Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Public Health 211 (2022) 164–170

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Themed Paper — Original Research

COVID-19 risk factors and predictors for handwashing, masking, and social distancing among a national prospective cohort of US older adults

R. Wong [a, *], J.R. Grullon [b], M.A. Lovier [a]

[a] Department of Public Health and Preventive Medicine, Norton College of Medicine, SUNY Upstate Medical University, Syracuse, NY, USA
[b] Norton College of Medicine, SUNY Upstate Medical University, Syracuse, NY, USA

ARTICLE INFO

Article history:
Received 19 April 2022
Received in revised form
1 August 2022
Accepted 9 August 2022
Available online 18 August 2022

Keywords:
COVID
Handwash
Mask
Older adults
Public health emergency
Social distance

ABSTRACT

Objectives: Older adults have a disproportionately higher COVID-19 risk; however, there is limited research investigating adherence to the major COVID-19 mitigation behaviors (handwashing, masking, social distancing) for older populations. We examined COVID-19 risk factors and predictors for adherence to COVID-19 mitigation behaviors among a national sample of US older adults.

Study design: Data were retrieved for 3257 respondents from a nationally representative prospective sample of US Medicare beneficiaries aged ≥65 years. COVID-19 variables were collected in 2020, whereas all other data were collected in 2019.

Methods: We used multiple logistic regression to analyze COVID-19 risk factors and predictors for handwashing, masking, and social distancing to minimize COVID-19 spread. All models applied survey sampling weights.

Results: Factors significantly associated with increased odds of COVID-19 diagnosis among US older adults were Hispanic ethnicity (adjusted odds ratio [aOR] = 2.83, $P = .01$), income (aOR = 0.71, $P = .04$), residential care or nursing home (aOR = 2.62, $P = .01$), and generalized anxiety disorder (aOR = 2.38, $P = .04$). We identified multiple factors significantly associated with adherence to handwashing, masking, and social distancing. Most notably, older males had a significantly lower odds of practicing all three COVID-19 mitigation behaviors, and Black older adults had a significantly higher odds of masking (aOR = 7.94, $P < .001$) and social distancing (aOR = 2.33, $P = .01$).

Conclusions: When prioritizing COVID-19 prevention efforts for older adults, risk factors that should be considered are race and ethnicity, income, residential setting, and anxiety. To effectively mitigate COVID-19 disease spread, public health professionals must also recognize sociodemographic and health factors may influence whether older adults adhere to handwashing, masking, and social distancing.

Introduction

The COVID-19 pandemic caused by severe acute respiratory coronavirus 2 (SARS-CoV-2) has reached critical levels and inundated many nations. As of April 2022, the United States leads the global community with more than 80.4 million total cases and 986,123 confirmed deaths.[1] As a result of this public health emergency, many countries, including the United States, have sought refuge in multipronged preventative public health actions, even going as far as implementing restrictive measures such as social distancing, home quarantine, and curfews to limit the spread.

Although COVID-19 affects all age groups, one group disproportionately impacted is older adults. Although those aged ≥50 years comprise only 35.7% of the US population, they account for 93.3% of the total US COVID-19 deaths.[1] Older adults have not only a higher risk for severe COVID-19 infections and hospitalization but also greater mortality compared with other age groups.[2] Older age is a major risk factor with those who get infected often needing hospitalization, critical care, or a ventilator. Older adults are generally more vulnerable because of their comorbidities and weakened immune systems.[3]

Given the limited research on COVID-19 among US older adults, few specific risk factors have been reported and elucidated.

* Corresponding author. 2263 Weiskotten Hall, 766 Irving Avenue, Syracuse, NY 13210, USA. Tel.: +1 631 533 0163.
E-mail address: WongRo@upstate.edu (R. Wong).

https://doi.org/10.1016/j.puhe.2022.08.002
0033-3506/

Nonetheless, there are multiple social determinants of health that are associated with increased risk for COVID-19. Race and ethnicity persist as a well-documented risk factor for COVID-19, especially in older adults.[4] Older adults of color compared with non-Hispanic Whites in the United States experience higher age-adjusted hospitalizations and death from COVID-19. One possible reason is differential exposure by residential setting. For instance, non-Hispanic Black older adults are disproportionately represented in US nursing homes.[4] During the pandemic, long-term care facilities commonly faced personal protective equipment and staffing shortages, which exacerbated their inability to comply with required infection control measures.[5] Even when controlling for self-reported staff and personal protective equipment shortage, US nursing homes that contained more racial and ethnic minority residents still reported higher weekly new confirmed COVID-19 cases and deaths.[6]

Similarly, living arrangement is another common COVID-19 risk factor for older adults, given the ease of transmitting the virus. In multigenerational households, older adults are more likely to live in overcrowded housing, in which there is more than one person per room.[4] When adjusting for area-level socio-economic and clinical characteristics, overcrowding in US multigenerational households remains as a risk factor for COVID-19 infection.[7] Thus, social distancing restrictions that increase house-bound populations may unintentionally increase transmission risk for COVID-19 in older adults.

