COVID-19 Vaccine Hesitancy Among Medicare Beneficiaries with and Without Cancer History: A US Population-based Study

Hermine Poghosyan1,2 · Zhao Ni1,3 · David Vlahov1,3 · LaRon Nelson1,3 · Soohyun Nam1

Abstract
Understanding COVID-19 vaccine hesitancy among Medicare beneficiaries is critical for increasing COVID-19 vaccine uptake in the US. This study aimed to estimate and compare the vaccine hesitancy rate among community-dwelling Medicare beneficiaries with and without cancer history, also to investigate factors associated with vaccine hesitancy during the first four months after COVID-19 vaccine became available. We used population-based, cross-sectional data on 3,034 community-living Medicare beneficiaries from the Medicare Current Beneficiary Survey COVID-19 Winter 2021 Supplement. Sample weights were applied to account for the complex survey design with results generalizable to 16.4 million Medicare beneficiaries. Weighted multivariable logistic regression model was conducted to investigate the association between cancer history and vaccine hesitancy adjusting for covariates. A total of 39.6% were hesitant about getting COVID-19 vaccine. Those with cancer history were significantly less likely to be hesitant to get vaccinated than those without cancer history (adjusted odds ratio $= 0.80$, 95% confidence interval: 0.64, 0.99, $p = 0.050$). The most common reason for being hesitant to get COVID-19 vaccine was that the vaccine could have side effects or was viewed as not safe (19.2%), followed by not trusting what government says about vaccine (11.4%). Those with cancer history were more likely to report ongoing health conditions, lack of recommendation from a doctor, and doctor recommending against COVID-19 vaccination as reasons for not getting the vaccine compared to participants without cancer history. Increasing the confidence and knowledge about vaccine benefits among high-risk and more hesitant individuals are urgently needed to increase the vaccine uptake.

Keywords COVID-19 · Cancer history · Medicare beneficiaries · Vaccine hesitancy

Introduction
Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is a highly contagious infection that has caused significant morbidity and mortality worldwide by producing coronavirus disease 2019 (COVID-19). As of May 10, 2022, there have been more than 81.9 million infections and over 1 million deaths due to COVID-19 in the United States (US) [1]. Individuals with underlying medical conditions including cancer history suffered higher morbidity and mortality from COVID-19 than those without medical conditions [2–4]. On December 11, 2020, the US policy makers authorized the emergency use of the COVID-19 vaccine to mitigate the impact of COVID-19 [5]. Currently, safe and highly-effective vaccines against COVID-19 infection are widely available across the US [5]. Promoting widespread acceptance of COVID-19 vaccines is critically important to end the COVID-19 pandemic and return to normal pre-pandemic activities of daily social life.

Due to compromised immune system, individuals with cancer history are considered as a high-risk, high-priority population group for COVID-19 vaccination for both primary and booster vaccinations. Yet, compared with the US general population, people with cancer history have lower rate of vaccination against COVID-19. As of March 7, 2022, 56% of people with cancer history reported receiving...
at least one dose of COVID-19 vaccine while 76.5% of the US general population have received at least one dose of COVID-19 vaccine [6, 7]. Vaccine hesitancy has been reported as one of the main barriers to vaccine uptake [4, 8–10]. Vaccine hesitancy, defined as the “delay in acceptance or refusal of safe vaccines despite availability of vaccination services,” has been one of the major obstacles to mitigating the COVID-19 pandemic [11]. Studies reported that up to 30% of the general population were hesitant to get vaccinated against COVID-19 disease during the first year when vaccine became available [12–15]. Cancer survivors were reported to be more hesitant than the general population to receive the COVID-19 vaccine [16, 17]. However, data are sparse on factors associated with COVID-19 vaccine hesitancy when comparing individuals with and without cancer history. Studies postulated that the confluxes of social and health factors contributed to the higher levels of COVID-19 vaccine hesitancy among people with cancer histories [16–18].

