

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-044600
Article Type:	Original research
Date Submitted by the Author:	07-Sep-2020
Complete List of Authors:	Islam, Jessica; University of North Carolina Lineberger Comprehensive Cancer Center, Vidot, Denise; University of Miami Health System Camacho-Rivera, Marlene; SUNY Downstate Health Sciences University
Keywords:	Epidemiology < TROPICAL MEDICINE, PUBLIC HEALTH, PREVENTIVE MEDICINE, Infection control < INFECTIOUS DISEASES

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 1 **Determinants of COVID-19 Preventive Behaviors among Adults with Chronic Diseases in the**
4
5 2 **United States: an analysis of the nationally-representative COVID-19 Impact Survey**
6

7 3 Jessica Yasmine Islam, PhD, MPH
8 4 UNC Lineberger Comprehensive Cancer Center
9 5 School of Medicine
10 6 UNC Chapel Hill
11 7

12 8 Denise C. Vidot, PhD
13 9 School of Nursing and Health Studies
14 10 Sylvester Comprehensive Cancer Center, Miller School of Medicine
15 11 University of Miami
16 12

17 13 Marlene Camacho-Rivera, ScD, MPH
18 14 Department of Community Health Sciences
19 15 SUNY Downstate Health Sciences University
20 16
21 17

22 18 Running Title: COVID-19 Preventive Behaviors among Adults with Chronic Diseases
23 19

24 20 Corresponding Author: Dr. Jessica Yasmine Islam, PhD MPH
25 21 UNC Lineberger Comprehensive Cancer Center
26 22 School of Medicine
27 23 UNC Chapel Hill
28 24 450 West Drive
29 25 Chapel Hill, NC 27599
30 26 Email: islamjy@email.unc.edu
31 27

32 28 Abstract: 232 words
33 29

34 30 Main Text: 2918 words
35 31

36 32 Tables: 2
37 33

38 34 Figures: 2
39 35
40 36
41 37
42 38
43 39
44 40
45 41
46 42
47 43
48 44
49 45
50 46
51 47
52 48
53 49
54 50
55 51
56 52
57 53
58 54
59 55
60 56

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 (χ^2 -p<0.001), social distance (χ^2 -p<0.001), wash or sanitize hands (χ^2 -p<0.001), and avoid some or all restaurants (χ^2 -p=0.002) and public or crowded places (χ^2 -p=0.001). Adults with a \leq 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

1
2
3 68 **Article Summary**
4

5 69 **Strengths and Limitations of the Study**
6

- 7 70 • We were able to use nationally-representative survey data collected from adults residing in
8 the United States, which improves the generalizability of the findings.
9 71
10 72 • We were able to compare preventive behaviors of adults with and without chronic diseases
11 based on self-report and include several conditions including diabetes, high blood pressure,
12 73 heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis,
13 74 liver disease, compromised immune system, or cancer.
14 75
15 76 • Data for this analysis, including reported preventive behaviors, were based on self-report
16 77 which may be subject to social desirability bias.
17 78
18 79 • We were unable to address important factors in evaluating adherence of preventive behaviors,
19 80 such as frequency of practicing preventive behaviors in the past 7 days.
20 81
21 82 • We were unable to probe further into why adults may not be adhering to recommended
22 83 COVID-19 prevention behaviors as those data were not available.
23 84
24 85
25 86
26 87
27 88
28 89
29 90
30 91
31 92
32 93
33 94
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

95 **Background**

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

123 **Methods**

124 COVID-19 Impact Survey

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

136 AmeriSpeak Sample

137 Funded and operated by NORC at the University of Chicago, AmeriSpeak® is a probability-
138 based panel designed to be representative of the US household population. During the initial
139 recruitment phase of the AmeriSpeak panel, randomly selected US households were sampled using
140 area probability and address-based sampling, with a known, nonzero probability of selection from the
141 NORC National Sample Frame. These sampled households were then contacted by US mail,
142 telephone, and field interviewers (face to face). The panel provides sample coverage of approximately
143 97% of the US household population. Those excluded from the sample include people with P.O. Box
144 only addresses, some addresses not listed in the US Postal Service Delivery Sequence File, and some
145 newly constructed dwellings. While most AmeriSpeak households participate in surveys by web, non-
146 internet households were able to participate in AmeriSpeak surveys by telephone. Households without
147 conventional internet access but having web access via smartphones were allowed to participate in
148 AmeriSpeak surveys by web. AmeriSpeak panelists participate in NORC studies or studies conducted
149 by NORC on behalf of governmental agencies, academic researchers, and media and commercial
150 organizations. Interviews were conducted in English and Spanish. Panelists were offered a \$5

1
2
3 151 monetary incentive for completing the survey. Interviews were conducted with adults age 18 and over
4
5 152 representing the 50 states and the District of Columbia. Panel members were randomly drawn from
6
7 153 AmeriSpeak. In households with more than one adult panel member, only one was selected at random
8
9 154 for the sample. Invited panel members were given the option to complete the survey online or by
10
11 155 telephone with an NORC telephone interviewer. The number of participants invited and percentage of
12
13 156 interviews completed by week are as follows: 11,133 invited with 19.7% interviews completed during
14
15 157 Week 1; 8,570 invited with 26.1% interviews completed (Week 2); and 10, 373 invited with 19.7%
16
17 158 interviews completed (Week 3). The analytic sample includes 10,760 adults nationwide. The final
18
19 159 analytic sample were weighted to reflect the US population of adults aged 18 years and over. The
20
21 160 demographic weighting variables were obtained from the 2020 Current Population Survey. The count
22
23 161 of COVID-19 deaths by county was obtained from USA Facts.
24
25
26
27
28

29 163 Public Involvement Statement

30 164 Participants were not involved in the development of this manuscript or interpretation of the
31
32 165 results. The authors of this paper had not contact with the survey respondents and were not involved
33
34 166 in data collection as the publically-available data were collected by NORC at the University of
35
36 167 Chicago for the Data Foundation.
37
38
39
40

41 169 Measures

42
43 170 To evaluate adherence to COVID-19 preventive behaviors, we used participants' responses
44
45 171 (yes/no) to the following question: "Which of the following measures, if any, are you taking in
46
47 172 response to the coronavirus?" Participants were able to select all that applied from a list of 19 options.
48
49 173 We focused on the following most commonly recommended preventive behaviors: Worn a face mask;
50
51 174 Avoided some or all restaurants; Avoided public or crowded places; Canceled or postponed pleasure,
52
53 175 social or recreational activities; Washed or sanitized hands; and Kept six feet distance from those
54
55 176 outside my household.
56
57

58 177 We defined an adult to have a physical chronic disease using participants' self-reported
59
60 178 response (yes/no) to the following question: "Has a doctor or other health care provider ever told you

1
2
3 179 that you have any of the following: Diabetes; High blood pressure or hypertension; Heart disease,
4
5 180 heart attack or stroke; Asthma; Chronic lung disease or COPD; Bronchitis or emphysema; a Cystic
6
7 181 fibrosis; Liver disease or end-stage liver disease; Cancer; a Compromised immune system.” We
8
9 182 defined those who selected “Yes” to any of the listed conditions as adults with a physical chronic
10
11 183 condition.