Public health guidelines recommend mitigation behaviors such as masking, social distancing, and handwashing to mitigate the spread of COVID-19. Behaviors such as masking and social distancing have been shown to reduce the risk of positive cases of COVID-19.[8] In countries, including the United States, where masking is not the cultural norm, higher mask use was positively associated with the following factors: age <50 years; tertiary education; mask use before pandemic; knowing a family, friend, or colleague diagnosed with COVID-19; having cold or flu-like symptoms; self-reported adherence to local mask guidelines; and mask mandates.[9] In the same study, New York's mask use among participants aged ≥50 years was not significantly different.

Although there is limited US domestic data on handwashing during COVID-19, few specific handwashing predictors are known. In a study that included the United States among four other countries, handwashing was significantly associated with the following factors: older age, rural residence, female, and greater educational attainment.[10] The same study reported similar predictors for social distancing. In a US study, higher percentages of older adults, women, Hispanics, and Black adults self-reported that they remembered to wash their hands in multiple situations before and during the pandemic.[11]

Unlike handwashing, COVID-19–related social distancing and its predictors in the United States are more heavily researched. Social distancing varied by generational cohort, with older generations more likely to social distance despite lower risk perceptions.[12] Social distancing compliance is positively associated with perceived susceptibility of COVID-19 and perceived benefits of social distancing.[13]

Although older adults have been shown to have higher prevalence and incidence rates for COVID-19, there is limited research examining risk factors that contribute to this phenomenon using a national US sample. One prior study examined sociodemographic and health characteristics in the context of personality as a predictor for COVID-19 mitigation behaviors but did not focus on these factors primarily or to the same depth as our present research, nor did it investigate these factors as predictors of COVID-19 itself.[14] To our knowledge, this study is the most thorough analysis yet of sociodemographic and health predictors of COVID-19 diagnosis and of adherence to the three major COVID-19 mitigation behaviors (handwashing, masking, social distancing) among US older adults. Therefore, the purposes of this study were to (1) examine the risk factors for COVID-19 among US older adults and (2) examine the predictors for adherence to handwashing, masking, and social distancing as COVID-19 prevention measures.

Methods

Data source

We retrieved data from the National Health and Aging Trends Study (NHATS), a prospective longitudinal survey containing a nationally representative sample of US Medicare beneficiaries aged ≥65 years. The study oversamples persons at older ages and Black individuals. We merged data from the 2019 NHATS and the 2020 NHATS COVID-19 supplement, in which most of these self-administered questionnaires were completed in July 2020 (51.0%) or August 2020 (33.3%). There was an 82.2% response rate for the NHATS COVID-19 supplement, resulting in 3257 older adults in our final sample. Aside from the COVID-related dependent variables, all other variables were retrieved from the 2019 data.

Dependent variables

COVID-19 diagnosis

Self-reported COVID-19 diagnosis was derived from two questions. First, respondents were asked, 'Has a doctor or other health professional told you that you may have had COVID-19?' and available responses were, 'Yes, definitely,' 'Yes, possibly,' and 'No.' Second, respondents were asked, 'Have you had a positive test for COVID-19?' and could answer either 'Yes' or 'No.' We defined a positive COVID-19 diagnosis as a 'Yes, definitely' or a 'Yes, possibly' diagnosis from a health professional and a 'Yes' from a COVID-19 test.

COVID-19 mitigation behaviors

Three COVID-19 mitigation behaviors included handwashing, masking, and social distancing. All three behaviors were asked under the question, 'During the COVID-19 outbreak, have you ever done the following to keep the disease from spreading?' Handwashing was measured as, 'Frequently wash your hands or use sanitizer,' and responses included 'Yes' or 'No.' Masking was measured as, 'Wear a face mask when going out,' and responses included 'Yes,' 'No,' or 'Does not apply.' Social distancing was measured as, 'Stay at least 6 feet away from people not living with you,' and responses included 'Yes,' 'No,' or 'Does not apply.' Any 'Does not apply' response was coded as missing. For one of the regression models, we constructed a composite score (range 0–3) by aggregating the number of mitigation behaviors.

Independent variables

Sociodemographic and health variables were included in the regression models. Sociodemographic variables included age, gender, race, and ethnicity (non-Hispanic White [hereafter, White], non-Hispanic Black [hereafter, Black], Hispanic, or Other), highest level of education (less than high school, high school, or college), total household income, marital status (married or unmarried), metropolitan residence (metro or non-metro), and residential setting (community or residential care/nursing home).

Health variables included self-rated health (poor to excellent), body mass index (BMI), activities of daily living (no ADL limitations or at least one ADL limitation), proxy respondent, major depressive disorder in 2019, generalized anxiety disorder in 2019, dementia in

2019, history of heart attack, history of hypertension, history of diabetes, and history of stroke.

