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Determinants of COVID-19 Preventive Behaviors among Adults with Chronic Diseases in the United States: an analysis of the nationally-representative COVID-19 Impact Survey

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Abstract

Background: Preventive behaviors have been recommended to control the spread of SARS-CoV-2. Adults with chronic diseases (CDs) are at high-risk of dying from COVID-19. Our objective was to evaluate adherence to COVID-19 preventive behaviors among adults without CDs compared to those with CDs and identify determinants of non-adherence COVID-19 preventive behaviors.

Study Design: Cross-sectional

Setting and Participants: We used data from the nationally-representative COVID Impact Survey(n=10,760) conducted in the United States (US).

Primary Measures: Adults with CDs were categorized based on a self-reported diagnosis of: diabetes, high blood pressure, heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis, liver disease, compromised immune system, or cancer (54%).

Results: Compared to adults without CDs, adults with CDs are more likely to adhere to preventive behaviors including wearing a face mask (χ2-p<0.001), social distance (χ2-p<0.001), wash or sanitize hands(χ2-p<0.001), and avoid some or all restaurants(χ2-p=0.002) and public or crowded places (χ2-p=0.001). Adults with a ≤ high school degree (aPR:1.82, 95% CI:1.04-3.17), household income<$50,000 (aPR:2.03, 95%CI:1.34-2.72), uninsured (aPR:1.65, 95% CI:1.09-2.52), employed (aPR:1.48, 95% CI:1.02-2.17), residing in rural areas (aPR:1.70, 95% CI:1.01-2.85), and without any CD (aPR:1.78, 95% CI:1.24-2.55) were more likely to not adhere to COVID-19 preventive behaviors

Conclusion: Adults with CDs are more likely to adhere to recommended COVID-19 preventive behaviors. Public health messaging targeting specific demographic groups and geographic areas, such as adults without CD or living in rural areas, should be prioritized.

Keywords: COVID-19, preventive behaviors

Article Summary

Strengths and Limitations of the Study

- We were able to use nationally-representative survey data collected from adults residing in the United States, which improves the generalizability of the findings.
- We were able to compare preventive behaviors of adults with and without chronic diseases based on self-report and include several conditions including diabetes, high blood pressure, heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis, liver disease, compromised immune system, or cancer.
- Data for this analysis, including reported preventive behaviors, were based on self-report which may be subject to social desirability bias.
- We were unable to address important factors in evaluating adherence of preventive behaviors, such as frequency of practicing preventive behaviors in the past 7 days.
- We were unable to probe further into why adults may not be adhering to recommended COVID-19 prevention behaviors as those data were not available.

Background

In the United States (U.S.), the COVID-19 pandemic has led to the death of over 160,000 individuals as of August 15th, 2020 [1]. Epidemiologic data suggest that certain groups are at higher risk of developing and dying from COVID-19 including older adults, adults with chronic diseases, and the immunocompromised[2]. Currently, in the absence of a an effective prophylactic vaccine against SARS-CoV-2, the virus that leads to COVID-19, prominent public health authorities including the Centers for Disease Control and Prevention have recommended certain preventive behaviors[3]. The most commonly recommended preventive behaviors include the "3 W's" which include, wear a mask, wash your hands, and watch your distance (i.e. social distancing)[4]. Other preventive behaviors include, avoiding high risk people, avoiding crowds and large gatherings, and generally staying home when able. These preventive behaviors have proven successful in several countries, including New Zealand, Vietnam, and Taiwan, by stopping the spread of COVID-19 through successful enforcement of population-level prevention guidelines[5,6]. However, in the U.S., many are not practicing recommended preventive behaviors, and practice varies greatly by demographic groups and chronic disease groups[7]. At the onset of the pandemic differences in adherence to preventive behavior were identified among adults with and without difference chronic diseases, for example, adults with immune conditions were twice more likely to report wearing a face mask when compared with individuals without immune conditions[7]. Additionally, in the general population recent reports show that adherence to preventive behaviors, particularly wearing masks, varies greatly across the United States based on location suggesting that mask use is high in the Northeast and the West, and lower in the Plains and parts of the South[8]. With the recent rise of COVID-19 [9,10] and reports suggesting variability in adherence to preventive behaviors in various geographic areas within the U.S. it is important to examine changes in COVID-19 preventive behaviors throughout the pandemic period. Our objective was to evaluate adherence to preventive behaviors among adults in the United States (US), specifically to compare adults with and without a history of physical chronic conditions. Additionally, to identify target demographic groups for tailored public health messaging, we assessed determinants of non-adherence to select COVID-19 preventive behaviors.

Methods

COVID-19 Impact Survey

Data for these analyses were obtained from the publicly available COVID-19 Household Impact Survey, conducted by the non-partisan and objective research organization NORC at the University of Chicago for the Data Foundation. The COVID-19 Household Impact Survey is a philanthropic effort to provide national and regional statistics about physical health, mental health, economic security, and social dynamics in the US.[11] The survey is designed to provide weekly estimates of the US adult (ages 18 and older) household population nationwide and for 18 regional areas including 10 states (CA, CO, FL, LA, MN, MO, MT, NY, OR, TX) and 8 Metropolitan Statistical Areas (Atlanta, Baltimore, Birmingham, Chicago, Cleveland, Columbus, Phoenix, Pittsburgh). Currently, data from Week 1 (April 20-26, 2020), Week 2 (May 4-10, 2020), and Week 3 (May 30th-June 8th, 2020) are available, which were merged for this analysis.

AmeriSpeak Sample

Funded and operated by NORC at the University of Chicago, AmeriSpeak® is a probability-based panel designed to be representative of the US household population. During the initial recruitment phase of the AmeriSpeak panel, randomly selected US households were sampled using area probability and address-based sampling, with a known, nonzero probability of selection from the NORC National Sample Frame. These sampled households were then contacted by US mail, telephone, and field interviewers (face to face). The panel provides sample coverage of approximately 97% of the US household population. Those excluded from the sample include people with P.O. Box only addresses, some addresses not listed in the US Postal Service Delivery Sequence File, and some newly constructed dwellings. While most AmeriSpeak households participate in surveys by web, non-internet households were able to participate in AmeriSpeak surveys by telephone. Households without conventional internet access but having web access via smartphones were allowed to participate in AmeriSpeak surveys by web. AmeriSpeak panelists participate in NORC studies or studies conducted by NORC on behalf of governmental agencies, academic researchers, and media and commercial organizations. Interviews were conducted in English and Spanish. Panelists were offered a $5

monetary incentive for completing the survey. Interviews were conducted with adults age 18 and over representing the 50 states and the District of Columbia. Panel members were randomly drawn from AmeriSpeak. In households with more than one adult panel member, only one was selected at random for the sample. Invited panel members were given the option to complete the survey online or by telephone with an NORC telephone interviewer. The number of participants invited and percentage of interviews completed by week are as follows: 11,133 invited with 19.7% interviews completed during Week 1; 8,570 invited with 26.1% interviews completed (Week 2); and 10, 373 invited with 19.7% interviews completed (Week 3). The analytic sample includes 10,760 adults nationwide. The final analytic sample were weighted to reflect the US population of adults aged 18 years and over. The demographic weighting variables were obtained from the 2020 Current Population Survey. The count of COVID-19 deaths by county was obtained from USA Facts.

Public Involvement Statement

Participants were not involved in the development of this manuscript or interpretation of the results. The authors of this paper had not contact with the survey respondents and were not involved in data collection as the publically-available data were collected by NORC at the University of Chicago for the Data Foundation.

Measures

To evaluate adherence to COVID-19 preventive behaviors, we used participants' responses (yes/no) to the following question: "Which of the following measures, if any, are you taking in response to the coronavirus?" Participants were able to select all that applied from a list of 19 options. We focused on the following most commonly recommended preventive behaviors: Worn a face mask; Avoided some or all restaurants; Avoided public or crowded places; Canceled or postponed pleasure, social or recreational activities; Washed or sanitized hands; and Kept six feet distance from those outside my household.