12
13
14 184 The following covariates were included in the multivariable analyses: age categories (18-29,
15
16 185 30-44, 25-59, 60+), sex (male, female), education categories (HS graduate/equivalent or below, some
17
18 186 college, baccalaureate degree or above), race/ethnicity categories [non-Hispanic (NH) White, NH-
19
20 187 Black, Hispanic, NH-Asian, NH-Other], having at least one COVID-19 related symptom, healthy with
21
22 188 no self-reported chronic disease, census region (Northeast, Midwest, South, West), insurance status,
23
24 189 household income (<\$50,000, \$50,000-<\$100,000, ≥\$100,000), and population density (rural,
25
26 190 suburban, urban). Population density was determined based on the 2010 US Census data.
27
28
29

30 192 Data Analysis

31
32
33 193 Descriptive statistics are displayed in percentages among all respondents unless otherwise
34
35 194 labeled, and include a margin of error of +/- 3.0 percentage points at the 95% confidence intervals
36
37 195 among all adults. Chi-squared (χ^2) tests were used for bivariate comparison of preventive behaviors
38
39 196 against the COVID-19 pandemic among adults with chronic diseases compared to others. Further, we
40
41 197 conducted multivariable Poisson regression analyses to evaluate associations of preventive behaviors
42
43 198 with having a chronic disease after adjustment for the following variables: age, sex, race
44
45 199 (white/Minority), area of residence (rural/suburban/urban), and annual household income. To estimate
46
47 200 determinants of not practicing COVID-19 preventive behaviors, we computed prevalence ratios with
48
49 201 Poisson regression using robust estimation of standard errors[12–14]. The COVID-19 preventive
50
51 202 behaviors evaluated include those who responded no to all of the following behaviors: worn a face
52
53 203 mask, avoided some or all restaurants, avoided public or crowded places, canceled or postponed
54
55 204 pleasure, social or recreational activities, washed or sanitized hands, and keep six feet distance.
56
57
58 205 Potential variables for inclusion in the model were assessed using available sociodemographic
59
60 206 variables and bivariate Poisson regression analysis. Due to the exploratory nature of this analysis

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

216

217 Results

218 Table 1 summarizes the demographic characteristics of the study population stratified by
219 having a chronic disease. Participants with chronic diseases were mostly over the age of 45 years
220 (68.3%) and non-Hispanic (NH) White (65.0%). Adults with chronic diseases were 51% female and
221 42% were employed within the past seven days. The majority had at least some college or
222 Baccalaureate degree or above (60.2%) and 21% had an income over \geq \$100,000. Sixty-nine percent
223 of adults with chronic diseases lived in urban areas and 48% had an employer-sponsored insurance.

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

1
2
3 235 similar trends over time for washing or sanitizing hands and avoiding some or all restaurants. Overall,
4
5 236 adults with chronic diseases were more likely to wash or sanitize their hands (92%) than adults
6
7 237 without chronic diseases (86%) (χ^2 -p <0.001). Adults with chronic diseases were also more likely
8
9 238 (72%) to avoid some or all restaurants than adults without chronic diseases (69%) (χ^2 -p =0.002) and
10
11 239 to avoid public or crowded places (78% vs. 74%) (χ^2 -p =0.001) (Figure 1).

12
13
14 240 On multivariable analyses, after adjustment for age, race/ethnicity, sex, area of residence
15
16 241 (rural/suburban/urban), and household annual income, we observed significant differences across
17
18 242 chronic disease status (Figure 2). Adults with chronic diseases had a 4% higher prevalence of wearing
19
20 243 a face mask (aPR: 1.04, 95% CI: 1.01-1.06), avoiding some or all restaurants (aPR: 1.04, 95% CI:
21
22 244 1.01-1.08), avoiding public or crowded places (aPR: 1.04, 95% CI: 1.01-1.07), and keeping six feet
23
24 245 distance (aPR: 1.04, 95% CI: 1.02-1.07). Additionally, adults with chronic diseases had a 2% higher
25
26 246 prevalence of washing or sanitizing hands (aPR: 1.02, 95% CI: 1.01-1.04).

27
28 247 Table 2 summarizes results of multivariable analyses to identify determinants of not adhering
29
30 248 to recommended COVID-19 preventive behaviors. Overall, 2.4% of adults responded no to all of the
31
32 249 following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded
33
34 250 places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands,
35
36 251 and keep six feet distance from those living outside their home. Non-adherence to recommended
37
38 252 preventive behaviors was more likely among adults with a high school degree or below compared to
39
40 253 those with a Baccalaureate degree or above (aPR: 1.86, 95% CI: 1.06-3.27). Additionally, non-
41
42 254 adherence to recommended behaviors was more likely among adults without any chronic diseases
43
44 255 (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
45
46 256 uninsured (aPR: 1.79, 95% CI: 1.16-2.75). Adults with a household income less than \$50,000 were
47
48 257 more likely not to adhere to preventive behaviors compared to those with an income over \$100,000
49
50 258 (aPR: 2.05, 95% CI: 1.14-2.85). Compared to adults living in urban areas, adults in rural areas had a
51
52 259 70% higher prevalence of non-adherence to recommended preventive behaviors. Non-adherence to
53
54 260 recommended preventive behaviors was less likely among female adults compared to males (aPR:
55
56 261 0.47, 95% CI: 0.32-0.69).

262

263 Discussion

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

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

1
2
3 289 Importantly, we found that adults without any chronic diseases were more likely to not adhere
4
5 290 to practice preventive behaviors, which indicates the potential for improvement among public health
6
7 291 professionals in communicating risk to impact risk perception. Prior studies have shown that higher
8
9 292 perceived risk of infection and COVID-19 disease had a positive impact on implementation of
10
11 293 protective behaviors such as handwashing and social distancing[23,24]. Early in the pandemic, one
12
13 294 study found that on a scale from 0-100%, the average perceived risk of infection incidence was 10%
14
15 295 and 5% for mortality, and perceived risk had a positive impact on practicing preventive behaviors: An
16
17 296 increase of 1 quartile in perceived infection risk was associated with 45% and 24% higher odds of
18
19 297 reporting handwashing and social distancing, respectively[24]. Similarly, another study found that the
20
21 298 perceived risk of infection increased from March to April, however, U.S. adults severely
22
23 299 underestimated their absolute and relative fatality risk compared to epidemiological figures available
24
25 300 at the time of the study. They also found that the participant's risk perception highly influenced their
26
27 301 actual or intended adherence to preventive behaviors that can reduce COVID-19 spread[23]. Our
28
29 302 findings complement these prior studies and underscore the need for improved risk communication
30
31 303 specifically among the demographic groups we identified. The public health and medical community
32
33 304 working to address the COVID-19 pandemic should also be aware that risk communication alone may
34
35 305 not meet the needs of certain demographic groups, and equitable access to resources or opportunities
36
37 306 to practice recommended preventive behaviors should be coupled into preventive programming.

38
39 307 Our study findings are subject to several limitations. First, behaviors and practice of
40
41 308 recommendations were self-reported; therefore, responses might be subject to recall, response, and
42
43 309 social desirability biases. Second, while we were able to adjust for many social and demographic
44
45 310 characteristics, we were limited by the availability of the data and may have failed to account for
46
47 311 unmeasured variables associated with practice of preventive behaviors and chronic conditions. We
48
49 312 were unable to probe further into why adults may not be adhering to recommended COVID-19
50
51 313 prevention behaviors as those data were not available. Future qualitative studies should be prioritized
52
53 314 to ask more detailed questions regarding attitudes and perceptions of COVID-19 recommended
54
55 315 preventive behaviors in the U.S. Strengths include the incorporation of multiple cross-sectional waves
56
57
58
59
60

1
2
3 316 of data to understand COVID-19 preventive behaviors over time, use of a nationally representative
4
5 317 sample of U.S. adults, and examination of a broad range of COVID-19 preventive behaviors.

6
7 318 As the pandemic progresses and subsequent outbreaks occur, understanding public behaviors
8
9 319 and determinants of preventive behaviors is critical. Practice of recommendations to wear cloth face
10
11 320 coverings, physical distancing, and quarantine guidelines are of utmost public health importance.

12
13 321 Overall, strong public adherence to these behaviors suggests an opportunity to normalize and continue
14
15 322 to promote safe practices as states reopen, while disparities in practice of behaviors among specific
16
17 323 demographic groups offers opportunities for targeted outreach and education.

18
19
20 324
21 325
22 326
23 327
24 328
25 329
26 330
27 331
28 332
29 333
30 334
31 335
32 336
33 337
34 338
35 339
36 340
37 341
38 342
39 343
40 344
41 345
42 346
43 347
44 348
45 349
46 350
47 351
48 352
49 353
50 354
51 355
52 356
53 357
54 358
55 359
56 360
57 361
58 362
59
60

1
2
3 **363 Footnotes**

4 364
5 365 Acknowledgements: We gratefully acknowledge NORC at the University of Chicago for the Data

6
7 366 Foundation for their efforts in data collection and making the COVID Impact Survey data publically
8
9 367 available.

10
11 368 Author Contributions: JYI conceptualized the manuscript, guided data analysis, interpreted critically,
12
13 369 wrote the manuscript; MCR and DV contributed to data interpretation and manuscript writing. All
14
15 370 authors have read and approved the submission.

