



# The intersectional importance of race/ethnicity, disability, and age in flu vaccine uptake for U.S. adults

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## ARTICLE INFO

### Keywords:

Intersectionality  
Disability  
Race/ethnicity  
Flu vaccination  
National Health Interview Survey

## ABSTRACT

Improving vaccination rates among marginalized populations is an important priority among public policy makers and healthcare providers in the United States of America (U.S.). Racial/ethnic minorities have a long history of reduced vaccination rates relative to white Americans (Khan, Hall, Tanner, & Marlow, 2018), while people with disabilities (PWD) have varied rates of vaccine use (Diab & Johnston, 2004; O'Neill, Newall, Antolovich, Lima, & Danchin, 2019). Yet, little is known about vaccine use among individuals who belong to both groups. This study examines the intersectional effects of race/ethnicity and disability on flu vaccine use. We used the 2015–2018 National Health Interview Survey to examine the odds of flu vaccine use by race/ethnicity, disability, and their interaction among adults aged 18+ in the U.S. non-institutionalized, civilian population stratified by age groups. For each unit increase in disability scores, we found a significant race-by-disability interaction for young black adults (18–39 years) who had higher odds of getting the flu vaccine compared to white adults in the same age group. A significant interaction occurred for middle-aged Hispanic vs. white adults (40–64 years) who had higher odds of getting the flu vaccine as their disability scores increased. Black vs. white adults were less likely to get the flu vaccine across all age groups irrespective of disability and other covariates, while results were more mixed among other racial/ethnic groups. Additionally, people with disabilities had higher odds of flu vaccination. Further, race/ethnicity had a moderating effect on the relationship between disability and flu vaccination and an interaction effect occurred between disability and certain racial/ethnic groups when stratified by age.

## 1. Introduction

Racial/ethnic minorities and people with disabilities (PWD) have historically faced many similar barriers that limit their use of preventative healthcare services (Goode, Carter-Pokras, Horner-Johnson, & Yee, 2014; Raudenbush, 2020; Sharby, Martire, & Iversen, 2015). Studies show that members of each group are more likely to have insufficient insurance coverage, an inability to pay for services and co-pays, and inadequate transportation to and from healthcare facilities compared to the general population (Brown, Ojeda, Wyn, & Levan, 2000, pp. 1–86; Goode et al., 2014; Raudenbush, 2020; Valdez & Romero, 2021). For those with physical disabilities, a lack of accessible exam rooms, medical equipment, and parking spaces are other commonly reported physical barriers (Iezzoni et al., 2021; Sharby et al., 2015).

Likewise, members of both groups may be less likely to seek preventative care due to concerns about how providers perceive, understand, or treat them during healthcare episodes. Research demonstrates that PWD are more likely to be dissatisfied with their healthcare services than their non-disabled peers and often perceive their providers as having insufficient knowledge of their disabilities, a lack of understanding about their unique healthcare needs, or negative attitudes toward the disability community (Diab & Johnston, 2004; Sharby et al., 2015). Perceived discrimination also contributes to these differences. Experts report that PWD experience higher rates of perceived discrimination in healthcare settings relative to their non-disabled peers and may avoid healthcare appointments due to experiences of unfair or disrespectful treatment by their healthcare providers (Namkung & Carr, 2019; Sharby et al., 2015). Further, researchers who examined survey responses among PWD in Peru found an association between perceived

*Abbreviations:* People with disabilities, PWD.

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<https://doi.org/10.1016/j.ssmph.2022.101211>

Received 5 May 2022; Received in revised form 11 August 2022; Accepted 14 August 2022

Available online 20 August 2022

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discrimination and lower rates of health-seeking behaviors (Moscoso-Porras & Alvarado, 2018).

Similarly, racial/ethnic minorities report high rates of negative provider attitudes, dissatisfaction with care, and discrimination during healthcare episodes (Mayberry, Mili, & Ofili, 2000; Raudenbush, 2020; Sorkin, Ngo-Metzger, & De Alba, 2010). For example, in a large population sample of California residents, 14.7% of participants reported incidents of discrimination based on their race/ethnicity, and their experience was associated with lower attendance at preventative care services (Trivedi & Ayanian, 2006). More specifically, researchers assert that America's history of medical abuse against black, Latino, and Native Americans contributes to their higher rates of mistrust toward healthcare providers. Mistrust alone, they argue, does not explain disparity gaps between racial/ethnic minority and white Americans in the receipt of preventative care such as vaccinations. Rather, the ongoing racism that is institutionalized into the healthcare system must also be acknowledged as an important contributing factor (Bajaj & Stanford, 2021; Raudenbush, 2020).

Policy makers and healthcare providers have identified flu vaccinations as one area of preventative care where marginalized populations are at a significant risk for under-utilization (Lu et al., 2021a). Differences in flu vaccine use are an important area of inquiry for racial/ethnic minorities and PWD because both groups exhibit higher rates of chronic illnesses such as high blood pressure and other cardiovascular diseases, obesity, and type II diabetes compared to the general population (Raudenbush, 2020; Scott & Haverkamp, 2014). These underlying health conditions subsequently place them at a higher risk for severe flu-related illness or death (Hebert, Frick, Kane, & McBean, 2005; Lu et al., 2015). Therefore, disparities in flu vaccination use could contribute to poorer health outcomes and higher healthcare costs for members of both groups, which in turn could widen health disparity gaps with white and able-bodied adults in the U.S. population, respectively.

