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RESEARCH ARTICLE

Context, Proximity, and Individual Risk for Early-Pandemic Fear of Covid-19 Infection: A Multilevel Analysis of American Adults in March 2020

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ABSTRACT

Background: The current study explores how characteristics of individuals, their communities, and their relative exposure to nearby Covid-19 cases are associated with specific fears or perceived threat/risk of the virus itself during the early stages of the pandemic in March 2020.

Aims: Drawing from research emphasizing the intersectional relationships between individual social vulnerabilities, community characteristics, and Covid-19 outbreak locales, we test several hypotheses predicting fear.

Method: Using data from a large-scale survey of 10,368 U.S. adults from March 2020, we construct a series of hierarchical linear and logistic regression models that nest individuals within their residential counties in order to account for key socio-demographic characteristics of individuals, communities, and each respondent's geographic proximity to Covid-19 cases.

Results: Results show that individual fear and perceived risk to oneself and family is predicted by individual social vulnerabilities, the type of community in which respondents live, and the relative presence of the virus in nearby places.

Conclusion: Our findings highlight the importance of understanding fear, particularly as a possible mediator for both mental and physical health outcomes. Likewise, we emphasize ongoing efforts aimed at understanding how different groups and communities respond to fear and/or concern over Covid-19 as the pandemic remains ongoing.

INTRODUCTION

Since the first confirmed case in the United States in early January 2020, the novel coronavirus (Covid-19) has resulted in over 1 million dead and more than 95 million confirmed cases reported.[1] Consequently, the pandemic has had downstream implications for the economy and psychological wellbeing of the population. For example, cracks in supply chains for food, medicine, household goods, and personal protective equipment have strained households and businesses,[2-4] while the healthcare system has – in some cases – struggled to find bed space and provide adequate testing amidst the virus's spread.[5-7]

One consequence of the pandemic has been growing fear, uncertainty, and worry among a large proportion of the population. Indeed, warnings of an escalating mental health crisis have emerged, even as vaccinations and a return to social life have begun to unfold across the country.[8,9] Social scientists have already catalogued the devastating mental and physical health challenges facing the future of our nation, even early in the pandemic.[10-13] In turn, Covid-related fear has been shown to be associated with higher levels of depression and anxiety,[10, 14] as well as physical health outcomes like cardiovascular health ,[15] high blood pressure,[16] and self-rated health.[17]

Yet, worry and fear have not been equally shared among every social group or community.[10, 18] Building from such observations, the current study explores how characteristics of individuals, their community context, and their relative exposure to nearby Covid-19 cases are associated with specific fears or perceived threat/risk of the virus itself. Our contribution is twofold. First, in understanding the inequalities in Covid-19 fear, our analysis aids in untangling those disparities in the accompanying and/or subsequent mental and physical health problems that have already been widely observed.[10, 18-20] We build from a social and community vulnerability theoretical framework to highlight the role played by socio-demographic, behavioral, and macro-contextual characteristics that might impact individual perceptions of threat of Covid-19 .[18]

Second, the current study advances knowledge pertaining to those vulnerabilities and risks most associated with fear responses to the virus, and could also help explain downstream mitigation behaviors like mask wearing, social distancing, or vaccine acceptance.[21-24] That is, Covid-related fear is a key mechanism that impacts subsequent health-related behaviors. The degree to which some individuals and communities are more fearful or perceive threat/risk from Covid-19 may help explain the unevenness of support for public and personal health policies implemented to manage the spread of the virus itself. We outline an interdisciplinary framework to help anchor the current examination of Covid-19 fear.

A Covid-19 FEAR FRAMEWORK

A prominent social scientific literature has emerged over the last several decades exploring the relationship between vulnerability, risk, and health outcomes.[25-27] Generally, scientists find that vulnerability is not a personal deficiency but a function of the interaction between individual and community risks.[28] That is, perceived risk and fear occur more frequently among certain vulnerable populations and these varying levels of fear and anxiety as expressed in populations around the world are tied to general health and well-being outcomes.[10,18,24,29] These "social vulnerabilities," including gender, race, nativity, work status, marital status, Hispanic status, and number of children living in a household under the age of 18,[10,18,24,30] also overlap with themes in Covid-19 -specific research on personal perceived risk of infection,[31-34] whereby higher morbidity and, in general, poorer health outcomes are linked to greater concern and worry.[35-37] Moreover, general distrust and historical discrimination has led to widespread misgivings regarding public health as a means of preventing infection among some individuals, making specific populations more vulnerable to fear than others.[38-40]