We defined an adult to have a physical chronic disease using participants' self-reported response (yes/no) to the following question: "Has a doctor or other health care provider ever told you

that you have any of the following: Diabetes; High blood pressure or hypertension; Heart disease, heart attack or stroke; Asthma; Chronic lung disease or COPD; Bronchitis or emphysema; a Cystic fibrosis; Liver disease or end-stage liver disease; Cancer; a Compromised immune system." We defined those who selected "Yes" to any of the listed conditions as adults with a physical chronic condition.

The following covariates were included in the multivariable analyses: age categories (18-29, 30-44, 25-59, 60+), sex (male, female), education categories (HS graduate/equivalent or below, some college, baccalaureate degree or above), race/ethnicity categories [non-Hispanic (NH) White, NH-Black, Hispanic, NH-Asian, NH-Other], having at least one COVID-19 related symptom, healthy with no self-reported chronic disease, census region (Northeast, Midwest, South, West), insurance status, household income (<50,000, $50,000-<$100,000, ≥$100,000), and population density (rural, suburban, urban). Population density was determined based on the 2010 US Census data.

Data Analysis

Descriptive statistics are displayed in percentages among all respondents unless otherwise labeled, and include a margin of error of +/- 3·0 percentage points at the 95% confidence intervals among all adults. Chi-squared (χ^2) tests were used for bivariate comparison of preventive behaviors against the COVID-19 pandemic among adults with chronic diseases compared to others. Further, we conducted multivariable Poisson regression analyses to evaluate associations of preventive behaviors with having a chronic disease after adjustment for the following variables: age, sex, race (white/Minority), area of residence (rural/suburban/urban), and annual household income. To estimate determinants of not practicing COVID-19 preventive behaviors, we computed prevalence ratios with Poisson regression using robust estimation of standard errors[12–14]. The COVID-19 preventive behaviors evaluated include those who responded no to all of the following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands, and keep six feet distance. Potential variables for inclusion in the model were assessed using available sociodemographic variables and bivariate Poisson regression analysis. Due to the exploratory nature of this analysis

using a predictive framework, an arbitrary p-value of <0.10 was used as criteria to include the variable in the multivariable Poisson regression model. For multivariable Poisson regression models, adjusted prevalence ratios (aPR), and 95% confidence intervals (CIs) for each independent variable were calculated. Additionally, p-value *<0.05* was used as the level of significance. Collinearity was assessed using the variance inflation factor to ensure a strong linear relationship among independent variables included in the model was not present. Based on the exploratory nature of this analysis, we did not include an adjustment for multiple comparisons[15]. All statistical analyses were conducted using Stata IC 15.1 (StataCorp LLC, College Station, TX). Sampling weights were applied to provide results that were nationally representative of the US adult population.

Results

Table 1 summarizes the demographic characteristics of the study population stratified by having a chronic disease. Participants with chronic diseases were mostly over the age of 45 years (68.3%) and non-Hispanic (NH) White (65.0%). Adults with chronic diseases were 51% female and 42% were employed within the past seven days. The majority had at least some college or Baccalaureate degree or above (60.2%) and 21% had an income over ≥$100,000. Sixty-nine percent of adults with chronic diseases lived in urban areas and 48% had an employer-sponsored insurance.

Figure 1 summarizes preventive behaviors stratified by having a chronic disease or not across all weeks of data collection and over time from Week 1 (late April) to Week 3 (early June). When evaluating all weeks combined, we observed that adults without chronic diseases (83%) were less likely to wear a mask (87%) (χ^2-p <0.001). Adults with chronic diseases were not more likely to cancel or postpone pleasure, social or recreational activities (66%) compared to adults without chronic diseases (64%) (χ^2-p =0.08). Next, we observed that over time adults with chronic diseases grew more likely to keep 6 feet distance from those outside their household: In late April there was no significant difference by chronic disease status (χ^2-p=0.71), however, during early May adults with chronic diseases were more likely to practice social distancing (86%) compared to adults without chronic diseases (80%) (χ^2-p <0.001). Similarly, again, in early June adults with chronic diseases were more likely (86%) than adults without chronic diseases (79%) (χ^2-p <0.001). We observed

similar trends over time for washing or sanitizing hands and avoiding some or all restaurants. Overall, adults with chronic diseases were more likely to wash or sanitize their hands (92%) than adults without chronic diseases (86%) (χ^2-p <0.001). Adults with chronic diseases were also more likely (72%) to avoid some or all restaurants than adults without chronic diseases (69%) (χ^2-p =0.002) and to avoid public or crowded places (78% vs. 74%) (χ^2-p =0.001) (Figure 1).

On multivariable analyses, after adjustment for age, race/ethnicity, sex, area of residence (rural/suburban/urban), and household annual income, we observed significant differences across chronic disease status (Figure 2). Adults with chronic diseases had a 4% higher prevalence of wearing a face mask (aPR: 1.04, 95% CI: 1.01-1.06), avoiding some or all restaurants (aPR: 1.04, 95% CI: 1.01-1.08). avoiding public or crowded places (aPR: 1.04, 95% CI: 1.01-1.07), and keeping six feet distance (aPR: 1.04, 95% CI: 1.02-1.07). Additionally, adults with chronic diseases had a 2% higher prevalence of washing or sanitizing hands (aPR: 1.02, 95% CI: 1.01-1.04).

Table 2 summarizes results of multivariable analyses to identify determinants of not adhering to recommended COVID-19 preventive behaviors. Overall, 2.4% of adults responded no to all of the following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands, and keep six feet distance from those living outside their home. Non-adherence to recommended preventive behaviors was more likely among adults with a high school degree or below compared to those with a Baccalaureate degree or above (aPR: 1.86, 95% CI: 1.06-3.27). Additionally, non-adherence to recommended behaviors was more likely among adults without any chronic diseases (aPR: 1.78, 95% CI: 1.24-2.55) as well as the employed (aPR: 1.48, 95% CI: 1.02-2.17) and the uninsured (aPR: 1.79, 95% CI: 1.16-2.75). Adults with a household income less than $50,000 were more likely not to adhere to preventive behaviors compared to those with an income over $100,000 (aPR: 2.05, 95% CI: 1.14-2.85). Compared to adults living in urban areas, adults in rural areas had a 70% higher prevalence of non-adherence to recommended preventive behaviors. Non-adherence to recommended preventive behaviors was less likely among female adults compared to males (aPR: 0.47, 95% CI: 0.32-0.69).

Discussion

In this analysis, we found that compared to adults without chronic diseases, adults with chronic diseases are more likely to adhere to recommended preventive behaviors to reduce the spread of COVID-19 in the United States. These findings are consistent with our prior study examining associations of COVID-19 preventive behaviors with chronic disease status at the onset of the COVID-19 pandemic[7]. Here we extend our previous analysis to identify determinants of non-adherence to COVID-19 preventive behaviors among U.S. adults. We observed that non-adherence to COVID-19 preventive behaviors was more likely among adults who are middle-aged, with less education, lower income, uninsured, employed, residing in rural and suburban areas, and those who are healthy without any physical chronic disease. Previous studies have documented disparities in adherence to COVID-19 preventive behaviors by education, occupation, urbanicity, and occupation[16]. As the effectiveness of preventive behaviors, including mask use and social distancing, in mitigating the spread of COVID-19, has been demonstrated, these findings have implications for preventive public health messaging and identifies demographic targets for improved education and improved allocation of resources [17–19].