Research consistently demonstrates that racial/ethnic minorities receive flu vaccinations at lower rates compared to whites (Bershadsky, Hiersteiner, Fay, & Bradley, 2014; CDC, 2021; Lu et al., 2021b). Generally, Hispanic Americans are less likely than white Americans to receive the flu vaccine, but the disparity gap between these groups narrows or disappears after adjusting for socio-economic, demographic, and access-to-care measures (Almario et al., 2016; Lu et al., 2015). Vaccine use among Asian Americans relative to whites is more varied and less understood. In studies of flu vaccine rates with Asian Americans as an aggregate group, they had similar or lower rates of vaccine use compared to white Americans (Almario et al., 2016). However, in a survey study of California residents, sub-groups of Asian Americans, such as Korean and Vietnamese Americans, were more likely to receive the flu vaccine than white Americans, while other sub-groups were as likely as white Americans to receive the vaccine after adjusting for covariates (Almario et al., 2016). In contrast, black Americans are consistently the least likely to receive flu vaccinations among all racial/ethnic minority groups, even after adjusting for socio-economic, demographic, and access-to-care measures (Almario et al., 2016; Lu et al., 2015).

Vaccine use varies and trends are less clear among PWD compared to their non-disabled peers. In a review of the literature on vaccine uptake in individuals who had physical or intellectual disabilities from an early life etiology, researchers found that PWD had lower vaccine rates compared to their peers in 78% of studies examined. These differences held across a range of participant ages, disabilities, immunization types, and countries of origin (O'Neill, Elia, & Perrett, 2019). For example, researchers found that adolescents with disabilities in both the U.S. and Australia were less likely to initiate or complete Human Papillomavirus (HPV) vaccination schedules compared to their peers (O'Neill, Elia, & Perrett, 2019; Rowe, Pritt, Stratton, & Yoost, 2017). Likewise, in a survey study of parental beliefs and practices, researchers found that 50% of participants changed or discontinued their children's vaccination schedules after having a child diagnosed with Autism Spectrum

Disorder (Bazzano, Zeldin, Schuster, Barrett, & Lehrer, 2012). In contrast, other research shows that PWD may be as or more likely to receive vaccinations compared to the non-disabled, particularly in studies where disability is defined by an individual's activity limitations rather than an early life etiology or a specific diagnosis. For example, in cross-sectional analyses using secondary data, researchers found that people with mobility impairments affecting their ability to walk, climb stairs, or stand for long periods of time were as likely to receive a flu vaccine as their peers (Iezzoni et al., 2021). Adolescents with special healthcare needs (i.e., having an activity impairment, need for prescription medications or specialized therapies, or presence of conditions requiring ongoing treatment or counseling) had similar odds of receiving meningococcal and tetanus vaccines and greater odds of HPV vaccinations compared to their peers (McRee, Maslow, & Reiter, 2017). Similarly, people with various functional impairments that limited their participation in basic self-care tasks like bathing and dressing (i.e., activities of daily living), or other daily life activities like shopping and home management duties (i.e., instrumental activities of daily living), were more likely to receive a flu vaccine compared to their non-disabled peers (Diab & Johnston, 2004; Khan et al., 2018; Pharr & Bungum, 2012).

Research also suggests that age may contribute to differences in vaccine uptake for racial/ethnic minorities and PWD. For example, in a study of flu vaccine uptake, disparities between racial/ethnic minorities and whites were greater for adults  $\geq 65$  years of age compared to younger cohorts (Lu et al., 2015). In addition, a study of preventative healthcare trends among PWD showed a larger proportion of adults  $\geq 65$  years of age receiving the flu vaccine compared to younger groups (Diab & Johnston, 2004). Differences in intent to receive the COVID-19 vaccine also varied by age group, with non-intent highest among adults 18–64 years (with or without underlying medical conditions) relative to older cohorts (Nguyen et al., 2021). Notably, researchers found a significant relationship between age and perceived institutional discrimination, including at healthcare facilities for PWD in their 40's through mid-60's, but did not find significant relationships among the very young and very old age groups relative to the non-disabled (Namkung & Carr, 2019). These findings highlight the importance of stratifying groups by age to understand differences more fully in preventative healthcare trends, including vaccine uptake.

## 2. Theory

Given racial/ethnic minorities and PWD experience disadvantages that reduce their access to preventative care services, and both groups face higher risks for health complications if they develop influenza, our focus in this study is to understand how these disadvantages impact flu vaccine use among individuals with both identities. Intersectional theory posits that individuals have multiple social identities or positions (i.e., race/ethnicity, sex, age, disability, etc.) which overlap to confer burdens or advantages to the individual depending on the stigma, oppression, or privilege associated with each (Bauer, 2014; Bowleg, 2012). For example, Artiles (2013) encourages the use of intersectional theory to explore the racialization of disability in special education students, to better understand the complexity of their intersecting identities, the connection between individual experiences and historical processes, and their limited access to general education curriculum. Similarly, Corus and Saatcioglu (2015) encourage examining multiplicatively oppressed groups and the processes and consequences of interpersonal and structural marginalization in healthcare. An intersectional approach can therefore elucidate the multidimensional nature of individual experiences. In some cases, the overlap of identities can lead to a double or multiple jeopardy effect (Ferraro & Farmer, 1996). Individuals who belong to more than one disadvantaged group can experience negative health outcomes that are disproportionately greater, or multiplicative in nature, compared to those who do not have this overlap of identities (Dowd & Bengtson, 1978; Ferraro & Farmer,

1996). If a double jeopardy effect occurs in this study, we expect to find a race/ethnicity-by-disability interaction leading to an increase in the disparity gap between racial/ethnic minorities and whites in flu vaccine use. In other cases, one identity may offer social benefits that reduce or “level out” the negative consequences of other identities (Bowleg, 2012; Hurtado, 2018; Shields, 2008). If a leveling effect occurs, we expect to find that racial/ethnic minorities with a disability will experience a decrease in their disparity gaps with whites in flu vaccine use. Finally, if no significant interaction or relationship exists between race/ethnicity and disability, we expect to find persistent disparity gaps between racial/ethnic minorities and whites regardless of disability level.