16
17 371 Data Availability: Data are publically available at the following website: [https://www.covid-](https://www.covid-impact.org/results)
18
19 372 [impact.org/results](https://www.covid-impact.org/results).

20
21 373 Funding and Financial Support: JYI is supported by UNC's Cancer Care Quality Training
22
23 374 2T32CA116339-11. MCR is supported by the TRANSPORT – The Translational Program of Health
24
25 375 Disparities Research Training 5S21MD012474-02.

26
27 376 Disclosure Statement: The authors declare no potential conflicts of interest.

28
29 377 Ethics and consent: Ethical approval was not obtained from the author's respective institutions as the
30
31 378 data were made publically available.

32
33 379

34
35 380

36
37 381

38
39 382

40
41 383

42
43 384

44
45 385

46
47 386

48
49 387

50
51 388

52
53 389

54
55 390

56
57 391

58
59 392

60
393

394

395

396

397

398

399

400

401

402

403

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

For peer review only

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

455
456

For peer review only

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	0.41-1.41
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.

457

458

459

460

461

462

463

464

465

466

467

468

469

470

471

472

473

474

475

476

477

478

479

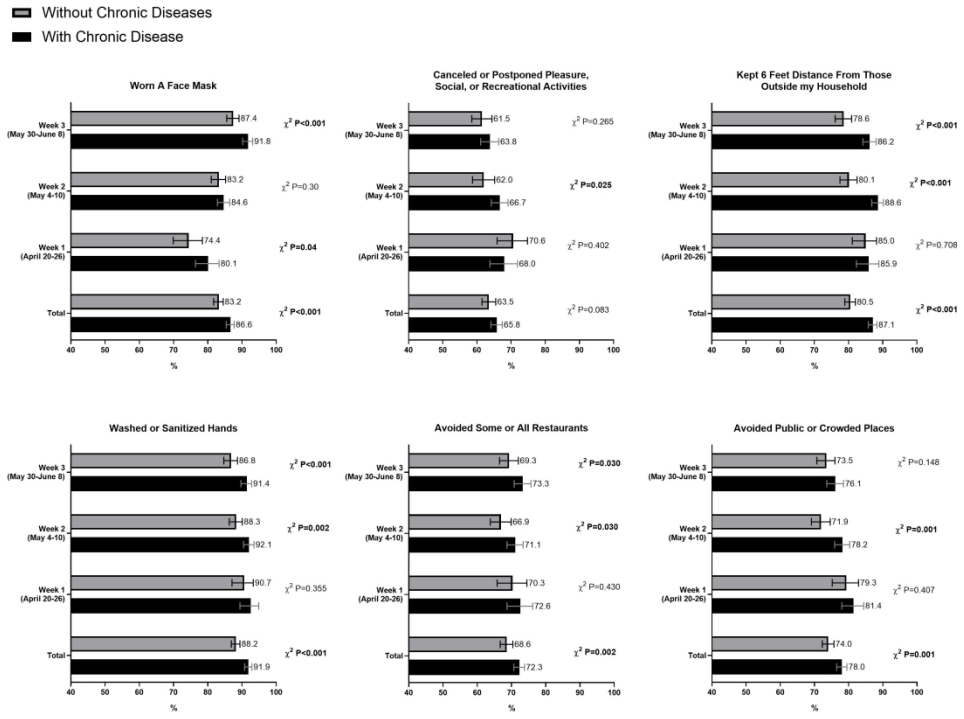
Bibliography

1. Cases and Deaths in the U.S. | CDC. (n.d.). Retrieved August 15, 2020, from <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/us-cases-deaths.html>
2. Certain Medical Conditions and Risk for Severe COVID-19 Illness | CDC. (n.d.). Retrieved August 15, 2020, from https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fneed-extra-precautions%2Fgroups-at-higher-risk.html
3. How to Protect Yourself & Others | CDC. (n.d.). Retrieved August 13, 2020, from <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html>
4. 3 W's to reduce the risk of COVID-19 | Prevent Epidemics. (n.d.). Retrieved August 15, 2020, from <https://preventepidemics.org/covid19/science/insights/3-ws-to-reduce-the-risk-of-covid-19/>
5. As Coronavirus Surges in U.S., Some Countries Have Just About Halted It - WSJ. (n.d.). Retrieved August 15, 2020, from <https://www.wsj.com/articles/as-coronavirus-surges-in-u-s-some-countries-have-just-about-halted-it-11594037814>
6. How Some Countries Brought New Coronavirus Cases Down To Nearly Zero : Goats and Soda : NPR. (n.d.). Retrieved August 15, 2020, from <https://www.npr.org/sections/goatsandsoda/2020/05/23/861577367/messaging-from-leaders-who-have-tamed-their-countrys-coronavirus-outbreaks>
7. Camacho-Rivera, M., Islam, J. Y., & Vidot, D. C. (2020). Associations Between Chronic Health Conditions and COVID-19 Preventive Behaviors Among a Nationally Representative Sample of U.S. Adults: An Analysis of the COVID Impact Survey. *Health equity*, 4(1), 336–344. doi:10.1089/heq.2020.0031
8. A Detailed Map of Who Is Wearing Masks in the U.S. - The New York Times. (n.d.). Retrieved August 17, 2020, from <https://www.nytimes.com/interactive/2020/07/17/upshot/coronavirus-face-mask-map.html>
9. CDC COVID Data Tracker. (n.d.). Retrieved August 17, 2020, from <https://www.cdc.gov/covid-data-tracker/>

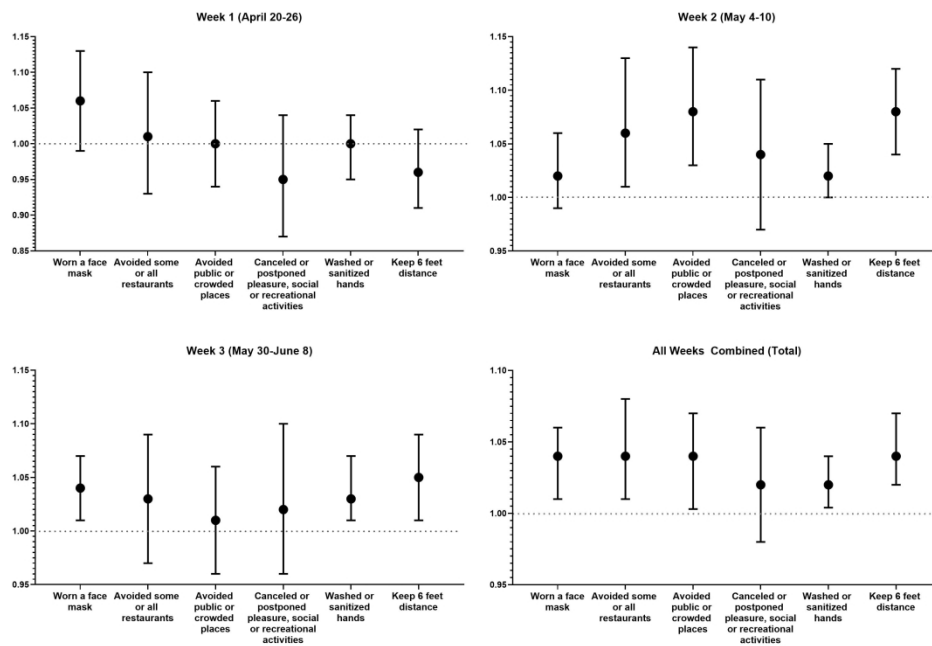
- 1
2
3 509 10. Here Are the States Where COVID-19 Is Increasing. (n.d.). Retrieved August 17, 2020, from
4
5 510 <https://www.healthline.com/health-news/here-are-the-states-where-covid-19-is-increasing>
6
7 511 11. COVID Impact Survey. (n.d.). Retrieved May 20, 2020, from <https://www.covid-impact.org/>
8
9 512 12. Barros, A. J. D., & Hiraikata, V. N. (2003). Alternatives for logistic regression in cross-sectional
10
11 513 studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC*
12
13 514 *Medical Research Methodology*, 3, 21. doi:10.1186/1471-2288-3-21
14
15 515 13. Behrens, T., Taeger, D., Wellmann, J., & Keil, U. (2004). Different methods to calculate effect
16
17 516 estimates in cross-sectional studies. A comparison between prevalence odds ratio and
18
19 517 prevalence ratio. *Methods of Information in Medicine*, 43(5), 505–509.
20
21 518 14. Coutinho, L. M. S., Sczufca, M., & Menezes, P. R. (2008). Methods for estimating prevalence
22
23 519 ratios in cross-sectional studies. *Revista de Saude Publica*, 42(6), 992–998.
24
25 520 15. Rothman, K. J. (1990). No adjustments are needed for multiple comparisons. *Epidemiology*, 1(1),
26
27 521 43–46.
28
29 522 16. Yue, S., Zhang, J., Cao, M., & Chen, B. (2020). Knowledge, Attitudes and Practices of COVID-
30
31 523 19 Among Urban and Rural Residents in China: A Cross-sectional Study. *Journal of*
32
33 524 *Community Health*. doi:10.1007/s10900-020-00877-x
34
35 525 17. Thu, T. P. B., Ngoc, P. N. H., Hai, N. M., & Tuan, L. A. (2020). Effect of the social distancing
36
37 526 measures on the spread of COVID-19 in 10 highly infected countries. *The Science of the*
38
39 527 *Total Environment*, 742, 140430. doi:10.1016/j.scitotenv.2020.140430
40
41 528 18. Siedner, M. J., Harling, G., Reynolds, Z., Gilbert, R. F., Haneuse, S., Venkataramani, A. S., &
42
43 529 Tsai, A. C. (2020). Social distancing to slow the US COVID-19 epidemic: Longitudinal
44
45 530 pretest–posttest comparison group study. *PLoS Medicine*, 17(8), e1003244.
46
47 531 doi:10.1371/journal.pmed.1003244
48
49 532 19. Koh, W. C., Alikhan, M. F., Koh, D., & Wong, J. (2020). Containing COVID-19: Implementation
50
51 533 of Early and Moderately Stringent Social Distancing Measures Can Prevent The Need for
52
53 534 Large-Scale Lockdowns. *Annals of global health*, 86(1), 88. doi:10.5334/aogh.2969
54
55 535 20. Dyal, J. W., Grant, M. P., Broadwater, K., Bjork, A., Waltenburg, M. A., Gibbins, J. D., ...
56
57 536 Steinberg, J. (2020). COVID-19 Among Workers in Meat and Poultry Processing Facilities -