Our findings indicate that U.S. adults with lower socioeconomic status, including lower income, educational background, and the uninsured, are less likely to adhere to COVID-19 recommended preventive behaviors. These findings may indicate that those with lower socioeconomic experience significant barriers to practice preventive behaviors due to inequitable access to health care, resources, and the ability to take off from work as we also observed those who are employed are more likely to not adhere to COVID-19 preventive behaviors. Prior studies have documented the higher risk of COVID-19 among essential workers due to difficulties in social distancing, inadequate access to personal protective equipment, and lack of COVID-19 specific disinfection guidelines[20,21]. Conversely, our study findings may also reflect changes in attitudes around COVID-19 preventive behaviors[22]. Inequities in ability to practice COVID-19 preventive behaviors may lead to inequitable risk and morbidity of COVID-19 among these at-risk groups.

Importantly, we found that adults without any chronic diseases were more likely to not adhere to practice preventive behaviors, which indicates the potential for improvement among public health professionals in communicating risk to impact risk perception. Prior studies have shown that higher perceived risk of infection and COVID-19 disease had a positive impact on implementation of protective behaviors such as handwashing and social distancing[23,24]. Early in the pandemic, one study found that on a scale from 0-100%, the average perceived risk of infection incidence was 10% and 5% for mortality, and perceived risk had a positive impact on practicing preventive behaviors: An increase of 1 quartile in perceived infection risk was associated with 45% and 24% higher odds of reporting handwashing and social distancing, respectively[24]. Similarly, another study found that the perceived risk of infection increased from March to April, however, U.S. adults severely underestimated their absolute and relative fatality risk compared to epidemiological figures available at the time of the study. They also found that the participant's risk perception highly influenced their actual or intended adherence to preventive behaviors that can reduce COVID-19 spread[23]. Our findings complement these prior studies and underscore the need for improved risk communication specifically among the demographic groups we identified. The public health and medical community working to address the COVID-19 pandemic should also be aware that risk communication alone may not meet the needs of certain demographic groups, and equitable access to resources or opportunities to practice recommended preventive behaviors should be coupled into preventive programming.

Our study findings are subject to several limitations. First, behaviors and practice of recommendations were self-reported; therefore, responses might be subject to recall, response, and social desirability biases. Second, while we were able to adjust for many social and demographic characteristics, we were limited by the availability of the data and may have failed to account for unmeasured variables associated with practice of preventive behaviors and chronic conditions. We were unable to probe further into why adults may not be adhering to recommended COVID-19 prevention behaviors as those data were not available. Future qualitative studies should be prioritized to ask more detailed questions regarding attitudes and perceptions of COVID-19 recommended preventive behaviors in the U.S. Strengths include the incorporation of multiple cross-sectional waves

of data to understand COVID-19 preventive behaviors over time, use of a nationally representative sample of U.S. adults, and examination of a broad range of COVID-19 preventive behaviors.

As the pandemic progresses and subsequent outbreaks occur, understanding public behaviors and determinants of preventive behaviors is critical. Practice of recommendations to wear cloth face coverings, physical distancing, and quarantine guidelines are of utmost public health importance. Overall, strong public adherence to these behaviors suggests an opportunity to normalize and continue to promote safe practices as states reopen, while disparities in practice of behaviors among specific demographic groups offers opportunities for targeted outreach and education.

Footnotes

Acknowledgements: We gratefully acknowledge NORC at the University of Chicago for the Data Foundation for their efforts in data collection and making the COVID Impact Survey data publically available.

Author Contributions: JYI conceptualized the manuscript, guided data analysis, interpreted critically, wrote the manuscript; MCR and DV contributed to data interpretation and manuscript writing. All authors have read and approved the submission.

Data Availability: Data are publically available at the following website: https://www.covid-impact.org/results.

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Disclosure Statement: The authors declare no potential conflicts of interest.

Ethics and consent: Ethical approval was not obtained from the author's respective institutions as the data were made publically available.

Figures

Figure 1: Adherence to COVID-19 preventive behaviors among those without chronic diseases compared to those with chronic diseases in the U.S.

Figure 2: Associations of adherence to COVID-19 preventive behaviors among US adults with chronic diseases

Table 1: Characteristics of COVID Impact Survey respondents (n = 10,760), a nationally representative survey of the US, stratified by cancer diagnosis (April-June 2020)

	Total		Adults with Chronic Disease		Adults without Chronic Diseases	
	Col %	95% CI	Col %	95% CI	Col %	95% CI
Age						
18-29	20.5	19.3,21.8	12.8	11.5,14.3	29.8	27.7,31.9
30-44	25.4	24.4,26.5	18.9	17.7,20.2	33.2	31.5,35.0
45-59	24.3	23.2,25.4	26.0	24.5,27.5	22.2	20.7,23.8
60+	29.8	28.6,30.9	42.3	40.6,44.0	14.8	13.5,16.1
Sex						
Male	48.3	47.0,49.6	48.2	46.5,50.0	48.4	46.4,50.4
Female	51.7	50.4,53.0	51.8	50.0,53.5	51.6	49.6,53.6
Race/Ethnicity						
White, NH	61.6	60.3,62.9	65	63.2,66.7	57.6	55.5,59.6
Black, NH	11.9	11.0,12.7	13.3	12.1,14.5	10.2	9.1,11.4
Hispanic	16.5	15.5,17.7	12.9	11.7,14.2	20.9	19.1,22.8
Asian, NH	5.1	4.4,5.8	3.4	2.7,4.3	7.1	5.9,8.4
Other, NH	3.5	3.1,3.9	3.9	3.4,4.6	2.9	2.5,3.5
Employed in the past 7 days	49.7	48.4,51.1	42	40.3,43.7	59.1	57.1,61.1
Education						
No HS Diploma	9.8	8.8,10.8	10.3	9.1,11.8	9.1	7.7,10.7
HS Graduate	28.2	27.0,29.6	29.4	27.7,31.1	26.9	24.9,29.0
Some College	27.7	26.7,28.7	29.4	28.1,30.8	25.7	24.2,27.2
Baccalaureate or Above	34.3	33.1,35.5	30.8	29.3,32.4	38.4	36.5,40.3
Household Income						
<$50,000	45.8	44.5,47.1	49.7	48.0,51.4	41.1	39.1,43.2
$50,000-<$100,000	32.1	30.9,33.3	29.1	27.6,30.7	35.6	33.7,37.5
≥$100,000	22.1	21.1,23.2	21.2	19.8,22.6	23.3	21.6,25.0
Population Density						
Rural	9.1	8.4,9.8	10.5	9.5,11.6	7.4	6.5,8.4
Suburban	18.8	17.8,19.7	20.5	19.2,21.9	16.7	15.4,18.1
Urban	72.2	71.0,73.3	69	67.4,70.5	75.9	74.3,77.5
Insurance Type or Health Coverage Plans						
Purchased Plan	17.4	16.4,18.5	18.9	17.5,20.3	15.7	14.2,17.4
Employer-Sponsored	51.7	50.3,53.0	48	46.2,49.7	56.1	54.1,58.1
TRICARE	4.9	4.4,5.4	5.3	4.6,6.1	4.4	3.8,5.2
Medicaid	23.5	22.4,24.7	28.1	26.5,29.8	18	16.5,19.6
Medicare	25.3	24.2,26.4	36.9	35.3,38.6	11.3	10.1,12.6

Dually Eligible (Medicare & Medicaid)	9.7	9.0,10.4	14.6	13.4,15.8	3.8	3.2,4.6
VA	4.5	4.0,5.0	5.7	5.0,6.6	3	2.5,3.6
Indian Health Service	1.2	0.9,1.6	1.6	1.1,2.2	0.7	0.4,1.3
No insurance	8.8	8.1,9.6	6.3	5.5,7.2	11.9	10.5,13.3

Table 2: Determinants of not adhering to recommended COVID-19 preventive behaviors* using COVID Impact Survey, a nationally representative survey of the US (n=10,760) (April-June 2020)