Social vulnerability also includes exposure to information sources that affect fear and responses to it, including news and social media[41] that can generate fear to a greater degree for some sub-populations more than others.[42-43] Broadly, research finds a positive relationship between media exposure and fear: the more an individual consumes media (e.g., pertaining to Covid-19), the more fear they internalize.[44-49] Likewise, higher levels of individual Covid-19 fear have been linked to inconsistent or conspiratorial stories expressing heightened severity or risk during the pandemic.[50-53] Overall, media exposure remains a critical part of social vulnerability that is, in turn, linked to socio-emotional problems. For example, frequent media exposure leads to heightened levels of Covid-19 -related anxiety.[45,47,48,54,55]

Additionally, a separate literature emphasizes risk of infection and fear resulting from contextual or geographic factors. While still comparably scarce,[18] these studies reveal structural disadvantages (e.g., poverty and unemployment)

linked to higher rates of Covid-19 cases and deaths more broadly,[56] while other research finds greater diversity and minority composition are associated with higher incidence of Covid-19 cases.[57,58] At the same time, individuals living in places with more socio-economic disadvantages (e.g., poverty, unemployment, etc.) or weaker healthcare infrastructure (e.g., fewer hospital beds, lower proportion with a primary care physician, etc.) may have higher levels of fear because they perceive a greater risk of serious illness or mortality given resource shortages. Thus, the relative geographic presence of the virus and surrounding socio-economic factors of the community may play critical roles in shaping fear.[10,18,23,59,60]

RESEARCH QUESTIONS AND HYPOTHESES

Drawing from this brief review of the fear literature emphasizing the intersectional relationships between social, contextual, and geographic vulnerabilities, we pose several hypotheses. Broadly, we expect that socially vulnerable groups will report higher levels of fear than their less vulnerable counterparts. This includes the following:

H1a: Women will report higher levels of Covid-19 fear than their male counterparts.

H1b: Racial and ethnic minorities will report higher levels of Covid-19 fear than their White counterparts.

H1c: Older persons will report higher levels of Covid-19 fear than their younger counterparts.

H1d: Persons living with children will report higher levels of Covid-19 fear than those persons/families without children.

H1e: Persons who are currently unemployed will report higher levels of Covid-19 fear than persons currently employed.

H1f: Persons who report a greater concern or worry about the pandemic severity, threat, and scope in media sources will report higher levels of Covid-19 fear and worry.

H1g: Persons who communicate and talk a lot about the media coverage related to Covid-19 will report higher levels of Covid-19 fear than their counterparts who talk about and engage in less communication about Covid-19 .

Finally, we expect to find significant differences among individuals living across different contexts or types of communities. To address how place matters we pose the following hypotheses:

H2a: Persons who live in communities with greater socio-economic disadvantage will report higher levels of Covid-19 fear compared to those persons who do not live in socioeconomically disadvantaged communities.

H2b: Persons who live in communities with greater racial and ethnic diversity will report higher levels of Covid-19 fear compared to those persons living in communities that are more racially and ethnically homogenous.

H2c: Persons living in communities with weaker healthcare infrastructure will have greater levels of fear than those living in places with stronger healthcare infrastructure.

Finally, regarding geographic vulnerability, we propose:

H3a: Persons living in communities where neighboring counties have higher Covid-19 death rates will report higher levels of Covid-19 fear compared to those persons living in communities where neighboring counties have lower Covid-19 death rates.

DATA AND METHODS

Data Sources and Sample

The current study draws from four sources of data. First, we use a large-scale survey of United States adults from March of 2020 that documented variation in Covid-19 fear across geographic boundaries and social/demographic groups. The online survey was released very early during the pandemic (March 23, 2020) through Qualtrics Inc. to a national panel of U.S. residents who participated in the institutional review board–approved survey. Questions assessed general fear, worry, and anxiety related to Covid-19 and social

and behavioral health changes, as well as physical and mental health assessments. The final sample of 10,368 adults was post-stratification-weighted by gender, age, race, income, and geography (state) to ensure the equitable contribution of respondents across their demographic and geographic strata relative to their representation in the overall population of the United States (for more details on the sample,[10,18]).