- 1
2
3 537 19 States, April 2020. *MMWR. Morbidity and Mortality Weekly Report*, 69(18).
4
5 538 doi:10.15585/mmwr.mm6918e3
6
7 539 21. McClure, E. S., Vasudevan, P., Bailey, Z., Patel, S., & Robinson, W. R. (2020). Racial Capitalism
8
9 540 within Public Health: How Occupational Settings Drive COVID-19 Disparities. *American*
10
11 541 *Journal of Epidemiology*. doi:10.1093/aje/kwaa126
12
13 542 22. Czeisler, M. É., Tynan, M. A., Howard, M. E., Honeycutt, S., Fulmer, E. B., Kidder, D. P., ...
14
15 543 Czeisler, C. A. (2020). Public Attitudes, Behaviors, and Beliefs Related to COVID-19, Stay-
16
17 544 at-Home Orders, Nonessential Business Closures, and Public Health Guidance - United
18
19 545 States, New York City, and Los Angeles, May 5-12, 2020. *MMWR. Morbidity and Mortality*
20
21 546 *Weekly Report*, 69(24), 751–758. doi:10.15585/mmwr.mm6924e1
22
23 547 23. Niepel, C., Kranz, D., Borgonovi, F., Emslander, V., & Greiff, S. (2020). The coronavirus
24
25 548 (COVID-19) fatality risk perception of US adult residents in March and April 2020. *British*
26
27 549 *journal of health psychology*. doi:10.1111/bjhp.12438
28
29 550 24. Bruine de Bruin, W., & Bennett, D. (2020). Relationships Between Initial COVID-19 Risk
30
31 551 Perceptions and Protective Health Behaviors: A National Survey. *American Journal of*
32
33 552 *Preventive Medicine*, 59(2), 157–167. doi:10.1016/j.amepre.2020.05.001
34
35
36
37 553
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



283x213mm (300 x 300 DPI)



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 of potential 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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-044600.R1
Article Type:	Original research
Date Submitted by the Author:	13-Dec-2020
Complete List of Authors:	Islam, Jessica; University of North Carolina Lineberger Comprehensive Cancer Center, Vidot, Denise; University of Miami Health System Camacho-Rivera, Marlene; SUNY Downstate Health Sciences University
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	Epidemiology < TROPICAL MEDICINE, PUBLIC HEALTH, PREVENTIVE MEDICINE, Infection control < INFECTIOUS DISEASES

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 1 **Determinants of COVID-19 Preventive Behaviors among Adults with Chronic Diseases in the**
4
5 2 **United States: an analysis of the nationally representative COVID-19 Impact Survey**
6

7 3 Jessica Yasmine Islam, PhD, MPH
8 4 UNC Lineberger Comprehensive Cancer Center
9 5 School of Medicine
10 6 UNC Chapel Hill
11 7

12 8 Denise C. Vidot, PhD
13 9 School of Nursing and Health Studies
14 10 Sylvester Comprehensive Cancer Center, Miller School of Medicine
15 11 University of Miami
16 12

17 13 Marlene Camacho-Rivera, ScD, MPH
18 14 Department of Community Health Sciences
19 15 SUNY Downstate Health Sciences University
20 16
21 17

22 18 Running Title: COVID-19 Preventive Behaviors among Adults with Chronic Diseases
23
24

25 19
26 20 Corresponding Author: Dr. Jessica Yasmine Islam, PhD MPH
27 21 UNC Lineberger Comprehensive Cancer Center
28 22 School of Medicine
29 23 UNC Chapel Hill
30 24 450 West Drive
31 25 Chapel Hill, NC 27599
32 26 Email: islamjy@email.unc.edu
33 27

34 28 Abstract: 232 words
35

36 29 Main Text: 3206 words
37

38 30 Tables: 2
39

40 31 Figures: 2
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 (χ^2 -p<0.001), social distance (χ^2 -p<0.001), wash or sanitize hands (χ^2 -p<0.001), and avoid some or all restaurants (χ^2 -p=0.002) and public or crowded places (χ^2 -p=0.001). Adults with a \leq 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

1
2
3 68 **Article Summary**
4

5 69 **Strengths and Limitations of the Study**
6

- 7 70 • We were able to use nationally representative survey data collected from adults residing in the
8 United States, which improves the generalizability of the findings.
9 71
10 72 • We were able to compare preventive behaviors of adults with and without chronic diseases
11 based on self-report and include several conditions including diabetes, high blood pressure,
12 73 heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, cystic fibrosis,
13 74 liver disease, compromised immune system, or cancer.
14 75
15 76 • Data for this analysis, including reported preventive behaviors, were based on self-report
16 77 which may be subject to social desirability bias.
17 78
18 79 • We were unable to address important factors in evaluating adherence of preventive behaviors,
19 80 such as frequency of practicing preventive behaviors in the past 7 days.
20 81
21 82 • We were unable to probe further into why adults may not be adhering to recommended
22 83 COVID-19 prevention behaviors as those data were not available.
23 84
24 85
25 86
26 87
27 88
28 89
29 90
30 91
31 92
32 93
33 94
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

95 **Background**

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

123

124 Methods**125 COVID-19 Impact Survey**

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

137

138 AmeriSpeak Sample

139 Funded and operated by NORC at the University of Chicago, AmeriSpeak® is a probability-
140 based panel designed to be representative of the US household population. During the initial
141 recruitment phase of the AmeriSpeak panel, randomly selected US households were sampled using
142 area probability and address-based sampling, with a known, nonzero probability of selection from the
143 NORC National Sample Frame. These sampled households were then contacted by US mail,
144 telephone, and field interviewers (face to face). The panel provides sample coverage of approximately
145 97% of the US household population. Those excluded from the sample include people with P.O. Box
146 only addresses, some addresses not listed in the US Postal Service Delivery Sequence File, and some
147 newly constructed dwellings. While most AmeriSpeak households participate in surveys by web, non-
148 internet households were able to participate in AmeriSpeak surveys by telephone. Households without
149 conventional internet access but having web access via smartphones could participate in AmeriSpeak
150 surveys by web. AmeriSpeak panelists participate in NORC studies or studies conducted by NORC on