	Unadjusted PR	95% CI	Adjusted PR	95% CI
Age				
18-29	2.55	1.33-4.91	1.41	0.64-3.13
30-44	2.08	1.64-3.73	1.41	0.77-2.57
45-59	2.27	1.24-4.18	1.75	0.95-3.25
60+	Ref.		Ref.	
Sex				
Male	Ref.		Ref.	
Female	0.47	0.32-0.68	0.47	0.32-0.69
Education				
HS Graduate or below	2.45	1.43-4.22	1.86	1.06-3.27
Some College	1.82	1.08-3.07	1.49	0.87-2.54
Baccalaureate or Above	Ref.		Ref.	
Race/Ethnicity				
White, NH	Ref.		Ref.	
Black, NH	1.05	0.62-1.77	1.01	0.56-1.83
Hispanic	1.20	0.70-2.07	0.97	0.48-1.96
Asian, NH	0.37	0.15-0.94	0.44	0.16-1.22
Other, NH	0.74	0.40-1.39	0.76	0.41-.141
At least One COVID-19 Related Symptom†	0.77	0.54-1.10	-	
No physical chronic diseases‡	2.03	1.39-2.97	1.78	1.24-2.55
Region				
Northeast	0.47	0.23-0.96	0.55	0.26-1.16
Midwest	1.01	0.66-1.55	1.02	0.64-1.62
South	Ref.		Ref.	
West	0.85	0.55-1.33	0.89	0.54-1.47
Employed	1.62	1.11-2.35	1.48	1.02-2.17
Uninsured	2.60	1.76-3.83	1.79	1.16-2.75
Household Income				
<$50,000	2.66	1.56-4.54	2.05	1.14-2.85
$50,000-<$100,000	2.24	1.26-4.01	1.33	0.85-2.08
≥$100,000	Ref.		Ref.	
Population Density				

Rural	1.81	1.14-2.87	1.70	1.01-2.85
Suburban	1.53	1.03-2.29	1.33	0.85-2.08
Urban	Ref.		Ref.	

*The COVID-19 preventive behaviors included in this definition are those who responded no to all of the following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands, and keep six feet distance.

†Symptoms include: Fever, chills, runny or stuffy nose, chest congestion, skin rash, cough, sore throat, sneezing, muscle or body aches, headaches, fatigue or tiredness, shortness of breath, abdominal discomfort, nausea or vomiting, diarrhea, changed or loss sense of taste or smell, loss of appetite

‡Physical chronic diseases include: diabetes, high blood pressure, heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis, liver disease, a compromised immune system, and cancer.

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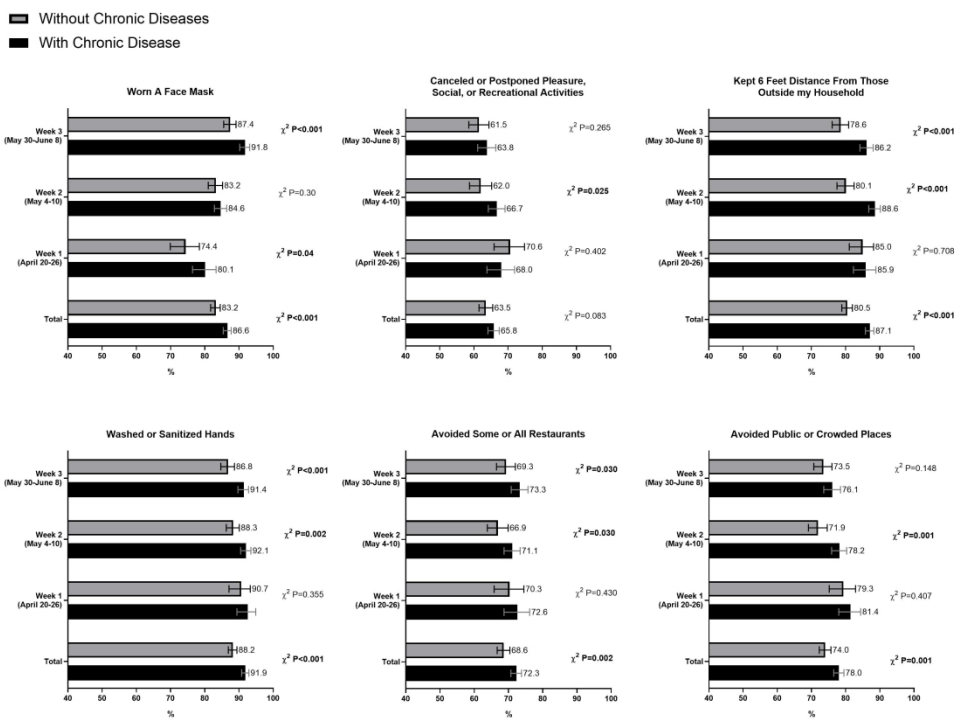

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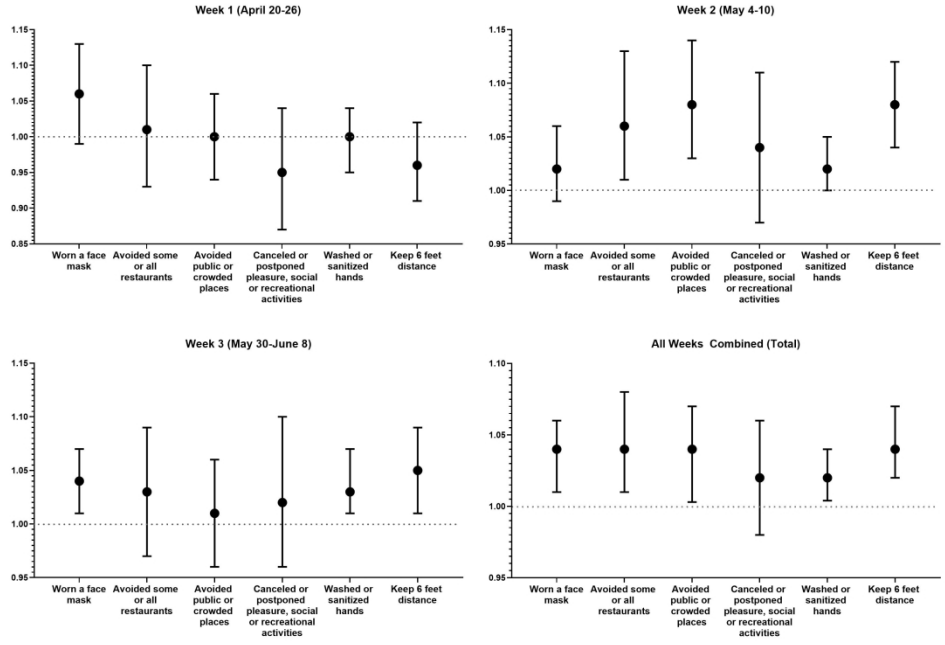

X-Axis: Preventive Behaviors | Y-Axis:Adjusted Prevalence Ratio and 95% Confidence Intervals

Models adjusted for: Age, race/ethnicity, sex, area of residence (rural, suburban, urban), household annual income

283x214mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5-6
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	7-8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5-6
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7-8
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of5potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	10-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Determinants of COVID-19 Preventive Behaviors among Adults with Chronic Diseases in the United States: an analysis of the nationally-representative COVID-19 Impact Survey

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Determinants of COVID-19 Preventive Behaviors among Adults with Chronic Diseases in the United States: an analysis of the nationally representative COVID-19 Impact Survey

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Abstract

Background: Preventive behaviors have been recommended to control the spread of SARS-CoV-2. Adults with chronic diseases (CDs) are at high-risk of dying from COVID-19. Our objective was to evaluate adherence to COVID-19 preventive behaviors among adults without CDs compared to those with CDs and identify determinants of non-adherence COVID-19 preventive behaviors.

Study Design: Cross-sectional

Setting and Participants: We used data from the nationally representative COVID Impact Survey(n=10,760) conducted in the United States (US).

Primary Measures: Adults with CDs were categorized based on a self-reported diagnosis of diabetes, high blood pressure, heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis, liver disease, compromised immune system, or cancer (54%).