### 3. Methods

#### 3.1. Data

We used secondary data from the National Health Interview Survey (NHIS) to examine flu vaccine use among disabled and racial/ethnic minority groups (Blewett, Rivera Drew, King, & Williams, 2019; CDC, 2021). Researchers use this cross-sectional data to characterize disability and health conditions, examine the effects of health programs, and identify barriers to care. The survey includes household and individual data from non-institutionalized civilian populations using computer-assisted personal interviewing (CAPI). Survey administrators used a multi-stage sampling strategy throughout the year to collect survey responses among citizens in all 50 U.S. states and the District of Columbia. The sampling frame consisted of stratified and cluster sampling across geographic regions in each state where a multi-stage probability design was used to identify representative households and non-institutional group quarters such as college dormitories (Blewett et al., 2019). We used data collected from interviews with an adult household member aged 18+ for years 2015–2018. We combined years to ensure an adequate sample size for comparing non-disabled and disabled groups among racial/ethnic groups. The final sample size, which accounted for missing data through multiple imputations, was  $n = 118,859$ . For more information on the NHIS, refer to their website at: <https://www.cdc.gov/nchs/nhis/index.htm>. We downloaded data for this study directly from the Integrated Public Use Microdata Series (IPUMS) Health Surveys website at <https://www.nhis.ipums.org>.

#### 3.2. Measures

Flu vaccination is the dependent variable in this study. Participants reported whether they received a flu vaccine within the past 12 months. We assigned individuals who had a positive response to receiving either the nasal spray or a flu shot as the reference group for this dichotomous variable.

Race/ethnicity and disability are the two primary independent variables. We divided race/ethnicity into four groups (non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic other) with non-Hispanic whites serving as the reference group. We included people who identified as American Indian/Alaskan Native, Asian, Multiple Race, and Other Race in the non-Hispanic other group. Individuals in the Other category represented only eight percent of all individuals, therefore we did not further sub-divide this group to preserve adequate numbers per group for logistic regression analysis.

We calculated disability into a continuous variable using responses to twelve questions about functional limitations. Each question asked respondents to identify the extent that a health problem interfered with their ability to complete each activity. A health problem was defined as “any physical, mental, or emotional problem or illness (not including pregnancy)” (Blewett et al., 2019). Further, the survey asked respondents to identify the level of difficulty they experienced when conducting various functional tasks such as walking, standing, sitting, stooping, reaching overhead, grasping small objects, carrying and pushing objects, going out into the community, attending social events,

and relaxing at home during leisure activities. These questions align with the Disablement Process model that views functional limitations as “restrictions in performing fundamental physical and mental actions used in daily life by one’s age-sex group” and which ultimately contribute to the experience of disability (Verbrugge & Jette, 1994, p. 3). These functional limitations occur early in the process of disability trajectories of decline to death.

Responses to these questions ranged from “Not at all difficult” to “Can’t do at all.” We recoded responses into a four-point Likert scale ranging from 0 to 4 and then summed the scores for each participant across all twelve items. Summary scores ranged from 0 to 48. Higher scores represented persons with greater levels of disability.

We adjusted the analysis for demographic and socioeconomic characteristics including number of members in each household as a continuous variable, sex (male = 1, female = 0), and marital status/partnered (yes = 1, no = 0). We calculated income as a continuous variable based on mid-point values derived from each income category. We coded education into a continuous variable ranging from 0 to 20 years of education, where 0 represented kindergarten and 20 represented a master’s degree or beyond. Due to research indicating that individuals living in the south and non-metropolitan areas had higher rates of non-intent to receive the COVID-19 vaccine, we used a dummy variable to represent four regions of the country (Northeast, North Central/Midwest, South, and West) with Northeast serving as the reference group (Nguyen et al., 2021). To understand if age differences impact flu vaccine uptake, we stratified all subjects across three age groups. Individuals ranging from 18 to 39 years were coded as Group 1/Young, individuals between 40 and 64 years were coded as Group 2/Middle-Aged, and participants who were 65 years or older were coded as Group 3/Older. We also accounted for a variety of health-related factors such as involvement with a usual place of care (yes = 1, no = 0) and insurance status (yes = 1, no = 0). For length of time since seeing a doctor, we coded individuals who discussed their health with a doctor or other healthcare professional in the past 12 months as the reference group (1) and coded all other individuals with various times since last care as 0. Because researchers found that smoking status was associated with lower rates of vaccine uptake among racial/ethnic groups, we created a dichotomous variable for smoking status (some days/every day = 1, not at all/not anymore = 0) (Almarino et al., 2016). Finally, research suggests that satisfaction with healthcare is associated with higher levels of vaccine uptake (Bazargan et al., 2020) and lower levels of perceived discrimination (Glover, Sims, & Winters, 2017; Harris, Cormack, & Stanley, 2019). We dichotomized satisfaction with healthcare in the past 12 months (very satisfied/somewhat satisfied = 1, somewhat dissatisfied/not satisfied = 0).

