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Trends in psychological distress and COVID-19 incidence across 15 U.S. metropolitan statistical areas in 2020

Yan Yan Wu [a], Margaret Walkover [b], Wei Zhang [b,*]

[a] Thompson School of Social Work & Public Health, University of Hawai'i at Mānoa, Honolulu, HI, USA
[b] Department of Sociology, University of Hawai'i at Mānoa, Honolulu, HI, USA

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ABSTRACT

The United States experienced three surges of COVID-19 community infection since the World Health Organization declared the pandemic on March 11, 2020. The prevalence of psychological distress among U.S. adults increased from 11 % in 2019 to 35.9 % in April 2020 when New York City become the epicenter of the COVID-19 outbreak. Analyzing 21 waves of the Household Pulse Survey data collected between April 2020 and December 2020, this study aimed to examine the distress level in the 15 most populated metropolitan areas in the U.S. Our study found that, as the pandemic swept from East to South and soared in the West, 39.9%–52.3 % U.S. adults living in these 15 metropolitan areas reported symptoms of psychological distress. The highest distress levels were found within the Western areas including Riverside-San Bernardino-Ontario (52.3 % in July 2020, 95 % CI: 44.9%–59.6 %) and Los Angeles-Long Beach-Anaheim (49.9 % in December 2020, 95 % CI: 44.5%–55.4 %). The lowest distress level was observed in Washington-Arlington-Alexandria ranging from 29.1 % in May 2020 to 39.9 % in November 2020. COVID-19 and its complex ecology of social and economic stressors have engaged high levels of sustained psychological distress. Our findings will support the efforts of local, state and national leadership to plan interventions by addressing not only the medical, but also the economic and social conditions associated with the pandemic.

1. Introduction

The United States (U.S.) has experienced three surges of COVID-19 community infection since the World Health Organization declared the pandemic on March 11, 2020. The first wave started in New York City and within one month quickly spread to neighboring states located across the northeastern U.S. According to the National Health Interview Survey (National Center for Health Statistics, 2020), the national-level prevalence of self-reported anxiety or depressive symptoms, referred to in this study as psychological distress, was 11 % between January and June in 2019. During the first wave of the U.S. COVID-19 pandemic, psychological distress levels rose precipitously to 35.9 % in April 2020 (Centers for Disease Control and Prevention, 2020).

During 2020, the economic, political and social consequences of COVID-19, along with a violent surge of Atlantic hurricanes in the South and wild firestorms in the West, formed an ecology of stressors that precipitously increased psychological distress among most U.S. adults. The initial wave of community infections presaged the second wave in July and a third that crested exponentially in the fall of 2020. Under this "perfect storm," this study aims to describe trends of psychological distress and its relation to three waves of COVID-19 incidence and death rates at the national level and across the most populated metropolitan areas in the U.S.

Defined as a feeling of powerlessness, psychological distress is generated by the objective conditions of inequality and disadvantage (Mirowsky and Ross, 2003). Anxiety, based in real or imagined fear, and depression, anchored in sadness and hopelessness, can appear as a cognitive, emotional, or physical response. People who experience one often experience the other. This study theorizes psychological distress as emerging from the consequences of COVID-19 morbidity and mortality, which includes abrupt and sustained changes in economic and social conditions. Psychological distress is therefore framed as a product of the social environment and is assessed using the subjective self-reports of populations experiencing symptoms of anxiety or depression.

Daily COVID-19 case and death data, published by the New York Times and retrieved from Github (2020), were aggregated to produce trend lines representing community infection and mortality within the 15 largest metropolitan statistical areas (MSAs) of the U.S. Self-reported

* Corresponding author. 2424 Maile Way, Saunders Hall Room 247, Honolulu, HI, 96822, USA.
E-mail address: weizhang@hawaii.edu (W. Zhang).