1
2
3 151 behalf of governmental agencies, academic researchers, and media and commercial organizations.
4
5 152 Interviews were conducted in English and Spanish. Panelists were offered a \$5 monetary incentive for
6
7 153 completing the survey. Interviews were conducted with adults age 18 and over representing the 50
8
9 154 states and the District of Columbia. Panel members were randomly drawn from AmeriSpeak. In
10
11 155 households with more than one adult panel member, only one was selected at random for the sample.
12
13 156 Invited panel members were given the option to complete the survey online or by telephone with an
14
15 157 NORC telephone interviewer. The number of participants invited, and percentage of interviews
16
17 158 completed by week are as follows: 11,133 invited with 19.7% interviews completed during Week 1;
18
19 159 8,570 invited with 26.1% interviews completed (Week 2); and 10,373 invited with 19.7% interviews
20
21 160 completed (Week 3). The analytic sample includes 10,760 adults nationwide. The final analytic
22
23 161 sample were weighted to reflect the US population of adults aged 18 years and over. The demographic
24
25 162 weighting variables were obtained from the 2020 Current Population Survey. The count of COVID-19
26
27 163 deaths by county was obtained from USA Facts.
28
29
30
31 164

32 165 Public Involvement Statement

33 166 Participants were not involved in the development of this manuscript or interpretation of the
34
35 167 results. The authors of this paper had not contact with the survey respondents and were not involved
36
37 168 in data collection as the publicly available data were collected by NORC at the University of Chicago
38
39 169 for the Data Foundation.
40
41
42

43 170

44 171 Measures

45
46
47 172 To evaluate adherence to COVID-19 preventive behaviors, we used participants' responses
48
49 173 (yes/no) to the following question: "Which of the following measures, if any, are you taking in
50
51 174 response to the coronavirus?" Participants were able to select all that applied from a list of 19 options.
52
53 175 We focused on the following commonly recommended preventive behaviors: Worn a face mask;
54
55 176 Avoided some or all restaurants; Avoided public or crowded places; Canceled or postponed pleasure,
56
57 177 social or recreational activities; Washed or sanitized hands; and Kept six feet distance from those
58
59 178 outside my household.
60

1
2
3 179 We defined an adult to have a physical chronic disease using participants' self-reported
4
5 180 response (yes/no) to the following question: "Has a doctor or other health care provider ever told you
6
7 181 that you have any of the following: Diabetes; High blood pressure or hypertension; Heart disease,
8
9 182 heart attack or stroke; Asthma; Chronic lung disease or COPD; Bronchitis or emphysema; a Cystic
10
11 183 fibrosis; Liver disease or end-stage liver disease; Cancer; a Compromised immune system." We
12
13 184 defined those who selected "Yes" to any of the listed conditions as adults with a physical chronic
14
15 185 condition.

16
17
18 186 The following covariates were included in the multivariable analyses: age categories (18-29,
19
20 187 30-44, 25-59, 60+), sex (male, female), education categories (HS graduate/equivalent or below, some
21
22 188 college, baccalaureate degree or above), race/ethnicity categories [non-Hispanic (NH) White, NH-
23
24 189 Black, Hispanic, NH-Asian, NH-Other], having at least one COVID-19 related symptom, healthy with
25
26 190 no self-reported chronic disease, census region (Northeast, Midwest, South, West), insurance status,
27
28 191 household income (<\$50,000, \$50,000-<\$100,000, ≥\$100,000), and population density (rural,
29
30 192 suburban, urban). Population density was determined based on the 2010 US Census data[12].
31
32
33 193

34 194 Data Analysis

35
36
37 195 Descriptive statistics are displayed in percentages among all respondents unless otherwise
38
39 196 labeled and include a margin of error of +/- 3.0 percentage points at the 95% confidence intervals
40
41 197 among all adults. Chi-squared (χ^2) tests were used for bivariate comparison of preventive behaviors
42
43 198 against the COVID-19 pandemic among adults with chronic diseases compared to others. Further, we
44
45 199 conducted multivariable Poisson regression analyses to evaluate associations of preventive behaviors
46
47 200 with having a chronic disease after adjustment for the following variables: age, sex, race
48
49 201 (white/Minority), area of residence (rural/suburban/urban), and annual household income. To estimate
50
51 202 determinants of not practicing COVID-19 preventive behaviors, we computed prevalence ratios with
52
53 203 Poisson regression using robust estimation of standard errors[14–16]. The COVID-19 preventive
54
55 204 behaviors evaluated include those who responded no to all the following behaviors: worn a face mask,
56
57 205 avoided some or all restaurants, avoided public or crowded places, canceled or postponed pleasure,
58
59 206 social or recreational activities, washed or sanitized hands, and keep six feet distance. Potential

1
2
3 207 variables for inclusion in the model were assessed using available sociodemographic variables and
4
5 208 bivariate Poisson regression analysis. Due to the exploratory nature of this analysis using a predictive
6
7 209 framework, an arbitrary p-value of <0.10 was used as criteria to include the variable in the
8
9 210 multivariable Poisson regression model. For multivariable Poisson regression models, adjusted
10
11 211 prevalence ratios (aPR), and 95% confidence intervals (CIs) for each independent variable were
12
13 212 calculated. Additionally, p-value <0.05 was used as the level of significance. Collinearity was
14
15 213 assessed using the variance inflation factor to ensure a strong linear relationship among independent
16
17 214 variables included in the model was not present. Based on the exploratory nature of this analysis, we
18
19 215 did not include an adjustment for multiple comparisons[17]. All statistical analyses were conducted
20
21 216 using Stata IC 15.1 (StataCorp LLC, College Station, TX). Sampling weights were applied to provide
22
23 217 results that were nationally representative of the US adult population.
24
25
26 218

28 219 **Results**

30 220 Table 1 summarizes the demographic characteristics of the study population stratified by
31
32 221 having a chronic disease. Participants with chronic diseases were mostly over the age of 45 years
33
34 222 (68.3%) and non-Hispanic (NH) White (65.0%). Adults with chronic diseases were 51% female and
35
36 223 42% were employed within the past seven days. The majority had at least some college or
37
38 224 Baccalaureate degree or above (60.2%) and 21% had an income over \geq \$100,000. Sixty-nine percent
39
40 225 of adults with chronic diseases lived in urban areas and 48% had an employer-sponsored insurance.
41
42

43 226 Figure 1 summarizes preventive behaviors stratified by having a chronic disease or not across
44
45 227 all weeks of data collection and over time from Week 1 (late April) to Week 3 (early June). When
46
47 228 evaluating all weeks combined, we observed that adults without chronic diseases (83%) were less
48
49 229 likely to wear a mask (87%) (χ^2 -p <0.001). Adults with chronic diseases were not more likely to
50
51 230 cancel or postpone pleasure, social or recreational activities (66%) compared to adults without chronic
52
53 231 diseases (64%) (χ^2 -p =0.08). Next, we observed that over time adults with chronic diseases grew
54
55 232 more likely to keep 6 feet distance from those outside their household: In late April there was no
56
57 233 significant difference by chronic disease status (χ^2 -p=0.71), however, during early May adults with
58
59 234 chronic diseases were more likely to practice social distancing (86%) compared to adults without
60

1
2
3 235 chronic diseases (80%) (χ^2 -p <0.001). Similarly, again, in early June adults with chronic diseases
4
5 236 were more likely (86%) than adults without chronic diseases (79%) (χ^2 -p <0.001). We observed
6
7 237 similar trends over time for washing or sanitizing hands and avoiding some or all restaurants. Overall,
8
9 238 adults with chronic diseases were more likely to wash or sanitize their hands (92%) than adults
10
11 239 without chronic diseases (86%) (χ^2 -p <0.001). Adults with chronic diseases were also more likely
12
13 240 (72%) to avoid some or all restaurants than adults without chronic diseases (69%) (χ^2 -p =0.002) and
14
15 241 to avoid public or crowded places (78% vs. 74%) (χ^2 -p =0.001) (Figure 1).