#### 3.3. Statistical analysis

We used Stata version 16.1 to conduct all analyses, including multivariate imputations by chained equations (MICE) (Azur, Stuart, Frangakis, & Leaf, 2011). We chose this method because our analyses revealed that 27% of individuals in the sample had incomplete entries for one or more variables and concluded that MICE would satisfy the assumptions for Missing at Random (MAR), minimize bias in parameter estimates, and loss of power (Azur et al., 2011; Graham, 2009). Additional tests showed that missing-ness in flu vaccine uptake was conditional on eleven other variables to include marital status, sex, education, region, income, number of people in the household, insurance status, having seen a regular doctor, length of time since seeing a doctor, satisfaction with healthcare, smoking status, and race/ethnicity. Please refer to the Supplemental Table for a summary of missing-ness by variable. To account for missing data, we imputed 40 data sets for each age group using MICE. To improve our results, we imputed the twelve individual variables that make up the summative score for disability (Azur et al., 2011).

We calculated descriptive statistics from the imputed data sets to

examine the means and proportions with 95% confidence intervals of the independent and dependent variables and covariates stratified across the three age groups (e.g., Young, Middle-Aged, and Older). We used logistic regression to examine relationships between race/ethnicity and disability on flu vaccination with covariate adjustments (Model 1) and then added the race/ethnicity and disability interaction (Model 2). We used odds ratios, 95% confidence intervals, and *P* values to characterize all relationships. We also created a panel figure to graphically represent significant race/ethnicity-by-disability interactions using Excel software.

#### 4. Results

**Table 1** summarizes the proportion or mean for each variable across the three age groups of Young (18–39 years), Middle-Aged (40–64 years), and Older (65 years or older) individuals. The majority of respondents in the survey were non-Hispanic white, comprising 59% of Young, 68% of Middle-Aged, and 77% of Older participants. As expected, mean disability scores increased with age. Individuals in the Older age group had an average disability score of 8.21, followed by 4.21 for the Middle-Aged and 1.06 for the Young. Flu vaccine use was also more common as participants got older, such that 68% of the Older, 43% of the Middle-Aged, and 32% of the Young received a flu vaccine within the past year. Notably, the percentage of individuals who reported having insurance, a regular place for care, health care services within the past 12 months, and satisfaction with healthcare services increased across each subsequent age group from the Young to the Older groups.

**Table 2**, Model 1 describes the logistic regression results assessing the relationships between race/ethnicity, disability, and all covariates on flu vaccination rates, stratified by age groups. Compared to non-Hispanic whites, non-Hispanic blacks and non-Hispanic others aged 18–39 had a 25% lower and 16% greater odds of receiving a flu vaccine respectively, after adjusting for insurance status, having a usual place for medical care, having seen a health care provider in the past 12 months, education, married/partnered status, number of people living in the home, income, sex, being satisfied with health care, smoking status, and region. Similarly, non-Hispanic blacks and non-Hispanic others aged 40–64 years had 18% lower and 20% higher odds, respectively, of receiving the flu vaccine compared to non-Hispanic whites after adjusting for covariates. For individuals 65 years and older, non-Hispanic blacks had 32% lower odds and Hispanics had 17% lower odds of receiving the vaccine after adjusting for covariates. For all people in the sample, a one unit increase on the disability index was related to 2% higher odds of receiving the flu vaccine for the Young and Middle-Aged groups, and 1% higher odds for the Older age group.

A review of covariates demonstrated that having higher education and income, insurance and a usual place of care, being seen by a health care provider in the past 12 months, and being satisfied with healthcare were all related to higher odds of receiving a flu vaccine across all three age groups at significant levels ( $p < .05$ ). Smoking ( $p < .001$ ) and living in the West vs. Northeast ( $p < .05$ ) were associated with lower odds of flu vaccine uptake across all age groups at a significant level. Other covariates had varied effects on flu vaccination use across age groups.

**Table 3**, **Model 2** describes the logistic regression results assessing relationships between race/ethnicity, disability, and their interaction on flu vaccination rates, with covariate adjustments, stratified by age groups. A significant interaction was observed between race/ethnicity and disability for non-Hispanic blacks in age group 1 (Young) relative to non-Hispanic whites ( $p = .001$ ). Compared to the reference group, non-Hispanic blacks had 3% higher odds of receiving the flu vaccine for each unit increase in disability severity. Similarly, a significant race/ethnicity  $\times$  disability interaction was observed for Hispanics in age group 2 (Middle-Aged), where they had 1% higher odds of receiving the flu vaccine compared to non-Hispanic whites for every one unit increase in disability ( $p = .003$ ).

**Table 1**  
Characteristics of Study Sample by Age Group with 95% Confidence Intervals: 2015–2018 National Health Interview Survey, Respondents Aged 18–85 years, Multiple Imputation model,  $n = 118,859$ .