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symptoms of anxiety and depression from the Household Pulse Survey (HPS) were then analyzed to document concurrent levels of psychological distress as experienced by adults in the U.S. Results will shed light on local, state, and national efforts to plan interventions by addressing not only the medical, but also the economic and social conditions associated with the pandemic.

2. Methods

2.1. Data

The Household Pulse Survey (HPS) was developed by the U.S. Census Bureau to document the social and economic impact of COVID-19. The HPS uses the Census Bureau's Master Address File to select a sample of U.S. households large enough to produce valid estimates from the 15 largest metropolitan statistical areas (MSAs). We analyzed 21 waves of the HPS data from three survey Phases: Phase 1 (12 waves of weekly data between April 23 and July 21), Phase 2 (five waves of biweekly data between August 19 and October 26), and Phase 3 (four waves of biweekly data between October 28 and December 21). The average sample size per wave for the 15 MSAs ranged from 1114 to 2718. National and county-level daily COVID-19 case and death data were retrieved from Github (uploaded by the New York Times) (Github, 2020). County-level COVID-19 data were aggregated to MSA level using standard Census Bureau geographic codes.

2.2. Measures

Psychological distress was assessed using modified versions of the National Health Interview Survey's two-item Patient Health Questionnaire (PHQ-2) and two-item Generalized Anxiety Disorder (GAD-2) (Centers for Disease Control and Prevention, 2020). The HPS decreased the timeframe used by the respondent to answer questions based on these PHQ-2 and GAD-2 measures from two weeks to 7 days. The PHQ-2 and GAD-2 measures each asked how often (not at all = 0, several days = 1, more than half the days = 2, and nearly every day = 3) respondents were bothered by problems of depression or anxiety. The PHQ-2 depression measure asked how often respondents were "having little interest or pleasure in doing things" and were "feeling down, depressed, or hopeless." The GAD-2 anxiety measure asked how often respondents experienced the problems of "feeling nervous, anxious, or on edge" and "not being able to stop or control worrying." A sum score of 3 or greater on either the depression or anxiety measure was considered having symptoms of psychological distress.

2.3. Analysis

National level estimates were retrieved from the CDC (Centers for Disease Control and Prevention, 2020). We calculated 7-day moving averages of COVID-19 daily cases and deaths per 1,000,000 populations between March 10 and December 31, 2020. Prevalence of psychological distress and the 95 % confidence intervals (CIs) in the 15 MSAs were estimated from the weighted logistic regression models using the inverse logit function. Statistical software R version 3.6.2 was used for the entire analysis with R packages "survey" and "ggplot 2".

3. Results

Fig. 1 displays national levels of psychological distress using statistics in Table 1 and COVID-19 daily cases and deaths per million populations. COVID-19 cases and death rates initially rose together. After the first wave, COVID-19 death rates stabilized in comparison to the cases. In contrast, psychological distress and COVID-19 daily cases followed similar patterns during the first two waves of the pandemic. Following a similar pattern of COVID-19 cases in the first two waves, the prevalence of psychological distress increased to 35.9 % (95 % CI: 35.0%–36.8 %) in April and then peaked at 40.9 % (95 % CI: 40.1%–41.8 %) in July, mirroring the elevation and trough pattern of COVID-19 daily cases. In December, during the third wave, the psychological distress level increased only slightly to 42.6 % (95 % CI: 41.8%–43.4 %) and then plateaued. However, COVID-19 cases per million, when compared to their peak in July, exhibited an exponential rise, doubling in November and tripling in December.