Analysis plan

For the dependent variable of COVID-19 diagnosis, we used a series of multiple logistic regression models that first included sociodemographic variables (Model A), then added health variables (Model B), then added COVID-19 mitigation behaviors (Model C). In Model C, there were statistically significant correlations between all three COVID-19 mitigation behaviors, causing the model to automatically omit some behaviors due to multicollinearity. As a result, Model C contained only the aggregate score combining the three mitigation behaviors. The highest individual variance inflation factor (VIF) was 1.88, and the average VIF was 1.23, which indicates there is no evidence of multicollinearity.

Additional multiple logistic regression models were constructed to determine which sociodemographic and health variables were predictors for each COVID-19 mitigation behavior as a dependent variable. There was no evidence for multicollinearity since the average VIF was 1.24 for all three models.

To minimize bias due to missing data (10–15% depending on the dependent variable), multiple imputation by chained equations generated 100 imputed data files with 10 iterations each. There were no substantial differences in the results generated from multiple imputation by chained equation compared with listwise deletion. Odds ratios and 95% confidence intervals (CIs) were produced from the logistic regression models, which applied complex survey sampling weights to ensure the results are representative. Statistical analyses were performed in Stata statistical software version 16.1 (StataCorp LLC, College Station, TX, USA) with two-tailed tests at a 0.05 significance level.

Results

Sample characteristics

The 3257 survey respondents are described in Table 1. They ranged in age from 65 to 107 years, with a mean age of 74.2 years (standard deviation = 6.6 years), and a slight majority (57.9%) were female. White was the most common race and ethnicity (75.9%) and a high school degree being the most common highest level of education attained (48.2%). The average household income was approximately $61,090. About 80% of respondents resided in a metropolitan area, and most were community dwelling (93.1%). The average self-rated health was between good and very good (2.28 on a scale of 0–4; standard deviation = 0.98), and 15.8% had at least one ADL limitation. The most common health conditions include a history of hypertension (73.9%) and a history of diabetes (28.1%).

Table 1
Sample characteristics for the National Health and Aging Trends Study.

Characteristic	Mean (SD) or % (*n*)
Age (range 65–107)	74.18 (6.55)
Female	57.94% (1887)
Race and ethnicity	
White, non-Hispanic	75.90% (2472)
Black, non-Hispanic	16.67% (543)
Hispanic	4.08% (133)
Other	3.35% (109)
Highest level of education	
Less than high school	14.64% (471)
High school degree	48.23% (1552)
College degree	37.13% (1195)
Income (thousands, USD)	61.09 (67.35)
Marital status	
Not married	50.84% (1655)
Married	49.16% (1600)
Household size (no. of individuals)	1.93 (1.01)
Metropolitan residence	80.14% (2610)
Residential setting	
Community dwelling	93.12% (3033)
Residential care or nursing home	6.88% (224)
Self-rated health (0–4; poor to excellent)	2.28 (0.98)
Body mass index (kg/m^2)	27.91 (6.08)
ADL limitations	
None	84.20% (2728)
At least one	15.80% (512)
Proxy respondent	2.21% (72)
Depression	8.91% (288)
Anxiety	7.66% (248)
Dementia	14.89% (485)
History of heart attack	16.94% (548)
History of hypertension	73.88% (2401)
History of diabetes	28.10% (910)
History of stroke	12.43% (402)

ADL, activities of daily living; SD, standard deviation.

Risk factors for positive COVID-19 diagnosis

All the COVID-19 diagnosis models were significant, including our final model [$F(24,53) = 8.54$, $P < .01$; Table 2]. Three sociodemographic characteristics were significant risk factors for COVID-19 across all models. Hispanic ethnicity increased the odds of COVID-19 by 183% (adjusted odds ratio [aOR] = 2.83, 95% CI = 1.30–6.17, $P = .01$) compared with White older adults. A log increase in household income decreased the odds of COVID-19 by 29% (aOR = 0.71, 95% CI = 0.50–0.99, $P = .04$) and residential care increased the odds by 162% (aOR = 2.62, 95% CI = 1.27–5.41, $P = .01$).

Two health-related characteristics also had significant results. Every one unit increase in BMI increased the odds of COVID-19 by 3% (aOR = 1.03, 95% CI = 1.01–1.06, $P = .02$), but the relationship was no longer significant when adjusting for mitigation behaviors. On the other hand, anxiety was initially not significantly associated with COVID-19, but the relationship did become significant after adjusting for mitigation behaviors (aOR = 2.38, 95% CI = 1.02–5.56, $P = .04$).

Predictors for handwashing

The model for handwashing was significant [$F(23,53) = 4.46$, $P < .01$; Table 3]. Only two characteristics were significantly associated with handwashing. Being female increased the odds of handwashing by 155% (aOR = 2.55, 95% CI = 1.54–4.21, $P < .01$). In addition, older adults with dementia had a 55% significantly decreased odds of handwashing (aOR = 0.45, 95% CI = 0.24–0.85, $P = .01$).