Category	Total (Mean)	Age Group 1 (18–39 years) $n = 38,327$	Age Group 2 (40–64 years) $n = 48,621$	Age Group 3 (65 years or older) $n = 31,911$
Disability Score (0–48) (mean, CI)	3.32 (3.24, 3.40)	1.06 (1.01, 1.11)	4.21 (4.09, 4.33)	8.21 (8.03, 8.40)
<b>Race/Ethnicity (proportion, CI)</b>				
NH White	0.64 (0.63, 0.66)	0.59 (0.58, 0.60)	0.68 (0.67, 0.69)	0.77 (0.76, 0.78)
NH Black	0.12 (0.12, 0.13)	0.14 (0.13, 0.14)	0.13 (0.12, 0.13)	0.09 (0.09, 0.10)
Hispanic	0.15 (0.14, 0.16)	0.18 (0.17, 0.19)	0.12 (0.12, 0.13)	0.08 (0.07, 0.09)
NH Other	0.08 (0.08, 0.08)	0.09 (0.09, 0.10)	0.07 (0.06, 0.07)	0.05 (0.05, 0.06)
Received Flu Vaccine (mean, CI)	0.46 (0.45, 0.46)	0.32 (0.31, 0.33)	0.43 (0.42, 0.43)	0.68 (0.67, 0.69)
Age (mean)	42.27 (42.03, 42.51)	28.95 (28.84, 29.06)	52.44 (52.35, 52.53)	74.13 (74.03, 74.23)
Total Yearly HH Income in Thousands of Dollars (mean)	60.92 (60.24, 61.60)	57.05 (56.24, 57.86)	66.20 (65.42, 66.98)	49.50 (48.74, 50.27)
Education in Yrs (mean)	12.08 (12.03, 12.13)	13.86 (13.81, 13.92)	13.86 (13.80, 13.91)	13.25 (13.18, 13.31)
Insured (mean)	0.91 (0.91, 0.92)	0.86 (0.85, 0.86)	0.90 (0.89, 0.90)	0.99 (0.99, 1.00)
Having a regular doctor (mean)	0.89 (0.88, 0.89)	0.78 (0.77, 0.78)	0.90 (0.89, 0.90)	0.96 (0.96, 0.97)
Saw provider in past 12 months (mean)	0.93 (0.93, 0.93)	0.89 (0.88, 0.89)	0.92 (0.92, 0.93)	0.97 (0.97, 0.97)
Satisfied w/ healthcare (mean)	0.75 (0.75, 0.76)	0.91 (0.91, 0.92)	0.93 (0.93, 0.94)	0.96 (0.96, 0.97)
History of Smoking (mean)	0.12 (0.12, 0.13)	0.16 (0.15, 0.17)	0.19 (0.18, 0.19)	0.09 (0.09, 0.09)
Married/Partner (mean)	0.40 (0.40, 0.41)	0.45 (0.44, 0.46)	0.58 (0.57, 0.58)	0.45 (0.44, 0.45)
Sex (Male) (mean)	0.47 (0.47, 0.47)	0.48 (0.47, 0.48)	0.47 (0.47, 0.48)	0.41 (0.41, 0.42)
Number of People in Household (mean)	2.69 (2.67, 2.71)	2.83 (2.80, 2.86)	2.38 (2.36, 2.40)	1.68 (1.67, 1.70)
<b>Region (Proportion, CI)</b>				
Northeast	0.18 (0.16, 0.19)	0.16 (0.15, 0.17)	0.18 (0.17, 0.19)	0.19 (0.18, 0.20)
N. Central/MW	0.23 (0.22, 0.24)	0.24 (0.23, 0.25)	0.23 (0.22, 0.24)	0.23 (0.22, 0.24)
South	0.37 (0.35, 0.38)	0.36 (0.35, 0.38)	0.37 (0.36, 0.39)	0.37 (0.35, 0.38)
West	0.23 (0.21, 0.24)	0.24 (0.22, 0.25)	0.22 (0.21, 0.23)	0.21 (0.20, 0.23)

Source: NHIS 2015–2018 data.

**Table 2**  
Model 1: Odds Ratios, P-values, and 95% Confidence Intervals for Receiving the Flu Vaccine in the Past 12 Months: 2015–2018 National Health Interview Survey, Respondents Aged 18–85 years, Multiple Imputation Model.

Age Group 1 (18–39 years)			
	Received Flu Vaccine (Odds Ratio)	Confidence Interval	P-Value
<b>Race/Ethnicity</b>			
Non-Hispanic Black	0.751	(0.681, 0.828)	0.000
Hispanic	1.038	(0.960, 1.122)	0.346
Non-Hispanic Other	1.156	(1.051, 1.272)	0.003
Non-Hispanic White (reference)			
<b>Disability</b>			
	1.019	(1.012, 1.026)	0.000
<b>Control Variables</b>			
Insurance	1.666	(1.512, 1.836)	0.000
Usual Place of Care	1.608	(1.490, 1.734)	0.000
Saw Provider in Past 12 Months	2.271	(2.024, 2.548)	0.000
Education	1.101	(1.086, 1.116)	0.000
Married/Partnered	1.072	(1.012, 1.136)	0.019
Income	1.002	(1.001, 1.003)	0.000
Sex (Male)	0.737	(0.699, 0.777)	0.000
Number of People in Household	1.023	(1.004, 1.042)	0.017
Satisfied with Health Care	1.376	(1.215, 1.558)	0.000
History of Smoking Region	0.650	(0.599, 0.705)	0.000
North Central	0.943	(0.852, 1.043)	0.254
South	0.936	(0.854, 1.026)	0.158
West	0.876	(0.791, 0.970)	0.011
Northeast (reference)			
<b>Constant</b>			
	0.020	(0.015, 0.026)	0.000
<b>Age Group 2 (40–64 years)</b>			
	Received Flu Vaccine (Odds Ratio)	Confidence Interval	P-Value
<b>Race/Ethnicity</b>			
Non-Hispanic Black	0.815	(0.757, 0.879)	0.000
Hispanic	0.988	(0.912, 1.070)	0.762
Non-Hispanic Other	1.200	(1.098, 1.310)	0.000
<b>Disability</b>			
	1.023	(1.020, 1.026)	0.000
<b>Control Variables</b>			
Insurance	2.181	(1.987, 2.395)	0.000
Usual Place of Care	2.063	(1.872, 2.274)	0.000
Saw Provider in Past 12 Months	2.838	(2.499, 3.222)	0.000
Education	1.044	(1.034, 1.054)	0.000
Married/Partnered	0.982	(0.929, 1.039)	0.533
Income	1.003	(1.002, 1.004)	0.000
Sex (Male)	0.854	(0.817, 0.892)	0.000
Number of People in Household	0.950	(0.932, 0.969)	0.000
Satisfied with Health Care	1.368	(1.240, 1.509)	0.000
History of Smoking Region	0.744	(0.701, 0.789)	0.000
North Central	0.960	(0.888, 1.039)	0.311
South	0.900	(0.832, 0.973)	0.008
West	0.918	(0.843, 0.999)	0.049
Northeast (reference)			