Results: Compared to adults without CDs, adults with CDs are more likely to adhere to preventive behaviors including wearing a face mask (χ2-p<0.001), social distance (χ2-p<0.001), wash or sanitize hands(χ2-p<0.001), and avoid some or all restaurants(χ2-p=0.002) and public or crowded places (χ2-p=0.001). Adults with a ≤ high school degree (aPR:1.82, 95% CI:1.04-3.17), household income<$50,000 (aPR:2.03, 95%CI:1.34-2.72), uninsured (aPR:1.65, 95% CI:1.09-2.52), employed (aPR:1.48, 95% CI:1.02-2.17), residing in rural areas (aPR:1.70, 95% CI:1.01-2.85), and without any CD (aPR:1.78, 95% CI:1.24-2.55) were more likely to not adhere to COVID-19 preventive behaviors.

Conclusion: Adults with CDs are more likely to adhere to recommended COVID-19 preventive behaviors. Public health messaging targeting specific demographic groups and geographic areas, such as adults without CD or living in rural areas, should be prioritized.

Keywords: COVID-19, preventive behaviors

Article Summary

Strengths and Limitations of the Study

- We were able to use nationally representative survey data collected from adults residing in the United States, which improves the generalizability of the findings.
- We were able to compare preventive behaviors of adults with and without chronic diseases based on self-report and include several conditions including diabetes, high blood pressure, heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis, liver disease, compromised immune system, or cancer.
- Data for this analysis, including reported preventive behaviors, were based on self-report which may be subject to social desirability bias.
- We were unable to address important factors in evaluating adherence of preventive behaviors, such as frequency of practicing preventive behaviors in the past 7 days.
- We were unable to probe further into why adults may not be adhering to recommended COVID-19 prevention behaviors as those data were not available.

Background

In the United States (U.S.), the COVID-19 pandemic has led to the death of over 230,000 individuals as of November 18th, 2020 [1]. Epidemiologic data suggest that certain groups are at higher risk of developing and dying from COVID-19 including older adults, adults with chronic diseases, and the immunocompromised[2]. Currently, in the absence of a an effective prophylactic vaccine against SARS-CoV-2, the virus that leads to COVID-19, prominent public health authorities including the Centers for Disease Control and Prevention have recommended certain preventive behaviors[3]. The most commonly recommended preventive behaviors include the "3 W's" which include, wear a mask, wash your hands, and watch your distance (i.e. social distancing)[4]. Other preventive behaviors include, avoiding high risk people, avoiding crowds and large gatherings, and generally staying home when able. These preventive behaviors have proven successful in several countries, including New Zealand, Vietnam, and Taiwan, by stopping the spread of COVID-19 through successful enforcement of population-level prevention guidelines[5,6]. However, in the U.S., many are not practicing recommended preventive behaviors, and practice varies greatly by demographic groups and chronic disease groups [7]. At the onset of the pandemic differences in adherence to preventive behavior were identified among adults with and without difference chronic diseases, for example, adults with immune conditions were twice more likely to report wearing a face mask when compared with individuals without immune conditions[7]. Additionally, in the general population recent reports show that adherence to preventive behaviors, particularly wearing masks, varies greatly across the United States based on location suggesting that mask use is high in the Northeast and the West, and lower in the Plains and parts of the South[8]. With the recent rise of COVID-19 [9,10] and reports suggesting variability in adherence to preventive behaviors in various geographic areas within the U.S. it is important to examine changes in COVID-19 preventive behaviors throughout the pandemic period. Our objective was to evaluate adherence to preventive behaviors among adults in the United States (US), specifically to compare adults with and without a history of physical chronic conditions. Additionally, to identify target demographic groups for tailored public health messaging, we assessed determinants of non-adherence to select COVID-19 preventive behaviors.

Methods

COVID-19 Impact Survey

Data for these analyses were obtained from the publicly available COVID-19 Household Impact Survey, conducted by the non-partisan and objective research organization NORC at the University of Chicago for the Data Foundation. The COVID-19 Household Impact Survey is a philanthropic effort to provide national and regional statistics about physical health, mental health, economic security, and social dynamics in the US.[11] The survey is designed to provide weekly estimates of the US adult (ages 18 and older) household population nationwide and for 18 regional areas including 10 states (CA, CO, FL, LA, MN, MO, MT, NY, OR, TX) and 8 Metropolitan Statistical Areas (Atlanta, Baltimore, Birmingham, Chicago, Cleveland, Columbus, Phoenix, Pittsburgh). Currently, data from Week 1 (April 20-26, 2020), Week 2 (May 4-10, 2020), and Week 3 (May 30th-June 8th, 2020) are available, which were merged for this analysis. Details regarding the dataset and data collection methods have been previously published[12,13].

AmeriSpeak Sample

Funded and operated by NORC at the University of Chicago, AmeriSpeak® is a probability-based panel designed to be representative of the US household population. During the initial recruitment phase of the AmeriSpeak panel, randomly selected US households were sampled using area probability and address-based sampling, with a known, nonzero probability of selection from the NORC National Sample Frame. These sampled households were then contacted by US mail, telephone, and field interviewers (face to face). The panel provides sample coverage of approximately 97% of the US household population. Those excluded from the sample include people with P.O. Box only addresses, some addresses not listed in the US Postal Service Delivery Sequence File, and some newly constructed dwellings. While most AmeriSpeak households participate in surveys by web, non-internet households were able to participate in AmeriSpeak surveys by telephone. Households without conventional internet access but having web access via smartphones could participate in AmeriSpeak surveys by web. AmeriSpeak panelists participate in NORC studies or studies conducted by NORC on

behalf of governmental agencies, academic researchers, and media and commercial organizations. Interviews were conducted in English and Spanish. Panelists were offered a $5 monetary incentive for completing the survey. Interviews were conducted with adults age 18 and over representing the 50 states and the District of Columbia. Panel members were randomly drawn from AmeriSpeak. In households with more than one adult panel member, only one was selected at random for the sample. Invited panel members were given the option to complete the survey online or by telephone with an NORC telephone interviewer. The number of participants invited, and percentage of interviews completed by week are as follows: 11,133 invited with 19.7% interviews completed during Week 1; 8,570 invited with 26.1% interviews completed (Week 2); and 10, 373 invited with 19.7% interviews completed (Week 3). The analytic sample includes 10,760 adults nationwide. The final analytic sample were weighted to reflect the US population of adults aged 18 years and over. The demographic weighting variables were obtained from the 2020 Current Population Survey. The count of COVID-19 deaths by county was obtained from USA Facts.

Public Involvement Statement

Participants were not involved in the development of this manuscript or interpretation of the results. The authors of this paper had not contact with the survey respondents and were not involved in data collection as the publicly available data were collected by NORC at the University of Chicago for the Data Foundation.

Measures

To evaluate adherence to COVID-19 preventive behaviors, we used participants' responses (yes/no) to the following question: "Which of the following measures, if any, are you taking in response to the coronavirus?" Participants were able to select all that applied from a list of 19 options. We focused on the following commonly recommended preventive behaviors: Worn a face mask; Avoided some or all restaurants; Avoided public or crowded places; Canceled or postponed pleasure, social or recreational activities; Washed or sanitized hands; and Kept six feet distance from those outside my household.

We defined an adult to have a physical chronic disease using participants' self-reported response (yes/no) to the following question: "Has a doctor or other health care provider ever told you that you have any of the following: Diabetes; High blood pressure or hypertension; Heart disease, heart attack or stroke; Asthma; Chronic lung disease or COPD; Bronchitis or emphysema; a Cystic fibrosis; Liver disease or end-stage liver disease; Cancer; a Compromised immune system." We defined those who selected "Yes" to any of the listed conditions as adults with a physical chronic condition.

The following covariates were included in the multivariable analyses: age categories (18-29, 30-44, 25-59, 60+), sex (male, female), education categories (HS graduate/equivalent or below, some college, baccalaureate degree or above), race/ethnicity categories [non-Hispanic (NH) White, NH-Black, Hispanic, NH-Asian, NH-Other], having at least one COVID-19 related symptom, healthy with no self-reported chronic disease, census region (Northeast, Midwest, South, West), insurance status, household income (<50,000, $50,000-<$100,000, ≥$100,000), and population density (rural, suburban, urban). Population density was determined based on the 2010 US Census data[12].