Predictors for masking

Masking also had a significant model [$F(22,52) = 7.46$, $P < .01$] and a large number of significant predictors (Table 3). Females had a significantly higher odds of masking by 251% (aOR = 3.51, 95% CI = 2.03–6.09, $P < .01$). Race and ethnicity were significant predictors as well. Black older adults were 7.9 times more likely to mask than White older adults (aOR = 7.94, 95% CI = 2.33–27.04, $P < .01$). Each unit increase in the five-point self-rated health score, meanwhile, decreased the odds of masking by 0.7 times (aOR = 0.72, 95% CI = 0.55–0.94, $P = .02$). Using a proxy respondent for the survey was associated with a decrease in masking by 0.1 times (aOR = 0.10, 95% CI = 0.02–0.53, $P < .01$), and anxiety also notably decreased the odds of masking by 0.3 times (aOR = 0.30,

Table 2
Adjusted odds of a positive COVID-19 diagnosis among US older adults.

Independent variable	Model A, aOR (95% CI), *P*	Model B, aOR (95% CI), *P*	Model C, aOR (95% CI), *P*
Age	1.00 (0.97–1.04), .96	1.00 (0.96–1.04), .94	1.00 (0.96–1.05), 1.00
Female	0.71 (0.40–1.27), .25	0.73 (0.40–1.34), .30	0.79 (0.43–1.42), .42
Race and ethnicity			
White, non-Hispanic	Reference	Reference	Reference
Black, non-Hispanic	1.19 (0.61–2.29), .61	1.15 (0.57–2.32), .69	1.30 (0.65–2.61), .45
Hispanic	2.67 (1.22–5.85), .02	2.76 (1.23–6.22), .02	2.83 (1.30–6.17), .01
Other	1.00 (0.29–3.43), .99	1.08 (0.29–3.97), .91	1.15 (0.30–4.39), .83
Highest level of education			
Less than high school	Reference	Reference	Reference
High school degree	0.90 (0.47–1.74), .75	1.00 (0.51–1.95), 1.00	1.04 (0.48–2.23), .92
College degree	1.29 (0.60–2.76), .51	1.68 (0.76–3.68), .20	1.77 (0.75–4.15), .19
Income (log)	0.69 (0.52–0.92), .02	0.73 (0.54–0.99), .04	0.71 (0.50–0.99), .04
Marital status			
Not married	Reference	Reference	Reference
Married	1.11 (0.61–2.01), .72	1.04 (0.58–1.89), .88	1.28 (0.72–2.30), .40
Household size	1.20 (0.99–1.45), .06	1.17 (0.94–1.45), .16	1.20 (0.97–1.49), .09
Metropolitan residence	1.37 (0.75–2.52), .30	1.64 (0.85–3.17), .19	1.82 (0.84–3.94), .13
Residential setting			
Community dwelling	Reference	Reference	Reference
Residential care or nursing home	3.35 (1.86–6.04), <.001	2.57 (1.31–5.03), .01	2.62 (1.27–5.41), .01
Self-rated health (0–4; poor to excellent)		0.88 (0.68–1.14), .32	0.91 (0.70–1.18), .46
Body mass index		1.03 (1.01–1.06), .02	1.03 (1.00–1.06), .09
ADL limitations			
None		Reference	Reference
At least one		1.46 (0.81–2.66), .21	1.70 (0.90–3.20), .10
Proxy respondent		1.24 (0.36–4.32), .73	1.23 (0.29–5.19), .77
Depression		0.78 (0.32–1.90), .58	0.76 (0.30–1.94), .56
Anxiety		2.07 (0.92–4.64), .08	2.38 (1.02–5.56), .04
Dementia		1.44 (0.76–2.70), .26	1.58 (0.77–3.23), .21
History of heart attack		1.68 (0.88–3.22), .11	1.79 (0.93–3.46), .08
History of hypertension		1.00 (0.59–1.71), 1.00	0.90 (0.51–1.58), .70
History of diabetes		0.92 (0.53–1.61), .78	0.81 (0.44–1.52), .51
History of stroke		0.60 (0.26–1.39), .23	0.48 (0.16–1.47), .19
Adherence to COVID-19 mitigation behaviors (0–3)			1.28 (0.48–3.43), .62
Weighted sample size	25,749,526	25,749,526	25,749,526
Model significance	$F(12,53) = 4.73$, $P < .001$	$F(23,53) = 12.04$, $P < .001$	$F(24,53) = 8.54$, $P < .001$

ADL, activities of daily living; aOR, adjusted odds ratio; CI, confidence interval.

95% CI = 0.13–0.70, $P = .01$). Having a history of diabetes (aOR = 0.47, 95% CI = 0.31–0.72, $P < .01$) or stroke (aOR = 0.48, 95% CI = 0.24–0.97, $P = .04$) also decreased the odds of masking.

Predictors for social distancing

Finally, the model for social distancing was significant [$F(23,52) = 3.29$, $P < .01$] and had several sociodemographic predictors (Table 3). Female gender significantly increased the odds of social distancing by 50% (aOR = 1.50, 95% CI = 1.08–2.08, $P = .02$), and those who self-identified as Black has 133% increased odds compared with White older adults (aOR = 2.33, 95% CI = 1.28–4.24, $P = .01$). Metropolitan residence was also significantly associated with social distancing and increased the odds by 53% (aOR = 1.53, 95% CI = 1.09–2.15, $P = .02$).