Second, we draw information on the socio-structural characteristics of the communities in which respondents live using the United States Census Bureau's 5-year (2014-2018) American Community Survey summary files. We use this data to calculate coronavirus case rates as described below, as well as to measure important community-level factors that might drive fear. Third, we capture county-level healthcare system vulnerability from the Surgo Ventures Covid Community Vulnerability Index (CCVI),[61] which allows us to assess the degree to which individual fear and perceived threat of Covid-19 differs across respondents living in locales with weaker healthcare infrastructure. Finally, fourth, we use the John Hopkins University coronavirus dashboard that identifies the number of confirmed cases and deaths by geography (county) in the United States each day.[1]

All data are paired using federal information processing standards (FIPS) codes for each state and county. Survey respondents reported their residential zip code. The zip code was used with the U.S. Department of Housing and Urban Development crosswalk file to assignment zip codes to counties.[62] To reduce instability in our estimates, we restrict our sample to only include those individuals and counties in which there are 10 or more respondents in a county. The final sample includes 6,781 United States adults nested within 201 counties.

Dependent Variables: Fear and Perceived Risk

We focus on two key dependent variables tapping into fear or perceived threat from the novel coronavirus. The first is a subjective assessment of *overall fear of Covid-19* . While there are several strategies used to assess generalized fear and anxiety in individuals,[63,64] we follow several prior studies that utilize single items by asking respondents to numerically rank on a sliding scale from zero (not at all fearful) to ten (very fearful): "How would you currently rate your fear of Covid-19 ?" Second, we also focus on the subjective assessment of *perceived Covid-19 risk to oneself and family* using responses from one (very low threat) to five (very high threat) to the question: "What level of threat do you think the coronavirus (Covid-19) poses to you or your family?" Responses of "high" or "very high" perceived threat were coded as indicating risk to one's family or oneself while all other responses were coded as not high threat (dummy variable). Recall, these measurements are taken early in the pandemic in mid-to-late March of 2020.

Social Vulnerability Variables

To address hypotheses 1a through 1f, we include the following individual characteristics as impacting fear: a dummy variable for *female*; measures for whether a respondent is non-Hispanic *Black*, *Hispanic*, non-Hispanic *Asian*, and non-Hispanic *Other* race (non-Hispanic White serves as the reference); a dummy variable for whether respondents had *children present* in their house at the time of response; political dummy variables for *Independent* and *Republican* (Democrat as reference); each respondent's *age* in years; and whether a respondent was *unemployed* at the time of the survey.

Uniquely, we also include two additional scales that capture media exposure that may impact fear. First, we include a *media concern* index that reflects respondents' answers to a prompt asking them to indicate from 1 (strongly disagree) to 5 (strongly agree) whether the news and information they have received from television, newspaper, and Internet reflect concern about (a) the threat of an epidemic, (b) the spread of the virus, and (c) the severity of an epidemic. Responses for these three measures are summed with the final scores ranging from 3 to 15 (Cronbach's alpha = 0.94). Importantly, bivariate correlations reveal that this media concern scale is moderately correlated with the overall fear and family risk outcomes (Pearson's r = 0.58 and 0.41, respectively) and, therefore, this taps into a unique dimension of media exposure separate from fear and threat more generally. Additionally, we include a Covid-19 *communication scale* that includes four variables measuring whether a respondent communicated with friends, family, peers, and co-workers, respectively, about Covid-19 for the month preceding the study period. Responses for each item ranged from 1 (not at all) and 5 (very often) for all groups, which were then summed to create a *personal communication scale* (Cronbach's alpha = 0.80).

Contextual Vulnerability Variables

Individuals are nested within their residential counties, and we control for important contextual vulnerabilities that might impact perceived fear of Covid-19 or impact other

predictors related to that fear/concern. Specifically, we include: a measure of each county's overall *health infrastructure vulnerability* (e.g., available ICU and hospital beds, epidemiologists, health spending per capita, proportion of the population with a primary care physician, etc.) drawn from the Surgo database[61]; a measure of overall racial/ethnic *diversity* of the county using a multi-group entropy score[65]; and a principal component index of *disadvantage* that combines the percentage of the population unemployed, in poverty, households with females only and children present, and without a high school degree.