16
17
18 242 On multivariable analyses, after adjustment for age, race/ethnicity, sex, area of residence
19
20 243 (rural/suburban/urban), and household annual income, we observed significant differences across
21
22 244 chronic disease status (Figure 2). Adults with chronic diseases had a 4% higher prevalence of wearing
23
24 245 a face mask (aPR: 1.04, 95% CI: 1.01-1.06), avoiding some or all restaurants (aPR: 1.04, 95% CI:
25
26 246 1.01-1.08), avoiding public or crowded places (aPR: 1.04, 95% CI: 1.01-1.07), and keeping six feet
27
28 247 distance (aPR: 1.04, 95% CI: 1.02-1.07). Additionally, adults with chronic diseases had a 2% higher
29
30 248 prevalence of washing or sanitizing hands (aPR: 1.02, 95% CI: 1.01-1.04).

31
32
33 249 Table 2 summarizes results of multivariable analyses to identify determinants of not adhering
34
35 250 to recommended COVID-19 preventive behaviors. Overall, 2.4% of adults responded no to all the
36
37 251 following behaviors: worn a face mask, avoided some or all restaurants, avoided public or crowded
38
39 252 places, canceled or postponed pleasure, social or recreational activities, washed or sanitized hands,
40
41 253 and keep six feet distance from those living outside their home. Non-adherence to recommended
42
43 254 preventive behaviors was more likely among adults with a high school degree or below compared to
44
45 255 those with a Baccalaureate degree or above (aPR: 1.86, 95% CI: 1.06-3.27). Additionally, non-
46
47 256 adherence to recommended behaviors was more likely among adults without any chronic diseases
48
49 257 (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
50
51 258 uninsured (aPR: 1.79, 95% CI: 1.16-2.75). Adults with a household income less than \$50,000 were
52
53 259 more likely not to adhere to preventive behaviors compared to those with an income over \$100,000
54
55 260 (aPR: 2.05, 95% CI: 1.14-2.85). Compared to adults living in urban areas, adults in rural areas had a
56
57 261 70% higher prevalence of non-adherence to recommended preventive behaviors. Non-adherence to
58
59
60

262 recommended preventive behaviors was less likely among female adults compared to males (aPR:
263 0.47, 95% CI: 0.32-0.69).

264

265 **Discussion**

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

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

1
2
3 290 endorsement of COVID-19 misinformation (e.g. underestimating importance of social distancing,
4
5 291 misinformed beliefs around COVID-19 vaccination) have been documented in the US and beyond
6
7 292 [24,25]. Conversely, our study findings may also reflect changes in attitudes around COVID-19
8
9 293 preventive behaviors[26]. Prior studies examining the associations between COVID-19 information
10
11 294 sources and attitudes towards COVID-19 messaging have elucidated differences in trust of COVID-
12
13 295 19 information and self-reported adherence to COVID-19 preventive behaviors among men,
14
15 296 individuals who are unemployed or retired, and adults who politically identify as Republican [27–30].
16
17 297 While we were unable to adjust for political affiliation within our analyses due to the lack of data
18
19 298 availability within the COVID-19 Impact Survey, research shows that non-Hispanic Whites, men, and
20
21 299 individuals residing in rural areas more frequently identify their political affiliation as Republican
22
23 300 [31,32]. Our observed geographic disparities in COVID-19 preventive behaviors may also be a
24
25 301 reflection of variability in state or local policies regarding COVID-19 preventive behaviors across the
26
27 302 U.S. Individuals residing in U.S. states and counties that have implemented mandatory COVID-19
28
29 303 preventive behaviors, including stay-at-home orders, social distancing, and mandatory mask use in
30
31 304 public, are more likely to exhibit positive individual-level COVID-19 preventive behaviors [33–
32
33 305 35]. Inequities in ability or willingness to practice COVID-19 preventive behaviors may lead to
34
35 306 inequitable risk and morbidity of COVID-19 among these at-risk groups. Future research should focus
36
37 307 on the impact of state-level COVID-19 prevention policies to evaluate area-level differences in
38
39 308 individual preventive behaviors and to disentangle whether certain demographics of U.S. adults are
40
41 309 either unwilling or unable to adhere to recommended guidelines.

42
43
44
45 310 Importantly, we found that adults without any chronic diseases were more likely to not adhere
46
47 311 to practice preventive behaviors, which indicates the potential for improvement among public health
48
49 312 professionals in communicating risk to impact risk perception. Prior studies have shown that higher
50
51 313 perceived risk of infection and COVID-19 disease had a positive impact on implementation of
52
53 314 protective behaviors such as handwashing and social distancing[36,37]. Early in the pandemic, one
54
55 315 study found that on a scale from 0-100%, the average perceived risk of infection incidence was 10%
56
57 316 and 5% for mortality, and perceived risk had a positive impact on practicing preventive behaviors: An
58
59 317 increase of 1 quartile in perceived infection risk was associated with 45% and 24% higher odds of

1
2
3 318 reporting handwashing and social distancing, respectively[37]. Similarly, another study found that the
4
5 319 perceived risk of infection increased from March to April, however, U.S. adults severely
6
7 320 underestimated their absolute and relative fatality risk compared to epidemiological figures available
8
9 321 at the time of the study. They also found that the participant's risk perception highly influenced their
10
11 322 actual or intended adherence to preventive behaviors that can reduce COVID-19 spread[36]. Our
12
13 323 findings complement these prior studies and underscore the need for improved risk communication
14
15 324 specifically among the demographic groups we identified. The public health and medical community
16
17 325 working to address the COVID-19 pandemic should also be aware that risk communication alone may
18
19 326 not meet the needs of certain demographic groups, and equitable access to resources or opportunities
20
21 327 to practice recommended preventive behaviors should be coupled into preventive programming.

22
23
24 328 Our study findings are subject to several limitations. First, behaviors and practice of
25
26 329 recommendations were self-reported; therefore, responses might be subject to recall, response, and
27
28 330 social desirability biases. Second, while we were able to adjust for many social and demographic
29
30 331 characteristics, we were limited by the availability of the data and may have failed to account for
31
32 332 unmeasured variables associated with practice of preventive behaviors and chronic conditions. We
33
34 333 were unable to probe further into why adults may not be adhering to recommended COVID-19
35
36 334 prevention behaviors as those data were not available. Future qualitative studies should be prioritized
37
38 335 to ask more detailed questions regarding attitudes and perceptions of COVID-19 recommended
39
40 336 preventive behaviors in the U.S. The percentage of rural adults included in this sample was lower than
41
42 337 expected, potentially due to differences in response rates by area of residence, and as such, future
43
44 338 efforts to survey rural adults on their preventive behaviors should be specifically prioritized. Strengths
45
46 339 include the incorporation of multiple cross-sectional waves of data to understand COVID-19
47
48 340 preventive behaviors over time, use of a nationally representative sample of U.S. adults, and
49
50 341 examination of a broad range of COVID-19 preventive behaviors.

51
52
53 342 As the pandemic progresses and subsequent outbreaks occur, understanding public behaviors
54
55 343 and determinants of preventive behaviors is critical. Practice of recommendations to wear cloth face
56
57 344 coverings, physical distancing, and quarantine guidelines is of utmost public health importance.
58
59 345 Overall, strong public adherence to these behaviors suggests an opportunity to normalize and continue
60

1
2
3 346 to promote safe practices as states reopen, while disparities in practice of behaviors among specific
4
5 347 demographic groups offers opportunities for targeted outreach and education.
6
7 348
8 349
9 350
10 351
11 352
12 353
13 354
14 355
15 356
16 357
17 358
18 359
19 360
20 361
21 362
22 363
23 364
24 365
25 366
26 367
27 368
28 369
29 370
30 371
31 372
32 373
33 374
34 375
35 376
36 377
37 378
38 379
39 380
40 381
41 382
42 383
43 384
44 385
45 386
46 387
47 388
48 389
49 390
50 391
51 392
52 393
53 394
54 395
55 396
56 397
57 398
58
59
60

For peer review only

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>.

Funding and Financial Support: JYI is supported by UNC's Cancer Care Quality Training 2T32CA116339-11. MCR is supported by the TRANSPORT – The Translational Program of Health Disparities Research Training 5S21MD012474-02.

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 publicly available.