Discussion

Three sociodemographic characteristics were shown to be consistently associated with COVID-19 in older adults across all three models: residential care or nursing home residence, Hispanic ethnicity, and income. All three of these findings are supported by current literature.[15] Older adults in nursing homes are at a greater risk due to their congregate setting and the exchange of patients with hospitals.[16] CDC data, meanwhile, report that Hispanic/Latino persons share the highest rate of COVID-19 cases in the United States with American Indian and Alaskan Native persons.[17] This association is likely due to socio-economic status, healthcare access, working frontline jobs, and multigenerational housing,[4,15,17–19] which ties into income as a COVID-19 risk factor. Neighborhoods with lower average incomes or greater income inequality are significantly correlated with higher COVID-19 incidence,[20,21] and low income is associated with higher rates of COVID-related hospitalizations.[22]

Two health characteristics were also associated with COVID-19 risk, though not consistently. BMI was significantly associated with a positive diagnosis before controlling for mitigation behaviors. Other cohorts have also seen a J-shaped association between BMI and COVID admissions, although these did not control for handwashing, masking, or social distancing.[23] Anxiety, meanwhile, only became significantly associated with COVID-19 diagnoses after adjusting for mitigation behaviors. Although the mechanism is unclear, a diagnosis of anxiety in 2019 or earlier should be especially noted for its association with COVID-19 in 2020, especially with its 138% increased odds.

Each of the mitigation behaviors had significant predictors, as well. For example, female gender was positively associated with handwashing, masking, and social distancing. This may be due to women's traditional role as caregivers, which would encourage them to do more to protect themselves and their families or it may be that women are less susceptible than men to an 'honor culture' that values the projection of strength and rejection of weakness.[24–28] Acknowledging the SARS-CoV-2 virus as a threat worth taking precautions against may indicate undesirable vulnerability and weakness in various US populations.[25] The data also found that Black older adults were more likely to mask and social distance

Table 3
Adjusted odds of adherence to COVID-19 Mitigation behaviors among US older adults.

Independent variable	Handwashing, aOR (95% CI), *P*	Masking, aOR (95% CI), *P*	Social distancing, aOR (95% CI), *P*
Age	0.99 (0.95–1.04), .80	1.03 (0.99–1.07), .10	0.97 (0.94–1.00), .06
Female	2.55 (1.54–4.21), <.001	3.51 (2.03–6.09), <.001	1.50 (1.08–2.08), .02
Race and ethnicity			
White, non-Hispanic	Reference	Reference	Reference
Black, non-Hispanic	2.18 (0.81–5.91), .12	7.94 (2.33–27.04), <.001	2.33 (1.28–4.24), .01
Hispanic	6.53 (0.80–53.21), .08	NA	2.41 (0.79–7.29), .19
Other	4.00 (0.77–20.83), .10	18.13 (1.90–173.21), .01	1.22 (0.44–3.35), .70
Highest level of education			
Less than high school	Reference	Reference	Reference
High school degree	0.86 (0.32–2.30), .76	0.95 (0.30–2.97), .92	0.74 (0.43–1.28), .28
College degree	1.05 (0.39–2.85), .92	1.81 (0.55–5.95), .32	1.45 (0.72–2.92), .29
Income (log)	0.93 (0.61–1.43), .74	1.07 (0.76–1.50), .71	1.02 (0.79–1.31), .87
Marital status			
Not married	Reference	Reference	Reference
Married	1.48 (0.66–3.35), .34	1.33 (0.74–2.40), .34	0.91 (0.56–1.48), .69
Household size	0.92 (0.73–1.17), .48	0.91 (0.75–1.11), .36	1.08 (0.86–1.37), .50
Metropolitan residence	1.32 (0.61–2.83), .47	1.26 (0.64–2.51), .50	1.53 (1.09–2.15), .02
Residential setting			
Community dwelling	Reference	Reference	Reference
Residential care or nursing home	0.58 (0.26–1.32), .19	3.00 (0.50–17.94), .22	1.44 (0.66–3.15), .36
Self-rated health (0–4; poor to excellent)	0.93 (0.66–1.32), .70	0.72 (0.55–0.94), .02	1.04 (0.86–1.26), .66
Body mass index	1.00 (0.97–1.04), .79	0.99 (0.97–1.01), .18	1.01 (0.99–1.04), .28
ADL limitations			
None	Reference	Reference	Reference
At least one	0.58 (0.24–1.41), .23	2.69 (0.93–7.81), .07	0.75 (0.43–1.32), .31
Proxy respondent	0.42 (0.12–1.39), .15	0.10 (0.02–0.43), <.01	1.43 (0.44–4.71), .54
Depression	0.64 (0.26–1.55), .32	1.88 (0.57–6.19), .29	1.47 (0.74–2.94), .27
Anxiety	1.55 (0.51–4.75), .44	0.30 (0.13–0.70), .01	0.70 (0.33–1.48), .35
Dementia	0.45 (0.24–0.85), .01	1.23 (0.51–3.00), .64	1.05 (0.64–1.71), .85
History of heart attack	0.59 (0.24–1.48), .26	1.02 (0.47–2.18), .97	1.22 (0.80–1.86), .34
History of hypertension	1.18 (0.62–2.26), .61	1.18 (0.60–2.31), .62	1.26 (0.82–1.91), .28
History of diabetes	0.99 (0.53–1.82), .96	0.47 (0.31–0.72), <.01	1.13 (0.76–1.66), .55
History of stroke	1.14 (0.56–2.30), .72	0.48 (0.24–0.97), .04	0.66 (0.42–1.04), .08
Weighted sample size	26,195,301	26,188,528	26,186,801
Model significance	$F(23,53) = 4.46$, $P < .001$	$F(22,52) = 7.46$, $P < .001$	$F(23,52) = 3.29$, $P < .001$