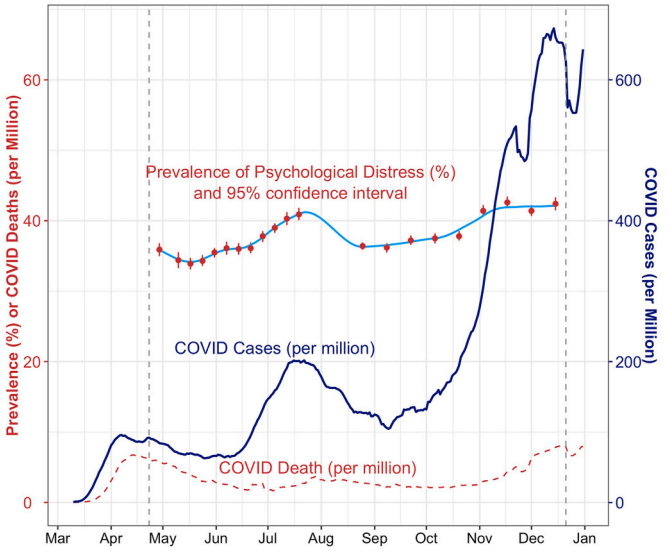

Fig. 1. Prevalence of psychological distress and 95 % confidence intervals (April–December 2020) in the U.S. and 7-day moving average of COVID-19 daily new cases and deaths per million populations (March 11 to December 31, 2020). *Notes:* Legend labels for psychological distress (%) and COVID-19 daily deaths (per million) are on the left y-axis (0–60); Legend label for COVID-19 daily new cases (per million) is on the right y-axis (0–600); Prevalence and 95 % confidence intervals are listed in Table 1.

Table 1
Prevalence of psychological distress (symptoms of depression or anxiety) in the U.S. and 95 % confidence interval during the survey periods from April 2020 to December 2020.

	Survey week	prevalence (95 % CI)
1	Apr 23 - May 5	35.9 (35.0, 36.8)
2	May 7 - May 12	34.4 (33.3, 35.5)
3	May 14 - May 19	33.9 (33.1, 34.7)
4	May 21 - May 26	34.3 (33.6, 35.1)
5	May 28 - June 2	35.5 (34.8, 36.1)
6	June 4 - June 9	36.1 (35.2, 37.0)
7	June 11 - June 16	36.0 (35.2, 36.8)
8	June 18 - June 23	36.1 (35.4, 36.9)
9	June 25 - June 30	37.8 (37.0, 38.5)
10	July 2 - July 7	39.0 (38.3, 39.6)
11	July 9 - July 14	40.3 (39.4, 41.2)
12	July 16 - July 21	40.9 (40.1, 41.8)
13	Aug 19 - Aug 31	36.4 (35.9, 36.9)
14	Sep 2 - Sep 14	36.2 (35.5, 36.8)
15	Sep 16 - Sep 28	37.2 (36.6, 37.9)
16	Sep 30 - Oct 12	37.5 (36.8, 38.2)
17	Oct 14 - Oct 26	37.8 (37.2, 38.5)
18	Oct 28 - Nov 9	41.4 (40.6, 42.2)
19	Nov 11 - Nov 23	42.6 (41.8, 43.4)
20	Nov 25 - Dec 7	41.4 (40.7, 42.2)
21	Dec 9 - Dec 21	42.4 (41.5, 43.3)

Fig. 2 visually displays trends of psychological distress in comparison to the patterns of COVID-19 new cases and deaths among the 15 MSAs. Table 2 displays the highest and lowest prevalence of psychological distress for each MSA. Among all areas, Seattle-Tacoma-Bellevue, San Francisco-Oakland-Berkeley, and Washington-Arlington-Alexandria MSAs had relatively lower COVID-19 cases throughout 2020. Whereas