Geographic Vulnerability Variables

To account for fear as a function of Covid-19 case proximity, we also included a variable for the confirmed neighboring county cases per 100,000 that measures the presence of coronavirus in each respondent's own county of residence and all surrounding counties. Queen's 1st order contiguity was used to identify immediate neighboring counties that share a common edge or a common vertex. These were drawn from the John Hopkins University dashboard.[1] All coding was done in ArcGIS™ Pro 2.6 and GeoDa.[66, 71]

Analytic Strategy

We begin our analysis by, first, describing the overall presence of fear or concern toward Covid-19 to one's family, as well as the demographic distribution of our sample. Second, we construct a series of mixed effects linear (for overall fear) and logistic (for family risk) regression models that nest individuals within their residential counties. Because respondents living within the same spaces share underlying similarities, residual errors are likely to be correlated within counties in our sample, violating the assumption of independence necessary for ordinary least squares models and producing mis-specified standard errors. To account for this, we employ mixed effects models that nest respondents within counties, adjust the degrees of freedom to correctly represent the number of counties in our analysis used for conducting statistical tests, and allow us to estimate the unique and independent relationship between social, contextual, and geographic vulnerabilities and Covid-related fear.[67,68] All covariates are grand-mean centered in order to provide a meaningful interpretation of the model constant and are estimated in Stata 15 using the *mixed* command.[69]

RESULTS

Table 1 displays the weighted descriptive statistics for our sample of 6,781 individuals and the 201 residential counties in which they live. Key findings are, first, that overall fear in mid-to-late March was moderate to high in our sample. The mean was 6.63 out of 10 with nearly 30 percent of the sample selecting 8 or above (not shown). Similarly, 45 percent of the sample indicated that they perceived a "high" or "very high" risk of coronavirus to themselves or their families at the time of response.

Table 1. Descriptive Statistics

	Mean	*Proportion*	*Std. Error*
Dependent Variables (n = 6,781):			
Overall Fear (zero – 10)	6.63	-	.05
Family Risk (dummy)	-	.45	.01
Individual-Level Independent Variables (n = 6,781):			
Female	-	.50	.02
White	-	.54	.02
Black	-	.13	.01
Hispanic	-	.21	.02
Asian	-	.07	.01
Other race	-	.03	.01
Children present	-	.26	.01
Democrat	-	.37	.01
Independent	-	.34	.01
Republican	-	.29	.01
Age	46.65	-	.67
Unemployed	-	.20	.01
Media Concern (scale	12.47	-	.05
Concern Threat [a]	4.12	-	.02
Concern Spread [a]	4.19	-	.01

Concern Severity [a]	4.17	-	.01
COVID Comm. (scale)	13.83	-	.09
CV-19 Comm. – Friends [b]	3.60	-	.02
CV-19 Comm. – Peers [b]	3.34	-	.02
CV-19 Comm. – Co-workers [b]	2.77	-	.03
CV-19 Comm. – Family [b]	3.96	-	.02
Socio-Structural Characteristics (n = 201 counties):			
Health Infrastructure Vulnerability	.40	-	.26
Racial Diversity	.64	-	.16
% Poverty [c]	11.91	-	4.21
% Unemployed [c]	5.73	-	1.44
% Female Headed Households [c]	12.56	-	3.14
% w/o High School Degree [c]	10.61	-	3.98
Spatial Characteristics (n = 201 counties):			
CV-19 Neighbor Case Rate [d]	385.61	-	325.34

Note: All means, proportions, and standard errors reported after employing *svy: mean* to adjust for post-stratification weights in Stata 15. To avoid skewed values, all socio-structural and spatial descriptive statistics are estimated from an aggregated database that includes only one of each county.
a Items are combined into Media Concern scale by summing responses (Cronbach's alpha = .94).
b Items are summed to create COVID Comm. scale (Cronbach's alpha = .80).
c Items are combined together using principal component analysis (eigenvalue = 2.94, shared variance = .74).
d Reflects average rate across all contiguous neighboring counties.

Second, we note that our sample is equally balanced between males and females but slightly more diverse than the population of the United States with 54 percent of the sample identifying as non-Hispanic White, 13 percent as non-Hispanic Black, and 21 percent as Hispanic. Twenty-six percent indicated a child under the age of 18 was present in the home, 20 percent were unemployed, and the average weighted age was 46.6 years. Political identification was distributed roughly equally across the three categories with only a slightly higher share of respondents (37%) identifying as Democrat than independent (34%) or Republican (29%). On average, respondents also indicated that media conveyed relatively high levels of concern for the threat, severity, and spread of Covid-19 in mid-to-late March with an average scale score of 12.47 out of 15, though nearly 20 percent of the sample indicated media showed moderate to low levels of concern overall (i.e., scale score of 8 or less out of 15). In much the same manner, the frequency of communication about coronavirus to friends, family, coworkers, and peers was high with an average of 13.83 out of 20.

