)	
Some college		−0.106*	−0.106*	−0.109*	−0.110*	
		(0.0628)	(0.0625)	(0.0627)	(0.0630)	
Bachelor's degree or more		−0.111*	−0.111*	−0.101	−0.104	
		(0.0629)	(0.0627)	(0.0625)	(0.0633)	
Married (spouse not there)		−0.209**	−0.209**	−0.201**	−0.214**	
		(0.0932)	(0.0930)	(0.0934)	(0.0972)	
Separated		−0.00116	−0.00106	−0.0101	−0.0228	
		(0.0934)	(0.0935)	(0.0938)	(0.0931)	
Divorced		−0.0916**	−0.0917**	−0.0948**	−0.0906**	
		(0.0425)	(0.0427)	(0.0413)	(0.0427)	
Widowed		0.0281	0.0280	0.0299	0.0245	
		(0.0513)	(0.0510)	(0.0517)	(0.0531)	
Never married		−0.0462	−0.0464	−0.0445	−0.0398	
		(0.0332)	(0.0328)	(0.0338)	(0.0331)	
Employed		0.0151	0.0151	0.0218	0.0229	
		(0.0258)	(0.0258)	(0.0272)	(0.0249)	
First-generation immigrant		−0.0334	−0.0335	−0.0344	−0.0496	
		(0.0354)	(0.0353)	(0.0337)	(0.0334)	
Second-generation immigrant		0.0236	0.0235	0.0267	0.0241	
		(0.0438)	(0.0439)	(0.0446)	(0.0458)	
Third-generation immigrant		0.0505	0.0502	0.0538	0.0509	
		(0.0338)	(0.0342)	(0.0348)	(0.0350)	
Unknown immigrant status		−0.0965	−0.0966	−0.102	−0.0972	
		(0.0703)	(0.0704)	(0.0714)	(0.0730)	
HH income $5 k to $7499		0.205	0.204	0.205	0.218	
		(0.146)	(0.145)	(0.143)	(0.138)	
HH income $7.5 k to $9999		0.270*	0.270*	0.254*	0.262*	
		(0.150)	(0.150)	(0.147)	(0.141)	
HH income $10 k to $12,499		0.146	0.147	0.147	0.140	
		(0.131)	(0.131)	(0.128)	(0.129)	
HH income $12.5 k to $14,499		0.316**	0.316**	0.325**	0.342**	
		(0.142)	(0.141)	(0.142)	(0.143)	
HH income $15 k to $19,999		0.155	0.155	0.168	0.187	
		(0.128)	(0.128)	(0.129)	(0.124)	
HH income $20 k to $24,999		0.255**	0.255**	0.269**	0.284**	
		(0.117)	(0.117)	(0.117)	(0.119)	
HH income $25 k to $29,999		0.190*	0.189*	0.194*	0.208*	
		(0.113)	(0.113)	(0.113)	(0.114)	
HH income $30 k to $34,999		0.167*	0.167*	0.176*	0.180*	
		(0.0951)	(0.0951)	(0.0940)	(0.0965)	
		0.0989	0.0987	0.112	0.133	

(*continued on next page*)

Table 2 (*continued*)

VARIABLES	Model 1: Change in psychological distress	Model 2: Change in psychological distress	Model 3: Change in psychological distress	Model 4: Change in psychological distress	Model 5: Change in psychological distress	Model 6: Change in psychological distress
HH income $35 k to $39,999						
		(0.113)	(0.113)	(0.114)	(0.112)	
HH income $40 k to $49,999		0.132	0.132	0.145	0.151	
		(0.109)	(0.109)	(0.107)	(0.110)	
HH income $50 k to $59,999		0.242**	0.241**	0.262**	0.280[a]	
		(0.102)	(0.102)	(0.0988)	(0.101)	
HH income $60 k to $74,999		0.221**	0.221**	0.239**	0.247**	
		(0.0974)	(0.0973)	(0.0975)	(0.0980)	
HH income $75 k to $99,999		0.216**	0.216**	0.233**	0.246**	
		(0.101)	(0.101)	(0.0998)	(0.0997)	
HH income $100 k to $149,999		0.248**	0.248**	0.262[a]	0.280[a]	
		(0.0971)	(0.0967)	(0.0949)	(0.0949)	
HH income $150 k or more		0.202**	0.201**	0.216**	0.239**	
		(0.0934)	(0.0931)	(0.0920)	(0.0928)	
Constant	0.0787**	0.0819	0.0818	0.0468	−0.143	
	(0.0334)	(0.111)	(0.111)	(0.112)	(0.110)	
Observations	5132	5132	5132	5132	5132	5132
R^2	0.004	0.025	0.025	0.034	0.058	0.064

Robust standard errors clustered by State in parenthesis. All models are weighted by survey weights.
Acronyms: OLS = Ordinary Least Squares; HH = Household.
$p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

incidence proportion changes between two waves. We then re-run our preferred specification for each of the quartiles. Appendix Table K shows the results for each quartile. We find that reduced mobility increases psychological distress for both lower or upper quartiles. One plausible explanation is that those in the states with a lower change in incidence proportion may be affected by the expectation effect of greater COVID-19 incidences and those in the higher quartile of change in incidence proportions may also be distressed.