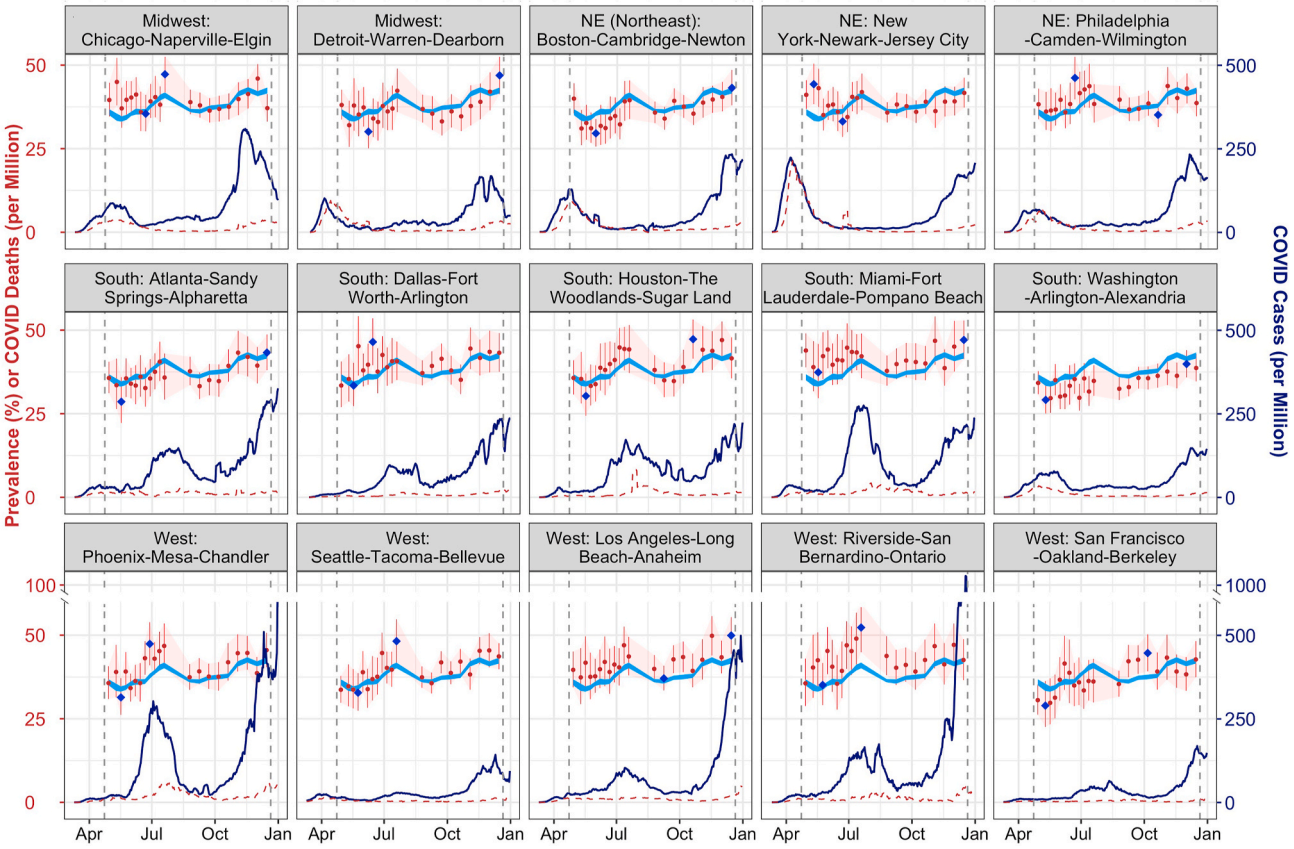

Fig. 2. Prevalence of psychological distress and 95 % confidence intervals (April–December 2020) among the largest 15 metropolitan statistical areas (MSAs) in the U.S. vs. 7-day moving average of COVID-19 daily new cases and deaths per million populations (March 11 to December 21, 2020). *Notes:* Legend labels for psychological distress (%) and COVID-19 deaths (per million) are on the left y-axis (0–100); Legend label for COVID-19 cases (per million) is on the right y-axis (0–1000); Blue rhombus points represent the highest and the lowest prevalence and the exact numbers are displayed in Table 2; The wide trend line is the 95 % confidence band of national prevalence (same as Fig. 1), in comparison to the shaded 95 % confidence intervals of the MSA distress levels. . (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the prevalence of psychological distress in Washington-Arlington-Alexandria was the lowest across all MSAs (ranging from 29.1 % to 39.9 %) and was below the national average, distress levels in Seattle-Tacoma-Bellevue and San Francisco-Oakland-Berkeley were more similar to the national average.