Turning to the contextual vulnerabilities, most counties report moderate levels of healthcare infrastructure vulnerability (.40 out of 1.0) with moderate-to-high levels of racial and ethnic diversity (.64 out of 1.0). The typical county has about 12 percent of the population in poverty, almost 6 percent unemployed, over 12 percent of families headed by a female with children present, and almost 11 percent of the population without a high school degree. The average confirmed Covid-19 case rate at the time of survey was 385.61 cases per 100,000 residents (recall, this reflects a period early in the pandemic during March of 2020).

Next, we construct a series of multi-variable, mixed effects models to predict our key fear outcomes as a function of both individual and contextual/spatial characteristics. Table 2 displays the results for the mixed effects linear models predicting overall fear, while Table 3 does the same using mixed effects logistic models to predict perceived risk to oneself or family. For each table, model 1 includes only social vulnerabilities (level 1), model 2 adds contextual vulnerabilities as predictors (level 2), and model 3 includes the geographic vulnerability reflected by the average neighboring Covid-19 case rate (level 2).

Table 2 shows that *overall fear is related to individual social, contextual, and geographic vulnerabilities*. For instance, model 1 reveals that Hispanic and Asian respondents have higher levels of fear than White respondents, while respondents with children present in the household, unemployed persons, those reporting greater media concern toward the virus, and persons who communicate more regularly with those in their social groups also report higher scores ($p < 0.05$), other factors held constant. In contrast and net of other key individual

level factors, those persons who identify as politically Independent or Republican show lower levels of overall fear than Democrats. These associations do not dissipate with the inclusion of county-level predictors, though we find that respondents living in counties with weaker healthcare infrastructures show higher levels of fear, net of other factors. Finally, model 3 shows that respondents living in counties with higher nearby case rates report higher levels of fear.

Table 2. Hierarchical Linear Regression Models Predicting Overall Fear of Covid-19 , March 2020

	Model 1		*Model 2*		*Model 3*	
	b	SE	b	SE	b	SE
Individual Characteristics:						
Female	.03	(.05)	.04	(.05)	.03	(.05)
Black	-.14	(.10)	-.14	(.10)	-.14	(.10)
Hispanic	.31**	(.10)	.30**	(.10)	.31**	(.10)
Asian	.42***	(.11)	.42***	(.12)	.44***	(.12)
Other race	-.14	(.23)	-.13	(.23)	-.08	(.24)
Children present	.39***	(.07)	.39***	(.07)	.39***	(.07)
Independent	-.34***	(.07)	-.33***	(.07)	-.33***	(.07)
Republican	-.32***	(.07)	-.32***	(.07)	-.32***	(.07)
Age	.01	(.01)	-.01	(.01)	.01	(.01)
Unemployed	.21**	(.08)	.20**	(.08)	.21**	(.08)
Media Concern	.58***	(.01)	.60***	(.01)	.58***	(.01)
COVID Comm.	.09***	(.01)	.09***	(.01)	.09***	(.01)
Socio-Structural Characteristics (County-Level):						
Health Inf. Vuln.	-	-	.34**	(.11)	.32**	(.11)
Racial Diversity	-	-	-.05	(.20)	.06	(.20)
Disadvantage	-	-	.01	(.02)	-.01	(.02)
Spatial Characteristics (County-Level):						
CV-19 Neighbor	-	-	-	-	.01**	(<.01)
Constant	6.63***	(.03)	6.65***	(.03)	6.63***	(.03)
n (individuals)	6,781		6,781		6,781	
n (counties)	201		201		201	
Wald	3940.45***		3949.67***		3946.87***	

Note: All variables are grand-mean centered. Models include only those individuals living in counties where there are at least 10 individuals responding. All likelihood-ratio tests indicate multi-level models are preferrable to standard linear regression models in all instances ($p<.05$).