5.9. Heterogeneity across a stay at home order status

We test whether the states that passed stay at home order at different points of time could influence the outcomes directly. Appendix Table L Model (1) shows the interaction of reduced mobility with a stay at home state dummy at the time of interview is not significant. Further, Model (2) shows the interaction of reduced mobility with the number of days since the stay at home order was effective is not significant. Therefore, we find no evidence from our analysis that the stay at home order and the timing of such order directly influenced the psychological distress.

5.10. Robustness test using the newly released wave 3 survey data

Our estimates are based on two waves, and we further test whether estimates were consistent for the very recently released wave 3 data [surveyed from April 15th' 2020 to May 12th' 2020]. In the combined sample of 5036 participants, again using interview date to match UAS data with other data, the estimates in Appendix Table M are consistent with the main results of our Hypothesis 1. Appendix N shows the heterogeneity across age, gender, and race. Though we find support for increased distress when including wave 3 data, the effects of the heterogeneity by gender were not present in the later wave. We also note that by the third wave of data collection several states had announced reopening plans that may have lowered the differences in reported psychological distress. Nevertheless, the main effect of reduced mobility on an increase in distress was consistent with that in Wave 2.

6. Discussion

In this study, we examined the relationship between reduced mobility and change in reported psychological distress between interview dates of the two waves of a nationally representative survey conducted during the early COVID-19 wave in the U.S. The following findings emerge from the study. First, in line with our first hypothesis, reduced mobility between two waves had a positive association with an increase in psychological distress, with modest effect sizes (Table 2). In a sample of 1468 individuals, McGinty et al. (2020) found that in April 2020, 13.8% (11%) of U.S. adults reported always or often felt lonely and the small difference in reported loneliness indicates that other factors may be driving psychological distress during the COVID-19. The modest effect size confirmed in our study confirms potential heterogeneity in the effects. Based on stress process theory we argued that COVID-19 would induce a significant number of stressors through reduced mobility that in turn would increase distress. We find that the effects are small but positive, a one-standard-deviation decline in mobility was associated with an increase in reported psychological distress by 3.02%. Our metric of reduced mobility, though with potential measurement errors, is a reliable metric of the general decline in mobility at the state-level and used in a variety of studies. Our modeling approach allows us to control for the time-invariant individual fixed-effects in reporting and managing psychological distress in response to COVID-19. By drawing on a national survey and controlling for a variety of demographic factors the estimates are based on a large set of U.S. residents.

Second, based on stress process theory we also argued that the effect of reduced mobility will disproportionately influence older individuals (H2), females (H3), and non-whites (H4). The results lend support for H3, but not for the remaining two hypotheses (H2 and H4) (Table 3). The findings consistent with COVID-19 studies, in general, are that females are more disproportionately distressed by the pandemic. Though widely acknowledged that older individuals and racial minorities have disproportionately been affected by COVID-19, we did not find support

Table 3
Heterogeneity by age, gender, and race.

VARIABLES	Model 1: Change in psychological distress	Model 2: Change in psychological distress	Model 3: Change in psychological distress
Interaction of reduced mobility with	Age	Male	White race
Change in reduced mobility	0.00120	0.00888***	0.00312
	(0.00674)	(0.00329)	(0.00401)
Age	−0.00210	−0.00103	−0.00105
	(0.00229)	(0.00103)	(0.00103)
Change in reduced mobility × Age	6.85e-05		
	(0.000133)		
Male	−0.0651**	0.0787	−0.0649**
	(0.0251)	(0.0791)	(0.0252)
Change in reduced mobility × Male		−0.00963**	
		(0.00452)	
White	0.0257	0.0265	0.00194
	(0.0337)	(0.0332)	(0.0866)
Change in reduced mobility × White			0.00159
			(0.00480)
Change in COVID-19 state incidence proportion	1.70e-05	3.12e-05	2.14e-05
	(4.37e-05)	(4.07e-05)	(3.98e-05)
Change in chance of running out of money	0.00172***	0.00163**	0.00172***
	(0.000631)	(0.000621)	(0.000632)
Change in chance of getting COVID-19	0.00164**	0.00165**	0.00164**
	(0.000642)	(0.000626)	(0.000640)
Constant	0.0961	−0.0192	0.0664
	(0.130)	(0.130)	(0.112)
All other controls	Included	Included	Included
Observations	5132	5132	5132
R^2	0.034	0.036	0.034

Robust standard errors clustered by State in parenthesis. All models are weighted by survey weights.
$p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

for these moderation effects. Related to additional heterogeneity tests, we find that those who are more educated or with a higher reported household income did not report a significant change in psychological distress (Appendix Table G). Overall, reduced mobility is associated with a modest increase in reported psychological distress in general and for females in particular. The findings call for more gender-informed policy-making, especially given females are more likely to follow lockdown directives and therefore may be more prone to psychological distress (Nivette et al., 2020; Sobol et al., 2020).

