

**The Association of COVID-19 Risk Perception, County Death Rates, and Voluntary Health Behaviors
among U.S. Adult Population**

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Summary: Our finding that American adults voluntarily spent more time at home in response to increased risk perception may inform future public health communication campaigns to improve voluntary uptake of preventive behaviors.

Abstract

The COVID-19 pandemic continues to adversely impact the United States (U.S.) socially, culturally, and economically. The purpose of this study was to understand the relationship between COVID-19 county death rates, risk perception, and U.S. adults' voluntary behaviors—particularly physical distancing. Data were collected from CloudResearch/Qualtrics, Johns Hopkins University, the American Community Survey, and SafeGraph. Our results indicated that higher COVID-19 county death rates were associated with higher risk perceptions, leading to greater time spent at home. These findings will help public health officials identify strategies that best encourage voluntary health behaviors to help curb the spread of COVID-19.

Keywords: COVID-19; risk perception; death rate; time spent at home

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Background

Exposure to the coronavirus disease 2019 (COVID-19) infections and deaths may increase an individual's risk perception [1]. In the United States (U.S.), there are more than 16.3 million confirmed cases (5% of U.S. population) and 300,000 confirmed deaths [2]. However, the variation of COVID-19 death rates in different regions of the U.S. [2] may strongly influence Americans' COVID-19 risk perception [1]. Risk perception may alter health behaviors as individuals normally make health decisions by comparing risk of consequences with benefits of action [3]. Emerging COVID-19 studies [4, 5] and substantial research on Americans' response to previous pandemics, such as the 2009 H1N1 pandemic influenza [6], suggest that individual voluntary behavioral shifts, particularly physical distancing, impact the trajectory of a disease outbreak. As the COVID-19 pandemic continues to evolve, the purpose of our study is to understand how Americans adults' COVID-19 risk perception is associated with their counties' COVID-19 death rates and whether their level of risk perception is associated with the amount of time they spend at home. Public health authorities and officials must continue to learn more about the factors that influence COVID-19 risk perception and lead to voluntary public health behaviors to better inform COVID-19 messaging and communication interventions.

Methods

Data Collection

Survey data were collected on May 7th, 2020 as described by Malik et al (2020) [7]. In brief, basic demographic and geographic information, as well as COVID-19 risk perception data were collected using an electronic questionnaire via Qualtrics®/CloudResearch, which is an online survey platform that allows for representative surveying of the U.S. general population based on age, gender, education, and race/ethnicity. [7]. Participants completed a COVID-19 risk perception scale (Cronbach's $\alpha = 0.72$; S Table 1), which had 10 survey-items (5-point Likert Scale: 0 = strongly disagree/disagree/neutral; 1 = agree/strongly agree). The scoring of the perceived risk perception

scale, which ranges from 0 to 10, was calculated by summing the participants' responses of "Agree" and "Strongly Agree" to 10 survey-items. The greater the number a participant receives on this scale, the greater their perceived risk of COVID-19. Additional risk perception scale details and calculation are described elsewhere [7]. Deaths related to COVID-19 by county were available for download from the Johns Hopkins University dashboard data [2]. Finally, time spent at home data, available from SafeGraph, were based on cellular phone location data aggregated at the county level [8]. We averaged three weeks (May 8 - May 31, 2020) of the daily median time (in minutes) spent at home. Data on stay-at-home orders were obtained from faculty members at Boston University [9].

Statistical Analysis

We used multi-variable regression models to test our two-part hypothesis: a) living in areas with higher rates of COVID-19 deaths is associated with higher risk perception and b) higher risk perception is associated with changing health behaviors, specifically spending more time at home. Both models accounted for clustering by counties. First, we used a multi-variable linear regression to test the association between COVID-19 deaths and risk perception. To account for the variability in reporting of COVID-19 deaths, we calculated death per hundred thousand as a function of population estimates, taken from the 2018 American Community Survey (ACS) data, and then created a trichotomized variable dividing the death rates equally among low, moderate, and high categories. We controlled for gender, age, race, ethnicity, education, and reported chronic illness. Second, we used a multi-variable ordinal logistic regression to test the association between risk perception and median time spent at home, which is suggestive of people's physical distancing habits. The average for the median time spent at home from May 8th to May 31st was used in the analysis to account for the day-to-day fluctuations of people staying at home. Additionally, to account for variability, given the small sample size, our variable for median time spent at home was also trichotomized. As sensitivity analysis, we used a linear regression model to test the association

between median time spent at home and risk perception. Data were analyzed using Stata Version 16 (StataCorp, College Station, Texas) and SAS/STAT[®] software.