415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439

1
2
3 **440 Figures**

4 441
5 442 Figure 1: Adherence to COVID-19 preventive behaviors among those without chronic diseases
6 443 compared to those with chronic diseases in the U.S.
7 444

8 445 Figure 2: Associations of adherence to COVID-19 preventive behaviors among US adults with
9 446 chronic diseases
10 447
11 448
12 449
13 450
14 451
15 452
16 453
17 454
18 455
19 456
20 457
21 458
22 459
23 460
24 461
25 462
26 463
27 464
28 465
29 466
30 467
31 468
32 469
33 470
34 471
35 472
36 473
37 474
38 475
39 476
40 477
41 478
42 479
43 480
44 481
45 482
46 483
47 484
48 485
49 486
50 487
51 488
52 489
53 490
54 491
55
56
57
58
59
60

For peer review only

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

492

493

For peer review only

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	0.41-1.41
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.

494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516

For peer review only

1
2
3 517 **Bibliography**

- 4 518 1 Cases and Deaths in the U.S. | CDC. [https://www.cdc.gov/coronavirus/2019-ncov/cases-](https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/us-cases-deaths.html)
5 519 updates/us-cases-deaths.html (accessed 15 Aug2020).
- 6 520 2 Certain Medical Conditions and Risk for Severe COVID-19 Illness | CDC.
7 521 [https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-](https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fneed-extra-precautions%2Fgroups-at-higher-risk.html)
8 522 conditions.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-
9 523 ncov%2Fneed-extra-precautions%2Fgroups-at-higher-risk.html (accessed 15 Aug2020).
- 10 524 3 How to Protect Yourself & Others | CDC. [https://www.cdc.gov/coronavirus/2019-ncov/prevent-](https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html)
11 525 getting-sick/prevention.html (accessed 13 Aug2020).
- 12 526 4 3 W's to reduce the risk of COVID-19 | Prevent Epidemics.
13 527 <https://preventepidemics.org/covid19/science/insights/3-ws-to-reduce-the-risk-of-covid-19/>
14 528 (accessed 15 Aug2020).
- 15 529 5 As Coronavirus Surges in U.S., Some Countries Have Just About Halted It - WSJ.
16 530 [https://www.wsj.com/articles/as-coronavirus-surges-in-u-s-some-countries-have-just-about-](https://www.wsj.com/articles/as-coronavirus-surges-in-u-s-some-countries-have-just-about-halted-it-11594037814)
17 531 halted-it-11594037814 (accessed 15 Aug2020).
- 18 532 6 How Some Countries Brought New Coronavirus Cases Down To Nearly Zero : Goats and Soda :
19 533 NPR. [https://www.npr.org/sections/goatsandsoda/2020/05/23/861577367/messaging-from-](https://www.npr.org/sections/goatsandsoda/2020/05/23/861577367/messaging-from-leaders-who-have-tamed-their-countrys-coronavirus-outbreaks)
20 534 leaders-who-have-tamed-their-countrys-coronavirus-outbreaks (accessed 15 Aug2020).
- 21 535 7 Camacho-Rivera M, Islam JY, Vidot DC. Associations Between Chronic Health Conditions and
22 536 COVID-19 Preventive Behaviors Among a Nationally Representative Sample of U.S. Adults: An
23 537 Analysis of the COVID Impact Survey. *Health Equity* 2020;**4**:336–344.
24 538 doi:10.1089/heq.2020.0031
- 25 539 8 A Detailed Map of Who Is Wearing Masks in the U.S. - The New York Times.
26 540 <https://www.nytimes.com/interactive/2020/07/17/upshot/coronavirus-face-mask-map.html>
27 541 (accessed 17 Aug2020).
- 28 542 9 CDC COVID Data Tracker. <https://www.cdc.gov/covid-data-tracker/> (accessed 17 Aug2020).
- 29 543 10 Here Are the States Where COVID-19 Is Increasing. [https://www.healthline.com/health-](https://www.healthline.com/health-news/here-are-the-states-where-covid-19-is-increasing)
30 544 news/here-are-the-states-where-covid-19-is-increasing (accessed 17 Aug2020).
- 31 545 11 COVID Impact Survey. <https://www.covid-impact.org/> (accessed 20 May2020).
- 32 546 12 Wozniak A, Willey J, Benz J, *et al*. The COVID Impact Survey: Methodological Approach. National
33 547 Opinion Research Center 2020.
34 548 [http://static1.squarespace.com/static/5e8769b34812765cff8111f7/t/5ee116321eed0b7432545](http://static1.squarespace.com/static/5e8769b34812765cff8111f7/t/5ee116321eed0b743254564c/1591809593661/COVID+Impact+Methods+Statement_wk3_web.pdf)
35 549 64c/1591809593661/COVID Impact_Methods Statement_wk3_web.pdf (accessed 10 Dec2020).
- 36 550 13 Islam JY, Camacho-Rivera M, Vidot DC. Examining COVID-19 Preventive Behaviors among
37 551 Cancer Survivors in the United States: An Analysis of the COVID-19 Impact Survey. *Cancer*
38 552 *Epidemiol Biomarkers Prev* 2020;**29**:2583–2590. doi:10.1158/1055-9965.EPI-20-0801
- 39 553 14 Barros AJD, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an
40 554 empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res*
41 555 *Methodol* 2003;**3**:21. doi:10.1186/1471-2288-3-21
- 42 556 15 Behrens T, Taeger D, Wellmann J, *et al*. Different methods to calculate effect estimates in cross-
43 557 sectional studies. A comparison between prevalence odds ratio and prevalence ratio. *Methods*
44 558 *Inf Med* 2004;**43**:505–509.
- 45 559 16 Coutinho LMS, Scazufca M, Menezes PR. Methods for estimating prevalence ratios in cross-
46 560 sectional studies. *Rev Saude Publica* 2008;**42**:992–998.
- 47 561 17 Rothman KJ. No adjustments are needed for multiple comparisons. *Epidemiology* 1990;**1**:43–46.
- 48 562 18 Yue S, Zhang J, Cao M, *et al*. Knowledge, Attitudes and Practices of COVID-19 Among Urban and
49 563 Rural Residents in China: A Cross-sectional Study. *J Community Health* Published Online First: 5
50 564 August 2020. doi:10.1007/s10900-020-00877-x
- 51 565 19 Thu TPB, Ngoc PNH, Hai NM, *et al*. Effect of the social distancing measures on the spread of
52 566 COVID-19 in 10 highly infected countries. *Sci Total Environ* 2020;**742**:140430.
53 567 doi:10.1016/j.scitotenv.2020.140430