Data Analysis

Descriptive statistics are displayed in percentages among all respondents unless otherwise labeled and include a margin of error of +/- 3·0 percentage points at the 95% confidence intervals among all adults. Chi-squared (χ^2) tests were used for bivariate comparison of preventive behaviors against the COVID-19 pandemic among adults with chronic diseases compared to others. Further, we conducted multivariable Poisson regression analyses to evaluate associations of preventive behaviors with having a chronic disease after adjustment for the following variables: age, sex, race (white/Minority), area of residence (rural/suburban/urban), and annual household income. To estimate determinants of not practicing COVID-19 preventive behaviors, we computed prevalence ratios with Poisson regression using robust estimation of standard errors[14–16]. The COVID-19 preventive behaviors evaluated include those who responded no to all the following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands, and keep six feet distance. Potential

variables for inclusion in the model were assessed using available sociodemographic variables and bivariate Poisson regression analysis. Due to the exploratory nature of this analysis using a predictive framework, an arbitrary p-value of <0.10 was used as criteria to include the variable in the multivariable Poisson regression model. For multivariable Poisson regression models, adjusted prevalence ratios (aPR), and 95% confidence intervals (CIs) for each independent variable were calculated. Additionally, p-value *<0.05* was used as the level of significance. Collinearity was assessed using the variance inflation factor to ensure a strong linear relationship among independent variables included in the model was not present. Based on the exploratory nature of this analysis, we did not include an adjustment for multiple comparisons[17]. All statistical analyses were conducted using Stata IC 15.1 (StataCorp LLC, College Station, TX). Sampling weights were applied to provide results that were nationally representative of the US adult population.

Results

Table 1 summarizes the demographic characteristics of the study population stratified by having a chronic disease. Participants with chronic diseases were mostly over the age of 45 years (68.3%) and non-Hispanic (NH) White (65.0%). Adults with chronic diseases were 51% female and 42% were employed within the past seven days. The majority had at least some college or Baccalaureate degree or above (60.2%) and 21% had an income over ≥$100,000. Sixty-nine percent of adults with chronic diseases lived in urban areas and 48% had an employer-sponsored insurance.

Figure 1 summarizes preventive behaviors stratified by having a chronic disease or not across all weeks of data collection and over time from Week 1 (late April) to Week 3 (early June). When evaluating all weeks combined, we observed that adults without chronic diseases (83%) were less likely to wear a mask (87%) (χ^2-p <0.001). Adults with chronic diseases were not more likely to cancel or postpone pleasure, social or recreational activities (66%) compared to adults without chronic diseases (64%) (χ^2-p =0.08). Next, we observed that over time adults with chronic diseases grew more likely to keep 6 feet distance from those outside their household: In late April there was no significant difference by chronic disease status (χ^2-p=0.71), however, during early May adults with chronic diseases were more likely to practice social distancing (86%) compared to adults without

chronic diseases (80%) (χ^2-p <0.001). Similarly, again, in early June adults with chronic diseases were more likely (86%) than adults without chronic diseases (79%) (χ^2-p <0.001). We observed similar trends over time for washing or sanitizing hands and avoiding some or all restaurants. Overall, adults with chronic diseases were more likely to wash or sanitize their hands (92%) than adults without chronic diseases (86%) (χ^2-p <0.001). Adults with chronic diseases were also more likely (72%) to avoid some or all restaurants than adults without chronic diseases (69%) (χ^2-p =0.002) and to avoid public or crowded places (78% vs. 74%) (χ^2-p =0.001) (Figure 1).

On multivariable analyses, after adjustment for age, race/ethnicity, sex, area of residence (rural/suburban/urban), and household annual income, we observed significant differences across chronic disease status (Figure 2). Adults with chronic diseases had a 4% higher prevalence of wearing a face mask (aPR: 1.04, 95% CI: 1.01-1.06), avoiding some or all restaurants (aPR: 1.04, 95% CI: 1.01-1.08). avoiding public or crowded places (aPR: 1.04, 95% CI: 1.01-1.07), and keeping six feet distance (aPR: 1.04, 95% CI: 1.02-1.07). Additionally, adults with chronic diseases had a 2% higher prevalence of washing or sanitizing hands (aPR: 1.02, 95% CI: 1.01-1.04).

Table 2 summarizes results of multivariable analyses to identify determinants of not adhering to recommended COVID-19 preventive behaviors. Overall, 2.4% of adults responded no to all the following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands, and keep six feet distance from those living outside their home. Non-adherence to recommended preventive behaviors was more likely among adults with a high school degree or below compared to those with a Baccalaureate degree or above (aPR: 1.86, 95% CI: 1.06-3.27). Additionally, non-adherence to recommended behaviors was more likely among adults without any chronic diseases (aPR: 1.78, 95% CI: 1.24-2.55) as well as the employed (aPR: 1.48, 95% CI: 1.02-2.17) and the uninsured (aPR: 1.79, 95% CI: 1.16-2.75). Adults with a household income less than $50,000 were more likely not to adhere to preventive behaviors compared to those with an income over $100,000 (aPR: 2.05, 95% CI: 1.14-2.85). Compared to adults living in urban areas, adults in rural areas had a 70% higher prevalence of non-adherence to recommended preventive behaviors. Non-adherence to

recommended preventive behaviors was less likely among female adults compared to males (aPR: 0.47, 95% CI: 0.32-0.69).

Discussion

In this analysis, we found that compared to adults without chronic diseases, adults with chronic diseases are more likely to adhere to recommended preventive behaviors to reduce the spread of COVID-19 in the United States. These findings are consistent with our prior study examining associations of COVID-19 preventive behaviors with chronic disease status at the onset of the COVID-19 pandemic[7]. Here we extend our previous analysis to identify determinants of non-adherence to COVID-19 preventive behaviors among U.S. adults. We observed that non-adherence to COVID-19 preventive behaviors was more likely among adults who are middle-aged, with less education, lower income, uninsured, employed, residing in rural and suburban areas, and those who are healthy without any physical chronic disease. Previous studies have documented disparities in adherence to COVID-19 preventive behaviors by education, occupation, urbanicity, and occupation[18]. As the effectiveness of preventive behaviors, including mask use and social distancing, in mitigating the spread of COVID-19, has been demonstrated, these findings have implications for preventive public health messaging and identifies demographic targets for improved education and improved allocation of resources [19–21].

Our findings indicate that U.S. adults with lower socioeconomic status, including lower income, educational background, and the uninsured, are less likely to adhere to COVID-19 recommended preventive behaviors. These findings may indicate that those with lower socioeconomic status experience significant barriers to practice preventive behaviors due to inequitable access to health care, resources, and the ability to take off from work as we also observed those who are employed are more likely to not adhere to COVID-19 preventive behaviors. Prior studies have documented the higher risk of COVID-19 among essential workers due to difficulties in social distancing, inadequate access to personal protective equipment, and lack of COVID-19 specific disinfection guidelines[22,23]. Additionally, associations between lower levels of education and less understanding of public health messaging around COVID-19 preventive behaviors and greater

endorsement of COVID-19 misinformation (e.g. underestimating importance of social distancing, misinformed beliefs around COVID-19 vaccination) have been documented in the US and beyond [24,25]. Conversely, our study findings may also reflect changes in attitudes around COVID-19 preventive behaviors[26]. Prior studies examining the associations between COVID-19 information sources and attitudes towards COVID-19 messaging have elucidated differences in trust of COVID-19 information and self-reported adherence to COVID-19 preventive behaviors among men, individuals who are unemployed or retired, and adults who politically identify as Republican [27–30]. While we were unable to adjust for political affiliation within our analyses due to the lack of data availability within the COVID-19 Impact Survey, research shows that non-Hispanic Whites, men, and individuals residing in rural areas more frequently identify their political affiliation as Republican [31,32]. Our observed geographic disparities in COVID-19 preventive behaviors may also be a reflection of variability in state or local policies regarding COVID-19 preventive behaviors across the U.S. Individuals residing in U.S. states and counties that have implemented mandatory COVID-19 preventive behaviors, including stay-at-home orders, social distancing, and mandatory mask use in public, are more likely to exhibit positive individual-level COVID-19 preventive behaviors [33–35].Inequities in ability or willingness to practice COVID-19 preventive behaviors may lead to inequitable risk and morbidity of COVID-19 among these at-risk groups. Future research should focus on the impact of state-level COVID-19 prevention policies to evaluate area-level differences in individual preventive behaviors and to disentangle whether certain demographics of U.S. adults are either unwilling or unable to adhere to recommended guidelines.