Ethical Approval

Yale University Institutional Review Board approved the survey from which the data were obtained (IRB protocol number: 2000027891). Participants provided informed consent prior to data collection.

Results

Demographics

A total of 672 participants (response rate: 72%) completed the survey with 386 (57%) females, 256 (38%) who were 55 years old or over, 436 (65%) identified as non-Hispanic white, 351 (52%) had a college or graduate degree, 510 (76%) did not have a chronic illness, and 314 (47%) were employed (S Table 2). Median participant per county representation was 1 (IQR: 1-2), while median participant per state representation was 6 (IQR: 4-21). 347 counties, 46 states, and Washington D.C. were represented in our sample.

County Death Rate and Risk Perception

County death rates (per 100,000; range: 0 – 1250 deaths; median: 8.4 deaths) were divided into three categories (low: ≤ 5 deaths, $n = 220$; moderate: 6 – 17 deaths, $n = 218$; and high: > 17 deaths, $n = 214$). After adjusting for gender, age, education, race/ethnicity, and chronic illness, a linear regression analysis of risk perception (range: 0 – 10; median = 6) showed that in a county with high death rates, individuals had 0.45 (95% CI: 0.06 – 0.85, $p = 0.02$; Table 1) points higher risk perception, on average, compared to individuals living in a county with low death rates. This 0.45-point increase translates to a 4.5% increase in risk perception on a 10-point scale. There was no difference in the overall risk perception in counties with moderate and low death rates.

Time Spent at Home and Risk Perception

Time spent at home data (in minutes; range: 413 – 1071 minutes; median: 793 minutes) were divided into three categories (low: 351 – 709 minutes, n = 223; moderate: 710 – 815 minutes, n = 224; and high: 816 - 1043 minutes, n = 222). After adjusting for gender, age, employment status, stay-at-home order status, work in healthcare, and chronic illness, an ordinal logistic regression analysis showed that an increase in risk perception (OR: 1.12, 95% CI: 1.04 – 1.20, $p < 0.01$; Table 2) was associated with an increase in the odds of spending more time at home. The proportional odds assumption was tested and met ($p < 0.01$). On sensitivity analysis using a linear model, we found that a unit increase in risk perception resulted in additional 7.6 minutes being spent at home after controlling for gender, age, employment status, stay-at-home order status, work in healthcare, and chronic illness (S Table 3).

Discussion

The purpose of this study was to determine if COVID-19 county death rates are associated with people's risk perception, which in turn is linked to the amount of time spent at home. After controlling for stay-at-home orders, we found that a higher risk perception was associated with spending more time at home—emphasizing that a portion of this behavior is voluntary. Additionally, adults living in counties with high death rates reported a higher risk perception compared to those living in counties with low death rates. To increase voluntary infection prevention behaviors and reduce the spread of the virus, public health authorities should learn how an increase in COVID-19 risk perception may contribute to voluntary behaviors [3, 10]. This understanding may then improve message-framing to encourage safe health preventive behaviors among U.S. adults.

Given the importance of and people's willingness to adhere to stay-at-home orders, health officials must create public health messaging that pairs risk perception with self-efficacy (e.g., believing that spending more time at home can be achieved) and response efficacy (e.g., believing spending more time at home can reduce the spread of COVID-19) leading to enhanced voluntary

behavior [5, 11]. Because several states have lifted their stay-at-home orders, there is a need to craft effective COVID-19 messaging that aims at encouraging all Americans to continue practicing physical distancing, frequent handwashing, and wearing face coverings [12].

Some populations, such as those living in multigenerational households, are more likely to have extended social networks, which increases their risk of contracting COVID-19. Therefore, it must be cautioned that any benefit from the decreased risk related to staying home may have its limitations. Additionally, other groups, particularly essential workers, must continue to work despite their possible perception of risk. Therefore, for both of these populations, preventive health behaviors extend beyond social distancing and include mask-wearing and vaccinating when recommended.

Health care facilities and other essential businesses must also continue to enforce mitigation policies—cleaning and disinfecting, symptom screening, and contact tracing protocols—to prevent and slow the spread of SARS-CoV-2 within the workplace.

Large scale support, in terms of resources and easily digestible public health guidelines, is important to increase risk perception and decrease the actual risk from the virus. The distribution of resources must be equitable so that positive outcomes will be felt among all populations, and not just those who have the capacity to act upon behavioral interventions.