Table 3 shows very similar results for the predictors of risk to oneself or family with regards to overall fear, though there are a few notable exceptions. Note that odds ratios are displayed for ease of interpretation, with those below 1.0 indicating a decline in the odds, and odds ratios greater than 1.0 indicating an increase in odds. Model 1 reveals that Hispanics are more likely to report a high or very high risk of coronavirus to themselves or families than Whites ($p < 0.01$), but Asians are no longer statistically more likely than Whites. Meanwhile, Black respondents and females are less likely to perceive the virus as a threat to their family ($p < 0.05$). As was the case with Table 2, having children present in the household, individuals reporting greater media concern for the virus, and greater communication about the virus is associated with elevated odds of perceived personal and family risk, while individuals who are older and politically Independent or Republican are less likely to see the virus as a threat.

Table 3. Hierarchical Logistic Regression Models Predicting Perceived Covid-19 Risk to Family, March 2020

	Model 1		*Model 2*		*Model 3*	
	OR	SE	OR	SE	OR	SE
Individual Characteristics:						
Female	.88*	(.05)	.88*	(.05)	.88*	(.05)
Black	.72**	(.08)	.72**	(.08)	.72**	(.08)
Hispanic	1.37**	(.15)	1.37**	(.15)	1.38**	(.15)
Asian	1.01	(.12)	1.05	(.13)	1.05	(.13)
Other race	.86	(.23)	.88	(.24)	.90	(.5)
Children present	1.56***	(.12)	1.56***	(.12)	1.56***	(.12)
Independent	.81**	(.06)	.81**	(.06)	.81**	(.06)
Republican	.78***	(.05)	.77***	(.05)	.77***	(.05)
Age	.99**	(<.01)	.99**	(<.01)	.99**	(<.01)
Unemployed	1.13	(.09)	1.12	(.09)	1.12	(.09)
Media Concern	1.61***	(.03)	1.61***	(.03)	1.61***	(.03)
COVID Comm.	1.08***	(.01)	1.08***	(.01)	1.08***	(.01)
Community Characteristics (County-Level):						
Health Inf. Vuln.	-	-	1.20	(.15)	1.20	(.15)
Racial Diversity	-	-	.65*	(.15)	.67	(.15)
Disadvantage	-	-	1.03	(.02)	1.03	(.02)
Spatial Characteristics (County-Level):						
CV-19 Neighbor	-	-	-	-	1.01*	(<.01)
Constant	.63***	(.02)	.66***	(.02)	.65***	(.02)
n (individuals)	6,781		6,781		6,781	
n (counties)	201		201		201	
Wald	1151.49		1156.33		1159.93	

Note: All variables are grand-mean centered. Models include only those individuals living in counties where there are at least 10 individuals responding. All likelihood-ratio tests indicate multi-level models are preferrable to standard logistic regression models in all instances ($p<.05$).

For model 2, we find that greater racial and ethnic diversity in a county is associated with a decline in the odds of seeing Covid-19 as a risk to oneself and family. Respondents from more homogenous communities appear to see Covid-19 as a greater risk than those from more heterogeneous ones. Finally, model 3 indicates that respondents with higher rates of confirmed virus cases in neighboring counties report higher levels of perceived risk ($p < 0.05$), net of other covariates.

DISCUSSION

The current study examined how fear is conceptualized in the context of a global pandemic, and the underlying mechanisms that may exacerbate this socio-emotional response. While positioning this work within the general fear response literature, there are several key contributions worth highlighting along with how this study has both scholarly and practical implications. Clearly, social vulnerabilities are an important set of markers for how we come to understand how certain individuals respond to the threat and worry of a global pandemic. Like many of those same persons who are at risk because of chronic health conditions, limited access to quality health care, those with poor living and work conditions, minorities, the unemployed, persons with children, females, and the elderly have a heightened sense of fear and worry. This puts them at heightened risk for negative socio-emotional consequences tied to their Covid-19 fear response. Though not shown in the analysis above, most of the variation in fear (just over 90 percent) that appears in our data results from disparities across individuals as compared to across residential counties.

Beyond these social vulnerabilities, we find that place matters, too. This is a key dimension to understanding fear during the pandemic, even if only a small part of the variation in fear is attributable to it (in our data, just under 10 percent of our outcomes). As we show in the current analysis,

the surrounding context in which individuals live has an important role in shaping perceived threat and fear, as does the geographic vulnerability for each person. For example, we found that healthcare vulnerability was inversely associated with overall fear of Covid-19 such that individuals living in counties with fewer available ICU and hospital beds, fewer epidemiologists, lower health spending per capita, a greater proportion of the population without a primary care physician, and other health-related resources reported greater fear than those in more robust healthcare environments. Likewise, those persons living in counties with more cases in surrounding counties were more likely to express fear or concern. To the best of our knowledge, the current study remains among the few to empirically demonstrate this link.