Importantly, we found that adults without any chronic diseases were more likely to not adhere to practice preventive behaviors, which indicates the potential for improvement among public health professionals in communicating risk to impact risk perception. Prior studies have shown that higher perceived risk of infection and COVID-19 disease had a positive impact on implementation of protective behaviors such as handwashing and social distancing[36,37]. Early in the pandemic, one study found that on a scale from 0-100%, the average perceived risk of infection incidence was 10% and 5% for mortality, and perceived risk had a positive impact on practicing preventive behaviors: An increase of 1 quartile in perceived infection risk was associated with 45% and 24% higher odds of

reporting handwashing and social distancing, respectively[37]. Similarly, another study found that the perceived risk of infection increased from March to April, however, U.S. adults severely underestimated their absolute and relative fatality risk compared to epidemiological figures available at the time of the study. They also found that the participant's risk perception highly influenced their actual or intended adherence to preventive behaviors that can reduce COVID-19 spread[36]. Our findings complement these prior studies and underscore the need for improved risk communication specifically among the demographic groups we identified. The public health and medical community working to address the COVID-19 pandemic should also be aware that risk communication alone may not meet the needs of certain demographic groups, and equitable access to resources or opportunities to practice recommended preventive behaviors should be coupled into preventive programming.

Our study findings are subject to several limitations. First, behaviors and practice of recommendations were self-reported; therefore, responses might be subject to recall, response, and social desirability biases. Second, while we were able to adjust for many social and demographic characteristics, we were limited by the availability of the data and may have failed to account for unmeasured variables associated with practice of preventive behaviors and chronic conditions. We were unable to probe further into why adults may not be adhering to recommended COVID-19 prevention behaviors as those data were not available. Future qualitative studies should be prioritized to ask more detailed questions regarding attitudes and perceptions of COVID-19 recommended preventive behaviors in the U.S. The percentage of rural adults included in this sample was lower than expected, potentially due to differences in response rates by area of residence, and as such, future efforts to survey rural adults on their preventive behaviors should be specifically prioritized. Strengths include the incorporation of multiple cross-sectional waves of data to understand COVID-19 preventive behaviors over time, use of a nationally representative sample of U.S. adults, and examination of a broad range of COVID-19 preventive behaviors.

As the pandemic progresses and subsequent outbreaks occur, understanding public behaviors and determinants of preventive behaviors is critical. Practice of recommendations to wear cloth face coverings, physical distancing, and quarantine guidelines is of utmost public health importance. Overall, strong public adherence to these behaviors suggests an opportunity to normalize and continue

to promote safe practices as states reopen, while disparities in practice of behaviors among specific demographic groups offers opportunities for targeted outreach and education.

Footnotes

Acknowledgements: We gratefully acknowledge NORC at the University of Chicago for the Data Foundation for their efforts in data collection and making the COVID Impact Survey data publicly available.

Author Contributions: JYI conceptualized the manuscript, guided data analysis, interpreted critically, wrote the manuscript; MCR and DV contributed to data interpretation and manuscript writing. All authors have read and approved the submission.

Data Availability: Data are publicly available at the following website: https://www.covid-impact.org/results.

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Ethics and consent: Ethical approval was not obtained from the author's respective institutions as the data were made publicly available.

Figures

Figure 1: Adherence to COVID-19 preventive behaviors among those without chronic diseases compared to those with chronic diseases in the U.S.

Figure 2: Associations of adherence to COVID-19 preventive behaviors among US adults with chronic diseases

Table 1: Characteristics of COVID Impact Survey respondents (n = 10,760), a nationally representative survey of the US, stratified by cancer diagnosis (April-June 2020)

	Total		Adults with Chronic Disease		Adults without Chronic Diseases	
	Col %	95% CI	Col %	95% CI	Col %	95% CI
Age						
18-29	20.5	19.3,21.8	12.8	11.5,14.3	29.8	27.7,31.9
30-44	25.4	24.4,26.5	18.9	17.7,20.2	33.2	31.5,35.0
45-59	24.3	23.2,25.4	26.0	24.5,27.5	22.2	20.7,23.8
60+	29.8	28.6,30.9	42.3	40.6,44.0	14.8	13.5,16.1
Sex						
Male	48.3	47.0,49.6	48.2	46.5,50.0	48.4	46.4,50.4
Female	51.7	50.4,53.0	51.8	50.0,53.5	51.6	49.6,53.6
Race/Ethnicity						
White, NH	61.6	60.3,62.9	65	63.2,66.7	57.6	55.5,59.6
Black, NH	11.9	11.0,12.7	13.3	12.1,14.5	10.2	9.1,11.4
Hispanic	16.5	15.5,17.7	12.9	11.7,14.2	20.9	19.1,22.8
Asian, NH	5.1	4.4,5.8	3.4	2.7,4.3	7.1	5.9,8.4
Other, NH	3.5	3.1,3.9	3.9	3.4,4.6	2.9	2.5,3.5
Employed in the past 7 days	49.7	48.4,51.1	42	40.3,43.7	59.1	57.1,61.1
Education						
No HS Diploma	9.8	8.8,10.8	10.3	9.1,11.8	9.1	7.7,10.7
HS Graduate	28.2	27.0,29.6	29.4	27.7,31.1	26.9	24.9,29.0
Some College	27.7	26.7,28.7	29.4	28.1,30.8	25.7	24.2,27.2
Baccalaureate or Above	34.3	33.1,35.5	30.8	29.3,32.4	38.4	36.5,40.3
Household Income						
<$50,000	45.8	44.5,47.1	49.7	48.0,51.4	41.1	39.1,43.2
$50,000-<$100,000	32.1	30.9,33.3	29.1	27.6,30.7	35.6	33.7,37.5
≥$100,000	22.1	21.1,23.2	21.2	19.8,22.6	23.3	21.6,25.0
Population Density						
Rural	9.1	8.4,9.8	10.5	9.5,11.6	7.4	6.5,8.4
Suburban	18.8	17.8,19.7	20.5	19.2,21.9	16.7	15.4,18.1
Urban	72.2	71.0,73.3	69	67.4,70.5	75.9	74.3,77.5
Census Region						
Northeast	17.4	16.4,18.5	17.9	16.5,19.3	16.9	15.3,18.6
Midwest	20.7	19.8,21.7	21.7	20.4,23.1	19.5	18.2,21.0
South	38.0	36.7,39.3	38.6	36.9,40.3	37.3	35.3,39.3
West	23.8	22.8,24.9	21.8	20.4,23.2	26.3	24.6,28.1