**Table 2 (continued)**

Age Group 1 (18–39 years)			
	Received Flu Vaccine (Odds Ratio)	Confidence Interval	P-Value
<b>Constant</b>			
	0.029	(0.023, 0.367)	0.000
<b>Age Group 3 (65 years and older)</b>			
	Received Flu Vaccine (Odds Ratio)	Confidence Interval	P-Value
<b>Race/Ethnicity</b>			
Non-Hispanic Black	0.678	(0.614, 0.749)	0.000
Hispanic	0.828	(0.729, 0.939)	0.003
Non-Hispanic Other	1.017	(0.891, 1.161)	0.802
<b>Disability</b>			
	1.013	(1.010, 1.016)	0.000
<b>Control Variables</b>			
Insurance	3.506	(2.280, 5.392)	0.000
Usual Place of Care	2.739	(2.342, 3.205)	0.000
Saw Provider in Past 12 Months	4.045	(3.320, 4.929)	0.000
Education	1.015	(1.005, 1.025)	0.003
Married/Partnered	1.203	(1.118, 1.294)	0.000
Income	1.004	(1.003, 1.005)	0.000
Sex (Male)	0.964	(0.906, 1.025)	0.241
Number of People in Household	0.915	(0.880, 0.950)	0.000
Satisfied with Health Care	1.343	(1.158, 1.558)	0.000
History of Smoking Region	0.631	(0.576, 0.691)	0.000
North Central	0.997	(0.908, 1.095)	0.951
South	0.904	(0.827, 0.990)	0.029
West	0.875	(0.793, 0.965)	0.008
Northeast (reference)			
<b>Constant</b>			
	0.035	(0.021, 0.058)	0.000

Source: NHIS 2015–2018 data.

Fig. 1 provides a visual representation of relationships between race/ethnicity and flu vaccine use across levels of disability for age group 1 (18–39 years), age group 2 (40–64 years), and age group 3 (65 years and older), after adjusting for all covariates. We added the labels of no disability (minimum disability score = 0), moderate disability (median disability score = 24), and severe disability (maximum disability score = 48) to help readers interpret the increasing trajectory of race-by-disability interactions. A positive linear trend demonstrates that vaccine use increased as disability scores increased across all racial/ethnic groups, but a significant interaction occurred for young non-Hispanic blacks and middle-aged Hispanics. The slope of the lines indicate that flu vaccine use increased at a faster rate for non-Hispanic blacks (ages 18–39 years) and Hispanics (ages 40–64 years) relative to non-Hispanic whites.

To evaluate the impact of missing data, we conducted sensitivity analyses using a restricted sample of 87,143 complete observations with all model variables and then compared our results to the imputed analysis. Two substantive differences occurred between samples. In the restricted sample, young people (ages 18–39 years) living in the South had 9.56% lower odds of receiving the flu vaccine relative to individuals living in the Northeast at  $p = .009$  after adjusting for other covariates, while no significant differences were observed in the imputed analysis. Secondly, in the restricted sample, individuals who discussed their health with a healthcare professional within the past 12 months had 2.76 times the odds of receiving the flu vaccine compared to those who had not at  $p < .001$  and after adjusting for other covariates. In the

**Table 3**  
 Model 2: Odds Ratios, P-values, and Confidence Intervals for Race/Ethnicity × Disability Interactions on Receiving the Flu Vaccine in the Past 12 Months: 2015–2018 National Health Interview Survey, Respondents Aged 18–85 years, Multiple Imputation Model.

Age Group 1 (18–39 years)			
	Received Flu Vaccine (Odds Ratio)	Confidence Interval	P-Value
<b>Race/Ethnicity x Disability</b>			
Non-Hispanic Black x Disability	1.031	(1.012, 1.051)	0.001
Hispanic x Disability	1.009	(0.989, 1.029)	0.382
Non-Hispanic Other x Disability	1.017	(0.991, 1.044)	0.203
<b>Constant</b>	0.020	(0.015, 0.027)	0.000
Age Group 2 (40–64 years)			
	Received Flu Vaccine (Odds Ratio)	Confidence Interval	P-Value
<b>Race/Ethnicity x Disability</b>			
Non-Hispanic Black x Disability	1.003	(0.996, 1.011)	0.384
Hispanic x Disability	1.013	(1.005, 1.022)	0.003
Non-Hispanic Other x Disability	0.997	(0.986, 1.007)	0.536
<b>Constant</b>	0.030	(0.024, 0.037)	0.000
Age Group 3 (65 years and older)			
	Received Flu Vaccine (Odds Ratio)	Confidence Interval	P-Value
<b>Disability</b>			
Non-Hispanic Black x Disability	0.996	(0.989, 1.004)	0.374
Hispanic x Disability	1.000	(0.990, 1.010)	0.979
Non-Hispanic Other x Disability	1.007	(0.993, 1.022)	0.302
<b>Constant</b>	0.035	(0.021, 0.058)	0.000

Source: NHIS 2015–2018 data.

imputed analysis, the odds increased to 4.05, at  $p < .001$ .