New York-Newark-Jersey City MSA, the COVID-19 epicenter in the first wave, experienced the highest level of distress (44.3 % in May, 95 % CI 38.3%–50.4 %) in May. In the second COVID-19 wave, Miami-Fort Lauderdale-Pompano Beach and Phoenix-Mesa-Chandler had the highest COVID-19 incidence and the trends of psychological distress were above national average. During the third wave, the new COVID-19 cases in Phoenix-Mesa-Chandler, Los Angeles-Long Beach-Anaheim, and Riverside-San Bernardino-Ontario MSAs in the West region surpassed all other areas and reached to 50–100 per million in November and December. Distress level trends for these three MSAs were all above the national average. Los Angeles-Long Beach-Anaheim MSA experienced the highest distress level in December (49.9 %, 95 % CI: 44.5%–55.4 %), and Riverside-San Bernardino-Ontario hit 52.3 % in July (95 % CI: 44.9%–59.6 %) and maintained its high level above the national average. Additionally, for South region MSAs such as Miami-Fort Lauderdale-Pompano Beach and Houston-The Woodlands-Sugar Land, their distress levels held consistently above the national average over time.

4. Discussion

As the COVID-19 pandemic swept the U.S. from East to West during the first and second waves, residents faced sickness and death, job loss, and extreme changes to their daily routines. Our findings suggest that COVID-19 prevalence and its economic and social consequences were associated with a precipitous rise in levels of psychological distress in all major MSAs of the U.S. While COVID-19 daily cases rose exponentially in the third wave, there was only a relatively small elevation in psychological distress. Interpreted as an indicator of resilience (Chen and Bonanno, 2020), this trend might be explained by research suggesting that many people facing trauma, across social economic strata, are able to access their internal capacities and cultivate external resources in ways that support capacity for adaptation and positive growth. For instance, by November 2020, government aid may have reached many sectors of the economy and medical care system to stabilize, for some social groups, access to health care services and income, and COVID-19 death rates stabilized in comparison to the rate of new cases. In addition, Moderna and Pfizer, the two leading companies in COVID-19 vaccine development, published promising vaccine efficacy data on July 14 (Jackson et al., 2020) and August 12, 2020 (Mulligan et al., 2020), and immediately enrolled 70,000 participants aged 16 or older for phase III clinical trials. Collectively speaking, COVID-19 control and relief policies, along with the development of vaccines, brought a sense of personal control to those who look into authorities for solutions. This perspective complements Mirowsky and Ross's (2003) theory of psychological distress, suggesting how loss of control, which manifests as distress, may be alleviated by objective social conditions that engender authentic experiences of mastery.

The highest peaks of psychological distress were clustered far above the national level in the South (Miami and Houston) and West (Los Angeles, Riverside, Phoenix and Seattle). During the second and third waves, patterns of elevated distress emerged concurrently with a series

Table 2
The highest and lowest levels of prevalence (prev.) of psychological distress among the 15 largest Metropolitan Statistical Areas (MSAs) during the survey periods from April 2020 to December 2020.