The timeliness of this study is crucial as this was one of the earliest studies that evaluates the association of COVID-19 risk perception with county death rates, stay-at-home orders, and time spent at home. Our study, with a relatively high survey response rate (72%), was representative of the country's adult population based on age, gender, education, and race/ethnicity using the 2018 American Community Survey data from the U.S. Census Bureau. With the exception of Alaska, Delaware, Montana, and Nebraska, there was geographical representation from all other states. However, there are a few limitations that should be considered as well. While our study may be geographically represented, it must be noted that 68% of our sample was from high-risk counties, which may be a source of bias in our findings. Additionally, the survey was conducted in English

language only and was distributed on an online platform. Therefore, the generalizability of our findings for non-English speakers and those who may not have easy access to technology may have its limitations. There is also a stark difference between our sample demographics and those who have died from COVID-19 [13]. Additionally, time spent at home data was at the county level while risk perception data was based on each participant—recognizing the group to individual data limitation. Another limitation is the use of death rates, as opposed to infection rates (cases), which may bias our results given that the survey was conducted at a time when deaths due to COVID-19 were decreasing [2].

Although, voluntary health behaviors (e.g., physical distancing and wearing face coverings) to help prevent the spread of COVID-19 are well-known, they are not uniformly implemented [14]. Our finding that American adults voluntarily spent more time at home in response to increased risk perception may inform future public health communication campaigns to improve voluntary uptake of preventive behaviors.

Table 1: Multi-variable Regression Model of Death Rates and Risk Perception

Variables	Unadjusted Model			Adjusted Model		
	Estimate	p-value	95% CI	Estimate	p-value	95% CI
<i>Outcome: Risk Perception</i>						
Deaths (per 100,000)						
Low				<i>Ref</i>		
Moderate	0.09	0.67	(-0.34) - 0.52	0.08	0.67	(-0.31) - 0.48
High	0.40	0.05	(-0.01) - 0.81	0.45	0.02	0.06 - 0.85
Age (years)						
18-25				<i>Ref</i>		
26-35	0.09	0.78	(-0.56) - 0.75	-0.10	0.79	(-0.81) - 0.61
36-45	0.60	0.06	(-0.03) - 1.23	0.33	0.35	(-0.36) - 1.03
46-55	0.05	0.89	(-0.65) - 0.75	-0.25	0.50	(-0.99) - 0.49
55+	0.88	< 0.01	0.29 - 1.47	0.60	0.08	(-0.07) - 1.27
Race						
White				<i>Ref</i>		
Black/African American	-0.49	0.16	(-1.17) - 0.19	-0.55	0.11	(-1.22) - 0.12
Native American/Alaska Native	0.92	0.02	0.17 - 1.67	0.57	0.27	(-0.44) - 1.59
Asian	0.16	0.46	(-0.26) - 0.58	0.23	0.28	(-0.19) - 0.65
Native Hawaiian/Pacific Islander	-0.38	0.29	(-1.08) - 0.32	0.02	0.97	(-0.79) - 0.83
Ethnicity						
Non-Hispanic				<i>Ref</i>		
Hispanic	0.33	0.17	(-0.13) - 0.79	0.47	0.10	(-0.09) - 1.04
Education						
No High School				<i>Ref</i>		
High School	-0.65	0.44	(-2.33) - 1.02	-0.68	0.43	(-2.37) - 1.01
Some College	-0.15	0.86	(-1.83) - 1.52	-0.17	0.84	(-1.86) - 1.52
College	-0.12	0.89	(-1.81) - 1.57	-0.11	0.90	(-1.83) - 1.61

Graduate/Professional	-0.13	0.89	(-1.83) - 1.58	-0.18	0.83	(-1.89) - 1.52
Gender						
Female				<i>Ref</i>		
Male	-0.07	0.69	(-0.40) - 0.26	-0.15	0.35	(-0.47) - 0.16
Other	-2.17	0.10	(-4.72) - 0.39	-1.99	0.15	(-4.70) - 0.73
Chronic Illness						
No				<i>Ref</i>		
Yes	0.93	< 0.01	0.52 - 1.33	0.85	< 0.01	0.43 - 1.28
Don't know	-0.55	0.49	(-2.12) - 1.02	-0.26	0.74	(-1.81) - 1.29

Note: The model accounted for clustering by counties.