### 5. Discussion

Race/ethnicity was the moderating variable in this study and led to positive relationships between disability and flu vaccine uptake as disability scores increased for young non-Hispanic blacks (ages 18–39 years) and middle-aged Hispanics (ages 40–64 years) relative to non-Hispanic whites. We theorized that a leveling effect could occur if one social identity offered benefits that reduced or “leveled out” the negative consequences of a second identity. In this study, a partial leveling effect was observed for these two groups, although it was not observed across all age and racial/ethnic categories.

One explanation for these findings may relate to generational differences among non-Hispanic blacks and Hispanics unique to each cohort. In a qualitative study exploring trust in government and healthcare institutions related to flu vaccine uptake in adults aged 18+, researchers observed that among African Americans, members of the younger generation were more trusting of government institutions and influenza vaccines compared to older generations (Jamison, Quinn, & Freimuth, 2019). Researchers speculated that increased optimism toward government among young African Americans might reflect period effects of the Obama presidency. Generational perceptions about government authority and public health programs may therefore be

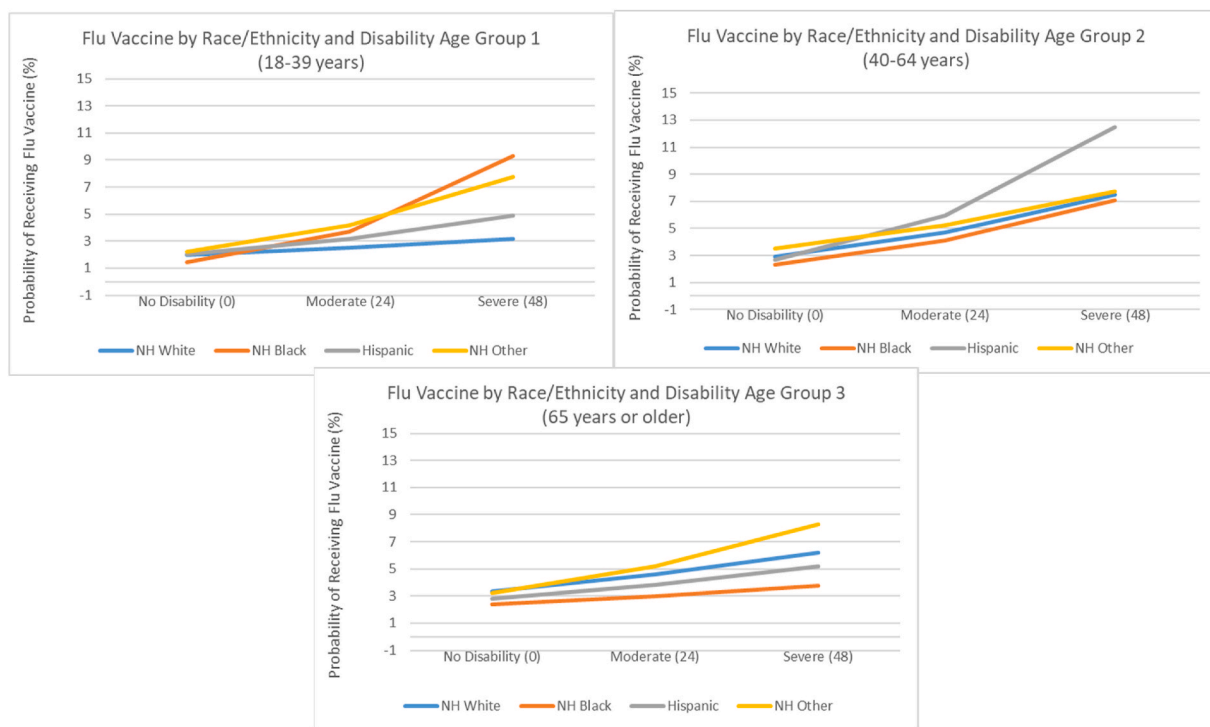
important factors affecting vaccine acceptance among this cohort. Furthermore, in a study of adult Mexican-origin men living in Texas, a higher proportion of individuals aged 40+ reported receiving a vaccine within the past year compared to those in younger age groups (Snyder et al., 2020). Individuals who had not received a vaccine within the past five years cited feeling healthy and being free from illness as reasons for abstaining from vaccines. Importantly, chronic conditions such as diabetes, obesity, and high blood pressure are more likely to be diagnosed among Hispanic individuals 40 years or older (Caballero, 2011; Snyder et al., 2020). Generational perceptions about health and the benefits of a vaccine may therefore be important determinants of vaccine uptake in this cohort.

Our study shows that age stratification is also important in race-by-disability interactions. Life experiences common to different age groups, along with the implementation of new policies affecting age groups uniquely, may further contribute to these differences. For example, the significant race-by-disability interactions for working-aged cohorts (non-Hispanic blacks aged 18–39 years and middle-aged Hispanics aged 40–64 years) may reflect the importance of policy changes on vaccine uptake. Since 2010, participants in the young and middle-aged cohorts likely benefitted from affordable insurance options, zero co-pays for annual well visits and flu vaccinations, and targeted outreach programs under the Affordable Care Act (ACA) (Buchmueller, Levinson, Levy, & Wolfe, 2016). After the implementation of the ACA, healthcare providers targeted underserved populations using mobile health units. Demographic data about people served by 811 mobile units operating in the U.S. from 2007 to 2017 suggests that people of working age benefitted more from this outreach approach compared to older individuals of retirement age (Malone et al., 2020).

Moreover, working-aged cohorts probably benefitted from an increased number of vaccine providers after the H1N1 flu pandemic of 2009, when public health agencies formed new partnerships with medical and non-medical vaccine providers and instituted recommendations for annual flu vaccination of all individuals ≥6 months (CDC, 2011). With more providers, individuals had greater opportunities to access flu vaccines across locations and hours of operation, which would be particularly beneficial for working-aged individuals. These findings highlight how improved access to vaccines for working-aged individuals, combined with generational differences among specific racial/ethnic cohorts, may contribute to the intersectional effects observed in this study.