ADL, activities of daily living; aOR, adjusted odds ratio; CI, confidence interval; NA, not available.
Hispanic was merged with 'Other' due to low statistical power.

than White older adults, and this may be because of a greater perception of risk due to health histories.[29] Black older adults may also know more family members who had been hospitalized with COVID-19, further increasing their perceived risk for the disease.[30] Finally, for sociodemographic factors, metropolitan residence was positively associated with social distancing, which may be because of higher population density in urban areas. By comparison, rural residents are less likely to have healthcare access, good health behaviors, high incomes, and higher education; inequalities that may lead to a corresponding decrease in social distancing.[31]

In general, only a small number of health variables were significantly associated with COVID-19 mitigation behaviors. Dementia decreased the odds of handwashing, which the US Alzheimer's Association posits is due to forgetfulness from impaired memory.[32] Previous research has found that although older adults with dementia have an increased COVID-19 risk and lower odds of handwashing, the relationship between dementia and COVID-19 is primarily mediated by functional impairment, income, and residential setting instead of mitigation behaviors.[33] Overall perceived health, anxiety, a history of diabetes, and a history of stroke were associated with masking. One potential reason for some of these associations may be that limited adoption of health-protective behaviors before the pandemic has now translated into limited adoption during it.[31] Because masks have been strongly polarized in the United States, they may be one of the first mitigation behaviors dropped.[34] Another possibility may be that the conditions themselves impact older adults' capacity to wear masks: individuals with certain pre-existing health concerns and their carers may be more anxious about those conditions than about COVID-19.[35] Anxiety decreasing the odds of masking is a perplexing finding because we found it is also associated with increased COVID-19 risk. Older adults with anxiety could have both lower feelings of control over their own health and lower perceived efficacy of masks,[34] suggesting that they are not only more likely to be mask resistant but that they may be especially susceptible to conspiracy theories regarding the pandemic.[36]

There are three notable limitations to this study. First, self-reported responses for all measures restrict psychometric information for the dependent variables in each model. Second, these results include only the first two waves of COVID-19 cases in the United States and therefore before other major variants that contributed to subsequent waves of infection. Third, our results are only generalizable to older adults aged ≥65 years; however, other gerontological research on COVID-19 mitigation may consider old age to begin after age 50 years.[14] Despite these limitations, to our knowledge, the findings in our study present the first examination of factors associated with COVID-19 infection and adherence to major COVID-19 mitigation behaviors using a nationally representative US older adult sample.

Future research can take an even broader view of COVID-19 risk and mitigation beyond the scope presented here. In a global pandemic, the United States is far from the only nation affected by viral infection and mitigation behavior non-adherence, and other work on these topics has been conducted in countries as disparate as Saudi Arabia, Italy, Singapore, and South Africa.[8,26–28] Although some similarities presented themselves internationally, such as the

association between female gender and mitigation behavior adherence,[26–28] absolute rates of adherence can vary dramatically between geographic regions.[26,28] Part of this may be due to differing social and political norms, such as pre-existing acceptance of masking in certain East Asian countries,[27] but some researchers suggest religion may play a role as well.[26,27] For example, cleanliness practices codified in the Islamic faith may have predisposed Saudi Arabians to regularly wash their hands and avoid anything that could be considered unclean.[26] Further work on COVID-19 and associated behaviors thus may want to analyze predictors on a global level or apply a sociocultural lens to their local populations.

Conclusion

Our study of US older adults from a nationally representative sample identified numerous risk factors for COVID-19 and predictors for adhering to mitigation behaviors. Knowledge of these nuanced relationships of social, clinical, and environmental factors with infection risk will help prioritize preventative public health approaches to alleviate the public health emergency caused by COVID-19 and other future pandemics. For example, the COVID-19 vaccine supply was severely restricted during the early phase of the pandemic, and our findings indicate prioritizing prevention efforts toward underresourced communities and congregate settings may be worthwhile when new vaccines are in development during future disease outbreaks. Public health messaging should also focus on promoting adherence to disease mitigation behaviors among older males and older adults with comorbidities, which were subsequently associated with increased disease risk. Further research is warranted to investigate the connection between anxiety and elevated COVID-19 risk and reasons for racial and ethnic differences in adhering to mitigation behaviors.