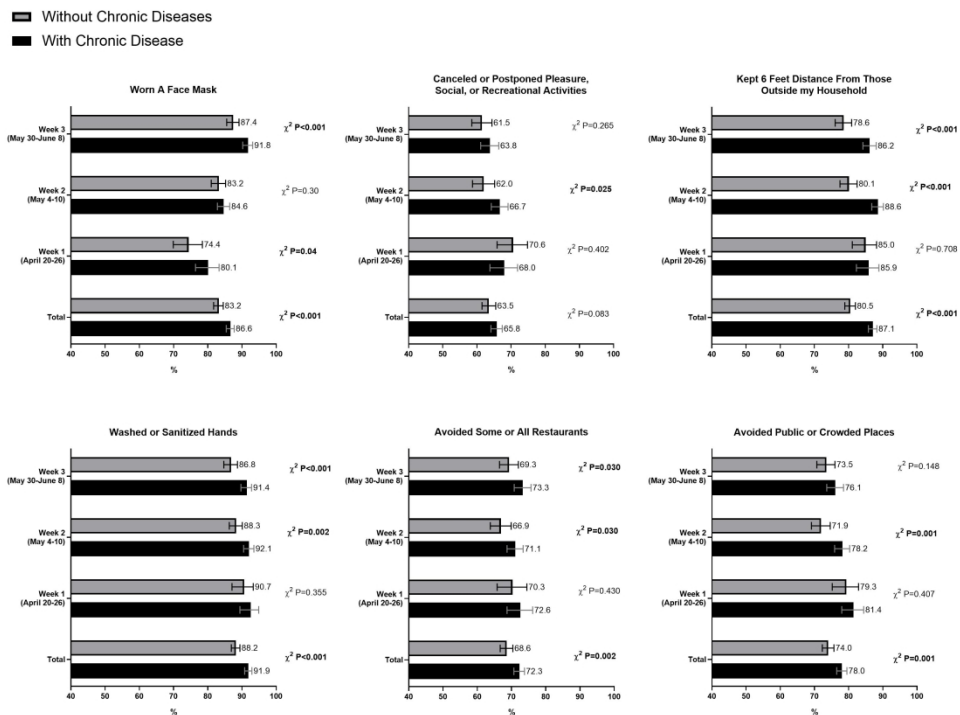
- 1
2
3 568 20 Siedner MJ, Harling G, Reynolds Z, *et al.* Social distancing to slow the US COVID-19 epidemic:
4 569 Longitudinal pretest-posttest comparison group study. *PLoS Med* 2020;**17**:e1003244.
5 570 doi:10.1371/journal.pmed.1003244
6 571 21 Koh WC, Alikhan MF, Koh D, *et al.* Containing COVID-19: Implementation of Early and
7 572 Moderately Stringent Social Distancing Measures Can Prevent The Need for Large-Scale
8 573 Lockdowns. *Ann Glob Health* 2020;**86**:88. doi:10.5334/aogh.2969
9 574 22 Dyal JW, Grant MP, Broadwater K, *et al.* COVID-19 Among Workers in Meat and Poultry
10 575 Processing Facilities - 19 States, April 2020. *MMWR Morb Mortal Wkly Rep* 2020;**69**.
11 576 doi:10.15585/mmwr.mm6918e3
12 577 23 McClure ES, Vasudevan P, Bailey Z, *et al.* Racial Capitalism within Public Health: How
13 578 Occupational Settings Drive COVID-19 Disparities. *Am J Epidemiol* Published Online First: 3 July
14 579 2020. doi:10.1093/aje/kwaa126
15 580 24 Bailey SC, Serper M, Opsasnick L, *et al.* Changes in COVID-19 Knowledge, Beliefs, Behaviors, and
16 581 Preparedness Among High-Risk Adults from the Onset to the Acceleration Phase of the US
17 582 Outbreak. *J Gen Intern Med* 2020;**35**:3285–3292. doi:10.1007/s11606-020-05980-2
18 583 25 O’Conor R, Opsasnick L, Benavente JY, *et al.* Knowledge and Behaviors of Adults with Underlying
19 584 Health Conditions During the Onset of the COVID-19 U.S. Outbreak: The Chicago COVID-19
20 585 Comorbidities Survey. *J Community Health* 2020;**45**:1149–1157. doi:10.1007/s10900-020-
21 586 00906-9
22 587 26 Czeisler MÉ, Tynan MA, Howard ME, *et al.* Public Attitudes, Behaviors, and Beliefs Related to
23 588 COVID-19, Stay-at-Home Orders, Nonessential Business Closures, and Public Health Guidance -
24 589 United States, New York City, and Los Angeles, May 5-12, 2020. *MMWR Morb Mortal Wkly Rep*
25 590 2020;**69**:751–758. doi:10.15585/mmwr.mm6924e1
26 591 27 Ali SH, Foreman J, Tozan Y, *et al.* Trends and Predictors of COVID-19 Information Sources and
27 592 Their Relationship With Knowledge and Beliefs Related to the Pandemic: Nationwide Cross-
28 593 Sectional Study. *JMIR Public Health Surveill* 2020;**6**:e21071. doi:10.2196/21071
29 594 28 Dhanani LY, Franz B. The Role of News Consumption and Trust in Public Health Leadership in
30 595 Shaping COVID-19 Knowledge and Prejudice. *Front Psychol* 2020;**11**:560828.
31 596 doi:10.3389/fpsyg.2020.560828
32 597 29 Nagler RH, Vogel RI, Gollust SE, *et al.* Public perceptions of conflicting information surrounding
33 598 COVID-19: Results from a nationally representative survey of U.S. adults. *PLoS One*
34 599 2020;**15**:e0240776. doi:10.1371/journal.pone.0240776
35 600 30 Callow MA, Callow DD, Smith C. Older Adults’ Intention to Socially Isolate Once COVID-19 Stay-
36 601 at-Home Orders Are Replaced With “Safer-at-Home” Public Health Advisories: A Survey of
37 602 Respondents in Maryland. *J Appl Gerontol* 2020;**39**:1175–1183.
38 603 doi:10.1177/0733464820944704
39 604 31 Lesthaeghe R, Neidert L. US presidential elections and the spatial pattern of the american
40 605 second demographic transition. *Popul Dev Rev* 2009;**35**:391–400. doi:10.1111/j.1728-
41 606 4457.2009.00284.x
42 607 32 Stoetzer MW, Gerlich S, Koesters J. Trump’s first triumph: The US republican primaries 2016-An
43 608 analysis of socio-demographic, time-related and regional influences. 2017.
44 609 33 Liu Y, Mattke S. Association between state stay-at-home orders and risk reduction behaviors
45 610 and mental distress amid the COVID-19 pandemic. *Prev Med* 2020;**141**:106299.
46 611 doi:10.1016/j.ypmed.2020.106299
47 612 34 Van Dyke ME, Rogers TM, Pevzner E, *et al.* Trends in County-Level COVID-19 Incidence in
48 613 Counties With and Without a Mask Mandate - Kansas, June 1-August 23, 2020. *MMWR Morb*
49 614 *Mortal Wkly Rep* 2020;**69**:1777–1781. doi:10.15585/mmwr.mm6947e2
50 615 35 Gallaway MS, Rigler J, Robinson S, *et al.* Trends in COVID-19 Incidence After Implementation of
51 616 Mitigation Measures - Arizona, January 22-August 7, 2020. *MMWR Morb Mortal Wkly Rep*
52 617 2020;**69**:1460–1463. doi:10.15585/mmwr.mm6940e3
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

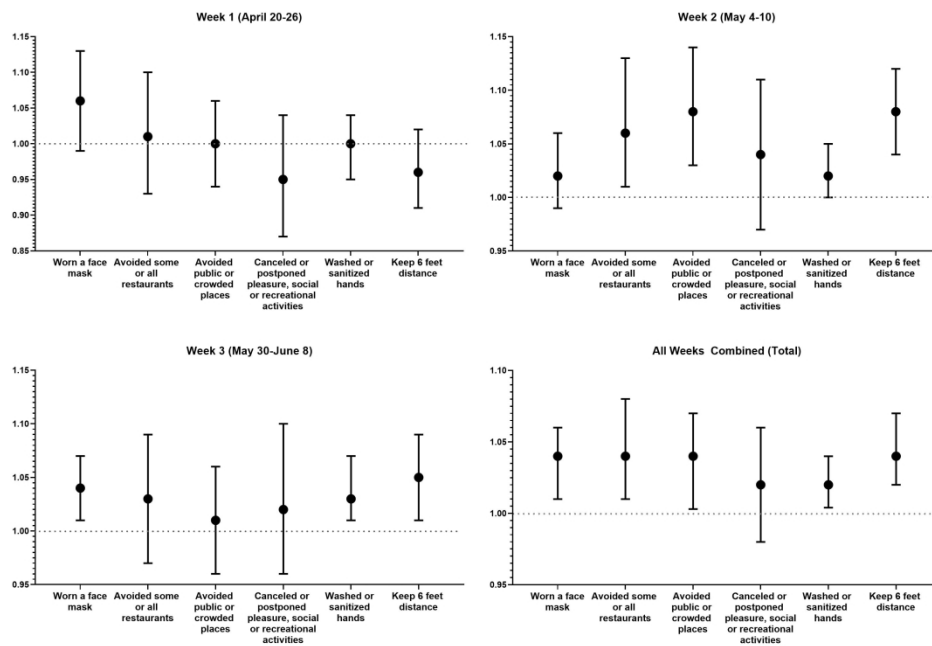
618 36 Niepel C, Kranz D, Borgonovi F, *et al*. The coronavirus (COVID-19) fatality risk perception of US
619 adult residents in March and April 2020. *Br J Health Psychol* Published Online First: 10 June
620 2020. doi:10.1111/bjhp.12438
621 37 Bruine de Bruin W, Bennett D. Relationships Between Initial COVID-19 Risk Perceptions and
622 Protective Health Behaviors: A National Survey. *Am J Prev Med* 2020;**59**:157–167.
623 doi:10.1016/j.amepre.2020.05.001
624

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



283x213mm (300 x 300 DPI)



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 of potential 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.