Finally, this study confirms the interesting, yet varied role disability may have on vaccine uptake. In our study, PWD had higher odds of flu vaccine use among all racial/ethnic groups as disability severity increased. Disability served to incentivize flu vaccination. In other words, PWD were better protected through their or their caretakers’ actions. The tendency for PWD to get vaccinated in this study is consistent with other studies that found individuals with pre-existing medical conditions were more likely to get a vaccine (Bhugra et al., 2021). Individuals who have more contact with the healthcare system or who perceive themselves to be at a higher risk of severe illness from influenza infection may therefore be more likely to receive the vaccination.

In the future, qualitative studies exploring the motivations and attitudes of racial/ethnic and disability intersectional groups, stratified by age, will better contextualize and inform policy makers about effective strategies to improve flu vaccine uptake for marginalized and at-risk groups. This research could help verify and explain how expanded site and hours of operation for working-aged adults, as well as family and caregiving contexts (Mendez-Luck, Walker, & Luck, 2016), play decision-making roles in getting flu vaccinations for racial/ethnic, disability, and age intersectional groups. First-hand data will be useful to confirm or challenge our speculations about the positive impact of healthcare policies, initiatives, and generational differences. These studies must consider social and behavioral factors, with possible connections between individual experiences and historical processes, to



**Fig. 1.** Interactional Effects of Race/Ethnicity and Disability Level on Flu Vaccine Use for Age Group 1 (18–39 years), Age Group 2 (40–64 years), and Age Group 3 (65 years and older), Multiple Imputation Model, Probabilities (%) Source: NHIS 2015–2018 data.

better understand decision-making for each group across the life course.

Our study could also be extended to other vaccines such as COVID-19 and HPV. We would expect findings to be similar for the COVID-19 vaccine since both influenza and COVID-19 can lead to serious health consequences for marginalized groups that may motivate individuals to get vaccinated. In contrast, we would expect different findings for the HPV vaccine since studies show that adolescents with disabilities are less likely to get the HPV vaccine compared to their non-disabled peers (O’Neill, Elia, et al., 2019; Rowe et al., 2017). Reasons for these discrepancies are not well understood but may be related in part to poor sexual healthcare and education for those with disabilities (O’Neill, Elia, et al., 2019).

**5.1. Limitations**

More broadly, we find the methods for identifying and defining individuals with disabilities in survey studies to be problematic. To improve researchers’ abilities to make meaningful comparisons, a standardized method for defining disability is needed that accounts for the conceptual complexities of defining disability and recognizes it as a state of health and functioning in society rather than a disease state or outcome of poor health (Verbrugge & Jette, 1994; World Health Organization, 2002). Another limitation of this study was our inability to measure perceived discrimination directly. Perceived discrimination plays an important role in an individual’s trust of physicians, willingness to seek medical care, or follow a physician’s recommendations (Valdez & Romero, 2021). Unfortunately, a variable measuring perceived discrimination was not available in the NHIS questionnaire. However, we believe satisfaction with healthcare services is inversely related to perceived discrimination (Glover et al., 2017; Harris et al., 2019); thus, this variable is a proxy for perceived discrimination. This study used cross-sectional data asking about individuals’ circumstances at a specific point in time. Thus, this data is not appropriate for drawing causal conclusions but does demonstrate possible relationships. Recall bias could limit this research as individuals may not accurately recall their

vaccination history. Further, the percentage of people with disabilities in our sample increased with age. Therefore, our sample may be skewed toward individuals with age-related disabilities and may be less representative of individuals with life-long or more severe disabilities. Finally, this sample included only non-institutionalized, civilian adults. The experiences of adults living in institutions such as nursing facilities, correctional facilities, or military bases were not represented.

**5.2. Conclusion**

This study supports research showing that the reasons an individual seeks or refuses a vaccine can be multifactorial and complex. Our findings support the success of initiatives to increase access to preventative care services for at-risk marginalized groups and people of working age through interventions such as the ACA, mobile health units, and community-based vaccination programs. Further, this study shows that disability, as defined in this study, incentivized people across racial/ethnic groups to get a flu vaccine as disability scores increased, and race/ethnicity had a moderating effect on the relationships between flu vaccine uptake and disability for young non-Hispanic blacks (ages 18–44 years) and middle-aged Hispanics (ages 45–64 years) as disability scores increased.

**Financial disclosure statement**

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

**Ethical statement**

We declare no conflicts of interest. This study was not funded from any source.

Approval from an ethics board was not obtained for this study. Per Colorado Multiple Institutional Review Board policy, this study does not meet the criteria for human subject’s research because the data used for

analysis was de-identified and publicly available.

## Author statement

**Rebecca Breaux:** Conceptualization, Methodology, Software, Formal Analysis, Data Curation, Writing, Visualization. **Ronica Rooks:** Validation, Writing-Review & Editing, Supervision.

## Declaration of competing interest

None.

## Data availability

Data will be made available on request.

## Acknowledgements

The National Health Interview Survey has been administered in the United States continuously since 1957 by the National Center for Health Statistics pursuant to the passage of the National Health Survey Act of 1956. We wish to thank Joshua Goode, statistics consultant with the Institute of Behavioral Science at the University of Colorado Boulder, for his assistance with multiple imputations and Patrick Krueger, with the Department of Health and Behavioral Sciences at the University of Colorado Denver, for his guidance and technical support in the early stages of this project.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2022.101211>.

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