Positioning Key Findings

Several findings from the current study are new, while others fit into a pattern well-established in existing literatures. For example, confirming prior literature examining the influence of vulnerabilities on level of Covid-19 fear, we showed that social vulnerability mattered greatly: race (Hispanic and Asian), the presence of children in the household, and employment status increased one's level of Covid-19 fear.[10,18,30,33] Additionally, media consumption and communication impacted levels of perceived threat and fear such that more time spent consuming media was associated with higher levels of Covid-19 fear.[45,47,48,54,55] Aligning with prior work, the current study also indicated that individuals who communicate more regularly about Covid-19 with those in their social groups report higher levels of Covid-19 fear.[44-46]

In addition, we advanced prior literature by examining the relationship between community characteristics and fear. In support of our hypotheses, the current study found individuals living in counties with weaker healthcare infrastructure (e.g., fewer hospital beds, lower proportion with a primary care physician, etc.) show higher levels of Covid-19 fear. In contrast to expectation, the current study indicated that communities with greater racial and ethnic diversity experienced less Covid-19 fear, whereas respondents from more homogenous communities appear to experience greater perceived threat or fear. This could be explained by theoretical frameworks emphasizing the role played by "contact" and increasing diversity that reduces stereotypes and inter-group conflict.[70] Finally, our results built upon those established by Fitzpatrick et al.[18] in demonstrating a relationship between geographic vulnerability via case proximity and fear. Covid-19 fear was not equally distributed across place, whereby respondents living in counties with higher nearby case rates reported higher levels of fears.

Our findings have important practical implications, including the need for policymakers and public health officials to account for the uneven distribution of fear during public health crises for both prevention efforts and responding to fear-related social behaviors. On the one hand, attempts to leverage concern, worry, and fear for mitigation (e.g., vaccination, personal protective behaviors) will likely be unequally distributed, as well, such that public health officials should target those populations and communities with lower levels of fear to control viral spread since such communities may not take precautions on their own without greater levels of concern. On the other hand, policymakers are likely to find that fear-related outcomes, like panic buying, hoarding, or the deterioration of mental health, plague some places and individuals more than others. As such, coordinated responses to fear may require accounting more comprehensively for such disparities by adjusting the provision of limited resources (e.g., mental health services, supply chains).

Conclusions

Since the start of the coronavirus pandemic in the United States, social life has changed – where we work, how we shop, the distance we can stand from others. Often more subtle, the socio-emotional changes are equally important, including how we view our risk of infection or threat from the virus itself. Fear of the virus and its consequences has important implications for physical and mental health. Our study marks the start of the important work remaining to be done to fully understand how different groups and communities are impacted by fear of not only Covid-19 , but its variants and a vaccine distribution process that may in fact be exacerbating disparities across both individuals and places.

Study Limitations

Our findings are important and add to a growing literature describing the relationships between social, contextual, and geographic vulnerabilities and fear or perceived threat during the Covid-19 pandemic. Despite making important contributions, we note several important limitations to consider in the context of interpreting and generalizing this work. First, this study is cross-sectional and, as such, prevents us from utilizing causal models with longitudinal data to describe

how changes in our explanatory variables are related to Covid-19 fear over time. Because of additional years of exposure to health risk and media coverage, fear and worry is likely to mean something very different today than our analysis of the early pandemic reveals. As just one example, deaths in the United States have continued to increase and touched nearly every community in the country, which may mean that geographic vulnerabilities behave differently today than they did several years ago. Nevertheless, we note that our study's focus on the early stages of the United States pandemic provides a novel data collection period for which to study disparities in fear across individuals and their communities.

As a second limitation, there are alternative approaches that could have been used to measure fear and worry. Some of the measures employed here lack breadth and/or depth because the survey used to collect them was designed to get into the field as quickly as possible during the early stages of the U.S. Covid-19 pandemic. Fuller measurement of fear and perceived threat could prove fruitful. Finally, third, online surveys may be biased in their selection and/or systematically eliminate respondents with limited access to smart technology hardware and/or Internet connectivity. Thus, the data used here may over-represent computer users living in urban areas and underrepresent low-income or rural residents.

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