Third, we also explored plausible mechanisms through the mediation analysis and responses to reduced mobility that may influence psychological distress. Related to mediation effects, two sequences (i.e., [change in mobility → chance of running out of money → change in distress] and [change in reduced mobility → change in the chance of getting COVID-19 → change in psychological distress]) had small mediation effects, indicating that the mediators had trivial impacts on change in reported psychological distress (see Appendix Table F). Related to change in behaviors compensating for isolation, individuals may increase exercise or meditation, or increase the intake of alcohol, recreational drugs, and cannabis. However, we do not find support for the association of these activities on change in reported distress (see

Table 4
Effects controlling for change in behavior.

VARIABLES	Change in psychological distress	Standard error
Change in reduced mobility	0.00439**	0.00192
Change in COVID-19 state incidence proportion	2.31e-05	4.04e-05
Change in the chance of running out of money	0.00170**	0.000633
Change in the chance of getting COVID-19	0.00163**	0.000650
Change in exercise behavior	−0.00710	0.00549
Change in alcohol consumption	0.00650	0.0143
Change in Cannabis use	0.0204	0.0168
Change in recreational drug use	0.0114	0.0208
Change in Meditation	0.00548	0.00723
All controls	Included	
Constant	0.0454	0.110
Observations	5114	
R-squared	0.036	

Robust standard errors clustered by State in parenthesis. All models are weighted by survey weights.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 4). Additional analysis also shows that the timing of the stay at home order did not affect change in reported psychological distress (see Appendix Table L), however, reported psychological distress was significant for the first and fourth quartiles of COVID-19 incidence proportions in the state (see Appendix Table K).

Though effect sizes identified in the results are modest, findings highlight implications for policymakers based on evidence from the early COVID-19 wave in the U.S. Phenomenologically, distress from COVID-19 is visible, experienced, and widely discussed. In our study, we focused on the effect of reduced mobility. It seems that a decline in mobility has a smaller effect, however, this should not be interpreted as lower distress due to COVID-19 in general. In other words, though the effect of reduced mobility on psychological distress is modest, additional stressors could have a higher impact on psychological distress, and therefore, the effects of non-mobility related stressors should not be ruled out. In combination with the effects of reduced mobility and additional stressors, policymakers must provide necessary amenities and resource allocation to improve mental health during the pandemic. As the experience of psychological distress is idiosyncratic, the findings inform mental health professionals on the modest impact of reduced mobility on higher psychological distress during the early COVID-19 wave in the U.S. Duan, Bu, and Chen (2020) highlight that COVID-19 related stigma could also be distressing. Adding to their findings, it may be that efficacy of government programs to lower stigma and distress and promoting social cohesion is also conditional on sex, race, and age.

Higher psychological distress for females lends support to our earlier arguments on disproportionate household responsibilities borne by females, their greater presence in customer-facing service sector jobs coupled with higher economic vulnerability as some factors that could explain why females would be more likely to report higher psychological distress during COVID-19. Our findings inform both policymakers and workplaces on the added consideration of gender in assessing the job and home responsibilities and the mental health of female employees. At the household level, male partners in heterosexual couples could take added responsibilities to the lower burden on their female partners. Overall, higher psychological distress experienced by females could be an added consideration for policymakers, employers, and households.

6.1. Limitations

Our study is not without limitations. This study is limited by its design and provides only a limited snapshot of the COVID-19 experiences during the early COVID-19 wave in the U.S. A complex set of interactions among political, social, and healthcare factors along with unobserved individual experiences could also explain the effects. We note that causal interpretation should not be made from our findings, and inferences are only limited to the early wave of COVID-19. We note that in the latter part of 2020 the cases surged and therefore our findings may not be generalizable to the later surge in cases in the U.S. The dynamics of COVID-19 are evolving and fluid at the time of writing this article. Increasing concerns of a second-wave may also have a multiplier effect on psychological distress. Over time, attitudes about reduced mobility may likely mitigate psychological distress as individuals learn to cope with it better. As more specific data on COVID-19 become available, richer comparisons across countries and individuals over time may provide a clearer picture of individuals who adapted and coped with COVID-19 mobility restrictions. Though we use an established scale of psychological distress, we cannot rule out that it may have a different meaning and context during the pandemic. A COVID-19 specific scale of psychological distress was not used, and therefore, the psychometric validity, along with similar concerns in extant COVID-19 studies using non-COVID-19 validated scales remains.

7. Conclusions

The study provides intra-country evidence on the effect of lower mobility on a modest increase in psychological distress during the early COVID-19 wave in the U.S. Our modeling approach allows us to assess that increase in distress is related to COVID-19 related reduced mobility changes during the first wave in the U.S. The results provide early evidence of benchmark psychological distress levels and assessing the impact of change in reduced mobility on psychological distress in the U.S. population. Others have focused on behavioral traits, including personality, that influence reaction to quarantine, and the subsequent depression and anxiety outcomes (Ioannou et al., 2004). We call on future research to assess these additional drivers of psychological distress during COVID-19.

Credit author statement

Authors contributed equally.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2020.113615.

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