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Table 2: Multi-variable Ordinal Logistic Regression of Risk Perception and Time Spent at Home

Variable	Unadjusted			Adjusted		
	OR	p-value	95% CI	OR	p-value	95% CI
<i>Outcome: Time spent at home</i>						
Stay-at-Home Order	2.00	0.02	1.11 - 3.62	1.86	0.05	1.00 - 3.44
Risk Perception Score	1.10	0.01	1.03 - 1.18	1.12	< 0.01	1.04 - 1.20
Gender						
Female			<i>Ref</i>			
Male	0.74	0.16	0.49 - 1.12	0.71	0.12	0.47 - 1.09
Other*	0.89	0.87	0.22 - 3.61	1.03	0.97	0.21 - 5.09
Age (years)						
18-25			<i>Ref</i>			
26-35	1.12	0.72	0.60 - 2.11	1.17	0.67	0.58 - 2.36
36-45	0.90	0.75	0.47 - 1.74	0.80	0.55	0.38 - 1.67
46-55	0.92	0.75	0.54 - 1.55	1.01	0.97	0.54 - 1.90
55+	1.12	0.61	0.71 - 1.77	1.41	0.27	0.76 - 2.62
Employment						
Employed			<i>Ref</i>			
Unemployed	0.71	0.18	0.42 - 1.18	0.71	0.18	0.42 - 1.18
Retired	0.74	0.31	0.42 - 1.31	0.63	0.11	0.36 - 1.11
Work in Healthcare	1.17	0.51	0.73 - 1.88	1.02	0.94	0.58 - 1.79
Chronic Illness						
No			<i>Ref</i>			
Yes	0.72	0.07	0.50 - 1.03	0.58	0.01	0.40 - 0.85
Don't Know	0.43	0.13	0.14 - 1.27	0.35	0.12	0.09 - 1.33

Note: The proportionality odds assumption was met. The model accounted for clustering by counties.

*Category participants selected. We did not ask them to identify further.

Footnote

Conflict of Interest Statement: No reported conflicts.

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References

1. Zhong Y, Liu W, Lee T-Y, Zhao H, Ji J. Risk perception, knowledge, information sources and emotional states among COVID-19 patients in Wuhan, China. *Nursing Outlook* **2020**.
2. Johns Hopkins University of Medicine. COVID-19 United States Cases. Available at: <https://coronavirus.jhu.edu/us-map>. Accessed August 4 2020.
3. Ferrer R, Klein WM. Risk perceptions and health behavior. *Curr Opin Psychol* **2015**; 5:85-9.
4. Malik AA, Couzens C, Omer SB. COVID-19 related social distancing measures and reduction in city mobility. *medRxiv* **2020**.
5. Yan Y, Malik AA, Bayham J, Fenichel EP, Couzens C, Omer SB. Measuring voluntary and policy-induced social distancing behavior during the COVID-19 pandemic. *medRxiv* **2020**:2020.05.01.20087874.
6. Bayham J, Kuminoff NV, Gunn Q, Fenichel EP. Measured voluntary avoidance behaviour during the 2009 A/H1N1 epidemic. *Proceedings of the Royal Society B: Biological Sciences* **2015**; 282:20150814.
7. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 Vaccine Acceptance in the U.S. *medRxiv* **2020**:2020.05.22.20110700.
8. SafeGraph. Social distancing measures. Available at: <https://docs.safegraph.com/docs/social-distancing-metrics>. Accessed 4 August 2020.
9. Raifman et al. COVID-19 US state policy database. Available at: https://docs.google.com/spreadsheets/d/1zu9qEWI8PsOI_i8nI_S29HDGHIIp2lfVMsGxpQ5tvAQ/edit#gid=0. Accessed 4 August 2020.
10. Cori L, Bianchi F, Cadum E, Anthonj C. Risk Perception and COVID-19. *Int J Environ Res Public Health* **2020**; 17.
11. Habersaat KB, Betsch C, Danchin M, et al. Ten considerations for effectively managing the COVID-19 transition. *Nature human behaviour* **2020**:1-11.

12. Jasmine C. Lee SM, Yuriria Avila, Barbara Harvey and Alex Leeds Matthews. See How All 50 States Are Reopening (and Closing Again): The New York Times, **2020**.

13. CDC. Race, Ethnicity, and Age Trends in Persons Who Died from COVID-19 — United States. Available at: <https://www.cdc.gov/mmwr/volumes/69/wr/mm6942e1.htm>. Accessed February 2021.

14. CDC. Daily Activities and Going Out. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/going-out.html>. Accessed February 2021.

15. United States Census Bureau. Quick Facts United States. Available at: <https://www.census.gov/quickfacts/fact/table/US/PST045219>. Accessed August 4 2020.

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