Region	MSA	Highest prevalence			Lowest prevalence		
		Survey week		Prev. (95% CI)	Survey week		Prev. (95% CI)
Midwest							
	Chicago-Naperville-Elgin	12	July 16 - July 21	47.2 (41.8, 52.7)	8	June 18 - June 23	35.4 (30.2, 41.1)
	Detroit-Warren-Dearborn	21	Dec 9 - Dec 21	46.9 (41.3, 52.6)	6	June 4 - June 9	30.1 (25.1, 35.6)
Northeast							
	Boston-Cambridge-Newton	21	Dec 9 - Dec 21	43.2 (38.0, 48.6)	5	May 28 - June 2	29.6 (25.6, 33.8)
	New York-Newark-Jersey City	2	May 7 - May 12	44.3 (38.3, 50.4)	8	June 18 - June 23	33.1 (28.5, 38.1)
	Philadelphia-Camden-Wilmington	8	June 18 - June 23	46.2 (39.8, 52.7)	17	Oct 14 - Oct 26	35.1 (31.5, 38.9)
South							
	Atlanta-Sandy Springs-Alpharetta	21	Dec 9 - Dec 21	43.3 (38.0, 48.7)	3	May 14 - May 19	28.6 (22.2, 35.9)
	Dallas-Fort Worth-Arlington	7	June 11 - June 16	46.5 (39.5, 53.6)	3	May 14 - May 19	33.4 (27.3, 40.2)
	Houston-The Woodlands-Sugar Land	17	Oct 14 - Oct 26	47.3 (41.5, 53.2)	3	May 14 - May 19	30.3 (24.4, 37.0)
	Miami-Fort Lauderdale-Pompano Beach	21	Dec 9 - Dec 21	47.1 (41.3, 52.9)	3	May 14 - May 19	37.4 (29.6, 45.8)
	Washington-Arlington-Alexandria	20	Nov 25 - Dec 7	39.9 (35.9, 44.0)	2	May 7 - May 12	29.1 (25.1, 33.6)
West							
	Los Angeles-Long Beach-Anaheim	21	Dec 9 - Dec 21	49.9 (44.4, 55.4)	14	Sep 2 - Sep 14	37.1 (33.5, 40.9)
	Phoenix-Mesa-Chandler	9	June 25 - June 30	47.4 (41.0, 53.9)	3	May 14 - May 19	31.4 (26.2, 37.1)
	Riverside-San Bernardino-Ontario	12	July 16 - July 21	52.3 (44.9, 59.6)	4	May 21 - May 26	35.1 (29.1, 41.6)
	San Francisco-Oakland-Berkeley	16	Sep 30 - Oct 12	44.7 (39.2, 50.3)	2	May 7 - May 12	28.9 (22.6, 36.3)
	Seattle-Tacoma-Bellevue	12	July 16 - July 21	48.2 (41.7, 54.8)	4	May 21 - May 26	32.8 (27.4, 38.7)

of highly destructive wildfires in Western areas and intense hurricanes in Southern areas (Smith, 2021). In addition to the second and the third surges of COVID-19 incidence, extreme climate events hit these areas and exposed them to additional levels of vulnerability. The synergistic impacts of physical, economic, social and environmental stressors might be expected to produce a third wave of psychological distress in the South and West regions (Brazil, 2021; Evans, 2019). State leadership using local data may be able to connect the delayed distress wave to local economic and social activity resulting not only from COVID-19 morbidity, but also from necessary public health measures implemented to "flatten the curve."

In summary, although findings from this study revealed national as well as regional patterns of psychological distress in relation to COVID-19 incidence and death rates, our study did not include analysis of disparities in these trends and patterns. Future disparity studies are essential to build the regional capacity required to mitigate the impact of complex environmental stressors on diverse social groups experiencing structural inequalities. Our study's findings, however, suggest that the conflation of biological stressors and extreme climate events offer an opportunity to prepare differently for an unpredictable future. The ecology of stressors developing during the third wave created a 'perfect storm'. This level of complex challenge is best mitigated with interventions designed to increase social capacity for stability, structural equality, innovative problem solving and flexibility (Folke, 2016; Shultz et al., 2020). As COVID-19 and climate events further intensify, our capacity to survive and adapt will depend on how national, state and local leadership respond to consistently high levels of psychological distress.

Credit author statement

Yan Yan Wu: Conceptualization, Methodology, Formal analysis, and Writing – original draft. Margaret Walkover: Conceptualization and Writing – original draft. Wei Zhang: Conceptualization, Methodology, and Writing – original draft.

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Declaration of competing interest

None.

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