Author statements

Acknowledgments

National Health and Aging Trends Study (NHATS) is sponsored by the National Institute on Aging (grant number U01AG32947) and was conducted by the Johns Hopkins University.

Ethical approval

This study was approved by the SUNY Upstate Institutional Review Board for the Protection of Human Subjects (#1769765-1).

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests

The authors have no real or perceived competing interests to disclose.

Author contributions

R.W. conceived the study and conducted the analysis. J.R.G. and M.A.L. critically contributed to data interpretation. All authors drafted the article and approved the final submitted version.

References

1. CDC. COVID Data Tracker [Internet]. *Centers for Disease Control and Prevention*. 2020 [cited 2022 Apr 18]. Available from: https://covid.cdc.gov/covid-data-tracker.
2. Dhama K, Patel SK, Natesan S, Vora KS, Iqbal Yatoo M, Tiwari R, et al. COVID-19 in the elderly people and advances in vaccination approaches. *Hum Vaccines Immunother* 2020 Dec 1;**16**(12):2938–43.
3. Pietrobon AJ, Teixeira FME, Sato MN. Immunosenescence and inflammaging: risk factors of severe COVID-19 in older people. *Front Immunol* 2020;**11**:579220.
4. Guerrero LR, Wallace SP. The impact of COVID-19 on diverse older adults and health equity in the United States. *Front Public Health* 2021;**9**:661592.
5. Xu H, Intrator O, Bowblis JR. Shortages of staff in nursing homes during the COVID-19 pandemic: what are the driving factors? *J Am Med Dir Assoc* 2020 Oct;**21**(10):1371–7.
6. Li Y, Cen X, Cai X, Temkin-Greener H. Racial and ethnic disparities in COVID-19 infections and deaths across U.S. Nursing homes. *J Am Geriatr Soc* 2020 Nov;**68**(11):2454–61.
7. Ghosh AK, Venkatraman S, Soroka O, Reshetnyak E, Rajan M, An A, et al. Association between overcrowded households, multigenerational households, and COVID-19: a cohort study. *Public Health* 2021 Sep;**198**:273–9.
8. La Torre G, Marte M, Previte CM, Barone LC, Picchioni F, Chiappetta M, et al. The synergistic effect of time of exposure, distance and no use of personal protective equipment in the determination of SARS-CoV-2 infection: results of a contact tracing follow-up study in healthcare workers. *Int J Environ Res Public Health* 2021;**18**(18):9456. https://doi.org/10.3390/ijerph18189456. Published 2021 Sep. 8.
9. MacIntyre CR, Nguyen PY, Chughtai AA, Trent M, Gerber B, Steinhofel K, et al. Mask use, risk-mitigation behaviours and pandemic fatigue during the COVID-19 pandemic in five cities in Australia, the UK and USA: a cross-sectional survey. *Int J Infect Dis IJID Off Publ Int Soc Infect Dis* 2021 May;**106**:199–207.
10. Anderson-Carpenter KD, Tacy GS. Predictors of social distancing and hand washing among adults in five countries during COVID-19. *PLoS One* 2022;**17**(3):e0264820.
11. Haston JC, Miller GF, Berendes D, Andújar A, Marshall B, Cope J, et al. Characteristics associated with adults remembering to wash hands in multiple situations before and during the COVID-19 pandemic - United States, October 2019 and June 2020. *MMWR Morb Mortal Wkly Rep* 2020 Oct 9;**69**(40):1443–9.
12. Masters NB, Shih SF, Bukoff A, Akel KB, Kobayashi LC, Miller AL, et al. Social distancing in response to the novel coronavirus (COVID-19) in the United States. *PLoS One* 2020;**15**(9):e0239025.
13. Hansen AC, Farewell CV, Jewell JS, Leiferman JA. Exploring predictors of social distancing compliance in the United States during the COVID-19 pandemic. *Disaster Med Public Health Prep* 2021 Aug 9:1–7.
14. Choi SL, Martin P, Cho J, Ryou YJ, Heinz M. Personality and compliance with COVID-19 protective measures among older Americans: moderating effects of age, gender, and race/ethnicity. *Pers Individ Dif* 2022;**189**:111499. https://doi.org/10.1016/j.paid.2022.111499.
15. Rozenfeld Y, Beam J, Maier H, Haggerson W, Boudreau K, Carlson J, et al. A model of disparities: risk factors associated with COVID-19 infection. *Int J Equity Health* 2020 Jul 29;**19**(1):126.
16. Ouslander JG, Grabowski DC. COVID-19 in nursing homes: calming the perfect storm. *J Am Geriatr Soc* 2020;**68**(10):2153–62.
17. CDC. Cases, Data, and Surveillance [Internet]. *Centers for Disease Control and Prevention*. 2020 [cited 2022 Apr 18]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html.
18. Athavale P, Kumar V, Clark J, Mondal S, Sur S. Differential impact of COVID-19 risk factors on ethnicities in the United States. *Front Public Health [Internet]* 2021:9 [cited 2022 Apr 18]. Available from: https://www.frontiersin.org/article/10.3389/fpubh.2021.743003.
19. Magesh S, John D, Li WT, Li Y, Mattingly-App A, Jain S, et al. Disparities in COVID-19 outcomes by race, ethnicity, and socioeconomic status: a systematic-review and meta-analysis. *JAMA Netw Open* 2021 Nov 1;**4**(11):e2134147.
20. Baena-Díez JM, Barroso M, Cordeiro-Coelho SI, Díaz JL, Grau M. Impact of COVID-19 outbreak by income: hitting hardest the most deprived. *J Public Health* 2020 Nov 23;**42**(4):698–703.
21. Liao TF, De Maio F. Association of social and economic inequality with coronavirus disease 2019 incidence and mortality across US counties. *JAMA Netw Open* 2021 Jan 20;**4**(1):e2034578.
22. Wachtler B, Michalski N, Nowossadeck E, Diercke M, Wahrendorf M, Santos-Hövener C, et al. Socioeconomic inequalities and COVID-19 – a review of the current international literature. *J Health Monit* 2020 Oct 9;**5**(Suppl 7):3–17.
23. Gao M, Piernas C, Astbury NM, Hippisley-Cox J, O'Rahilly S, Aveyard P, et al. Associations between body-mass index and COVID-19 severity in 6·9 million people in England: a prospective, community-based, cohort study. *Lancet Diabetes Endocrinol* 2021 Jun 1;**9**(6):350–9.
24. Haischer MH, Beilfuss R, Hart MR, Opielinski L, Wrucke D, Zirgaitis G, et al. Who is wearing a mask? Gender-, age-, and location-related differences during the COVID-19 pandemic. *PLoS One* 2020 Oct 15;**15**(10):e0240785.
25. Kemmelmeier M, Jami WA. Mask wearing as cultural behavior: an investigation across 45 U.S. States during the COVID-19 pandemic. *Front Psychol*