Insurance Type or Health Coverage Plans						
Purchased Plan	17.4	16.4,18.5	18.9	17.5,20.3	15.7	14.2,17.4
Employer-Sponsored	51.7	50.3,53.0	48	46.2,49.7	56.1	54.1,58.1
TRICARE	4.9	4.4,5.4	5.3	4.6,6.1	4.4	3.8,5.2
Medicaid	23.5	22.4,24.7	28.1	26.5,29.8	18	16.5,19.6
Medicare	25.3	24.2,26.4	36.9	35.3,38.6	11.3	10.1,12.6
Dually Eligible (Medicare & Medicaid)	9.7	9.0,10.4	14.6	13.4,15.8	3.8	3.2,4.6
VA	4.5	4.0,5.0	5.7	5.0,6.6	3	2.5,3.6
Indian Health Service	1.2	0.9,1.6	1.6	1.1,2.2	0.7	0.4,1.3
No insurance	8.8	8.1,9.6	6.3	5.5,7.2	11.9	10.5,13.3

Table 2: Determinants of not adhering to recommended COVID-19 preventive behaviors* using COVID Impact Survey, a nationally representative survey of the US (n=10,760) (April-June 2020)

	Unadjusted PR	95% CI	Adjusted PR	95% CI
Age				
18-29	2.55	1.33-4.91	1.41	0.64-3.13
30-44	2.08	1.64-3.73	1.41	0.77-2.57
45-59	2.27	1.24-4.18	1.75	0.95-3.25
60+	Ref.		Ref.	
Sex				
Male	Ref.		Ref.	
Female	0.47	0.32-0.68	0.47	0.32-0.69
Education				
HS Graduate or below	2.45	1.43-4.22	1.86	1.06-3.27
Some College	1.82	1.08-3.07	1.49	0.87-2.54
Baccalaureate or Above	Ref.		Ref.	
Race/Ethnicity				
White, NH	Ref.		Ref.	
Black, NH	1.05	0.62-1.77	1.01	0.56-1.83
Hispanic	1.20	0.70-2.07	0.97	0.48-1.96
Asian, NH	0.37	0.15-0.94	0.44	0.16-1.22
Other, NH	0.74	0.40-1.39	0.76	0.41-.141
At least One COVID-19 Related Symptom†	0.77	0.54-1.10	-	
No physical chronic diseases‡	2.03	1.39-2.97	1.78	1.24-2.55
Region				
Northeast	0.47	0.23-0.96	0.55	0.26-1.16
Midwest	1.01	0.66-1.55	1.02	0.64-1.62
South	Ref.		Ref.	
West	0.85	0.55-1.33	0.89	0.54-1.47
Employed	1.62	1.11-2.35	1.48	1.02-2.17
Uninsured	2.60	1.76-3.83	1.79	1.16-2.75
Household Income				
<$50,000	2.66	1.56-4.54	2.05	1.14-2.85
$50,000-<$100,000	2.24	1.26-4.01	1.33	0.85-2.08
≥$100,000	Ref.		Ref.	
Population Density				

Rural	1.81	1.14-2.87	1.70	1.01-2.85
Suburban	1.53	1.03-2.29	1.33	0.85-2.08
Urban	Ref.		Ref.	

*The COVID-19 preventive behaviors included in this definition are those who responded no to all the following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands, and keep six feet distance.

†Symptoms include: Fever, chills, runny or stuffy nose, chest congestion, skin rash, cough, sore throat, sneezing, muscle or body aches, headaches, fatigue or tiredness, shortness of breath, abdominal discomfort, nausea or vomiting, diarrhea, changed or loss sense of taste or smell, loss of appetite

‡Physical chronic diseases include diabetes, high blood pressure, heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis, liver disease, a compromised immune system, and cancer.

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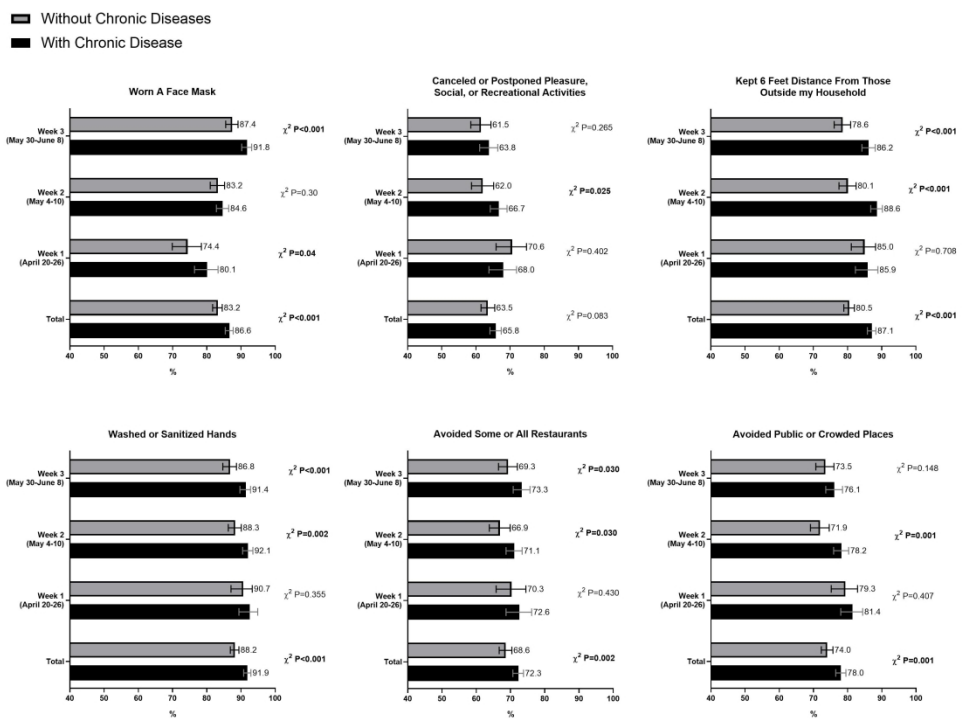

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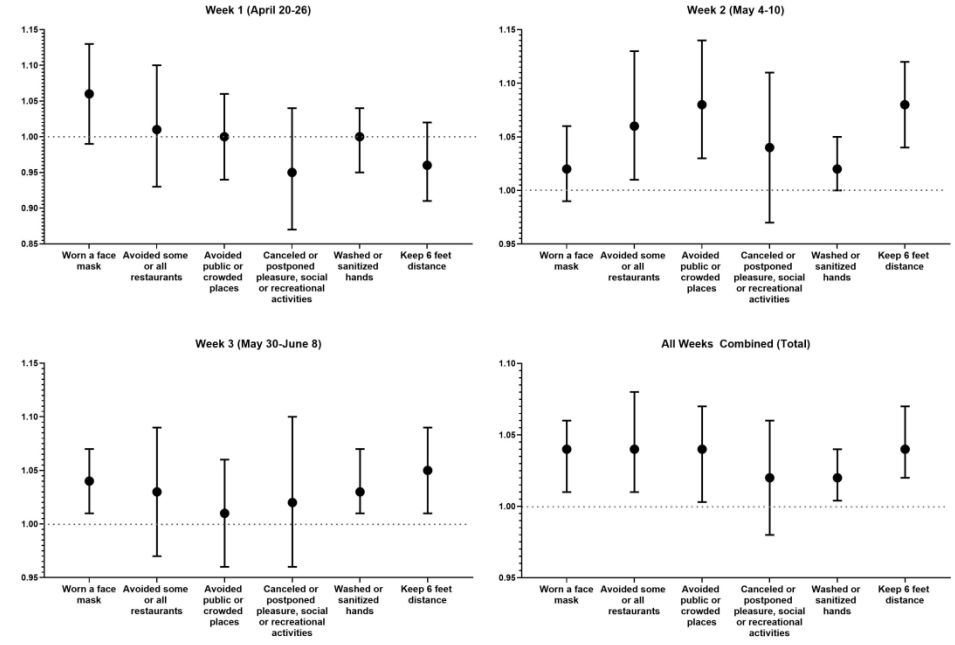

X-Axis: Preventive Behaviors | Y-Axis:Adjusted Prevalence Ratio and 95% Confidence Intervals

Models adjusted for: Age, race/ethnicity, sex, area of residence (rural, suburban, urban), household annual income

283x214mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5-6
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	7-8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5-6
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7-8
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of5potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	10-11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.