[Internet] 2021 [cited 2022 Apr 18];12. Available from: https://www.frontiersin.org/article/10.3389/fpsyg.2021.648692.
26. Alshammari AS, Alshammari H, Alshammari S. Factors associated with adherence to COVID-19 preventive measures among Saudi Arabians. *Cureus* 2021;**13**(4):e14623. https://doi.org/10.7759/cureus.14623. Published 2021 Apr 22.
27. Long VJE, Liu JCJ. Behavioural changes during the COVID-19 pandemic: results of a nationwide survey in Singapore. *Ann Acad Med Singap* 2021;**50**(3):222–31. https://doi.org/10.47102/annals-acadmedsg.2020391.
28. Majam M, Fischer A, Phiri J, Venter F, Lalla-Edward ST. International citizen project to assess early stage adherence to public health measures for COVID-19 in South Africa. *PLoS One* 2021;**16**(3):e0248055. https://doi.org/10.1371/journal.pone.0248055. Published 2021 Mar 4.
29. Hearne BN, Niño MD. Understanding how race, ethnicity, and gender shape mask-wearing adherence during the COVID-19 pandemic: evidence from the COVID impact survey. *J Racial Ethn Health Disparities* 2022 Feb;**9**(1):176–83.
30. Stockman JK, Wood BA, Anderson KM. Racial and ethnic differences in COVID-19 outcomes, stressors, fear, and prevention behaviors among US women: web-based cross-sectional study. *J Med Internet Res* 2021 Jul 12;**23**(7):e26296.
31. Zang E, West J, Kim N, Pao CUS. Regional differences in physical distancing: evaluating racial and socioeconomic divides during the COVID-19 pandemic. *PLoS One* 2021 Nov 30;**16**(11):e0259665.
32. Coronavirus (COVID-19): Tips for Dementia Caregivers [Internet]. *Alzheimers Dis Dement* 2021 [cited 2022 Apr 18]. Available from: https://alz.org/help-support/caregiving/coronavirus-(covid-19)-tips-for-dementia-care.
33. Wong R, Lovier MA. Relationship between dementia, COVID-19 risk, and adherence to COVID-19 mitigation behaviors among older adults in the United States. *Int J Geriatr Psychiatry* 2022;**37**(6). https://doi.org/10.1002/gps.5735. 10.1002/gps.5735.
34. Schneider AB, Leonard B. From anxiety to control: mask-wearing, perceived marketplace influence, and emotional well-being during the COVID-19 pandemic. *J Consum Aff* 2022;**56**(1):97–119.
35. Sauer KS, Jungmann SM, Witthöft M. Emotional and behavioral consequences of the COVID-19 pandemic: the role of health anxiety, intolerance of uncertainty, and distress (in)tolerance. *Int J Environ Res Public Health* 2020 Oct 3;**17**(19):E7241.
36. van Mulukom V, Pummerer LJ, Alper S, Bai H, Čavojová V, Farias J, et al. Antecedents and consequences of COVID-19 conspiracy beliefs: a systematic review. *Soc Sci Med 1982* 2022 May;**301**:114912.