The purpose of this study was to compare the rate of, and examine factors associated with, COVID-19 vaccine hesitancy among Medicare beneficiaries with and without cancer history. Using representative population-based data from the Medicare Current Beneficiary Survey (MCBS), the current study sought to (1) estimate and compare the vaccine hesitancy rate among community-dwelling Medicare beneficiaries with and without cancer history; (2) investigate factors associated with vaccine hesitancy; and (3) evaluate reasons participants had not received a vaccination during the first four months when COVID-19 vaccine became available. Findings of this study can help researchers, clinicians, and policy makers tailor interventions to deliver COVID-19 vaccine information, outreach efforts and strategies to different groups including cancer survivors and the general population in a way that will increase their readiness to be vaccinated and, consequently, increase rates of COVID-19 vaccination.

Methods

Data Source and Study Design

Data for the current study came from the Medicare Current Beneficiary Survey (MCBS) COVID-19 Winter 2021 Rapid Response Community Supplement Public Use File. [19] The MCBS is a nationally representative, cross-sectional telephone survey of community-dwelling Medicare beneficiaries aged 65 years and older and beneficiaries aged 64 years and below with certain disabling conditions. The MCBS has collected data on Medicare beneficiaries since 1991. It has collected information on health care use, health care expenditures, health care access barriers and factors that affect health care utilization. The MCBS also collects demographic characteristics, health status and functioning, financial resources, and potential family support. These data are collected in three data collection periods per year [19].

We used the MCBS COVID-19 survey data that was administered between February 28, 2021, and April 25, 2021, either in English or Spanish. The survey assessed the impact of COVID-19 pandemic on Medicare beneficiaries living in the community at the time of their interview using the following items: COVID-19 vaccine utilization, availability of telemedicine visits, access to technology devices and the internet, deferred medical care, social distancing and other preventive health behaviors, COVID-19 testing and vaccination intention, and other COVID-19 related variables. The MCBS COVID-19 Winter supplement includes data on 11,107 Medicare beneficiaries weighted to be nationally representative of 57,387,274 beneficiaries enrolled in Medicare at any point in 2020 and continued to be enrolled through winter 2021. The overall response rate was 79.6%. Additional information about the survey is available at the Centers for Medicare and Medicaid Services (CMS) MCBS website [19].

Study Sample

Out of 11,107 Medicare beneficiaries, 6,977 had received COVID-19 vaccine. As our focus was on hesitancy, inclusion criteria of participants were the following: community-dwelling Medicare beneficiaries who had not received a vaccine and responded to the question regarding COVID-19 vaccination intention (n = 4,111). The MCBS COVID-19 Winter supplement surveyed Medicare beneficiaries either themselves or through proxy respondents. We excluded observations completed by proxy respondents. Also, we excluded observations due to missing values on study variables. This resulted an analytic sample of 3,034 Medicare beneficiaries (Fig. 1). There were 105 missing values for evaluating reasons for not getting COVID-vaccine, thus, the analytic sample for evaluating reasons was 2,929.

Measures

Dependent Variable

The outcome variable of interest is self-reported intent to get vaccination. Respondents were asked “If a vaccine that protected you from Coronavirus was available to everyone who wanted it, would you get it?” Response options were 1 = definitely, 2 = probably, 3 = probably not, 4 = definitely not, and 5 = not sure. For this study, positive intent to get
vaccinated was treated as a dichotomous variable. We created a variable by combining *definitely* and *probably* (1 and 2) responses for positive intent and, for negative intent we combined the *probably not*, *definitely not* and *not sure* responses (3–5). In addition, the instrument provided 19 yes/no items for participants to respond on reasons for being hesitant and not getting the vaccine (e.g., mistrust of government, possible side effects, etc.).

**Independent Variables**

The key independent variable of interest was if participants ever had cancer history (other than skin cancer). It was categorized as a binary variable with responses 1 = yes and 0 = no. Socio-demographic variables included age (< 65, 65–74, and ≥ 75 years), sex (male, female), race and ethnicity (non-Hispanic Black, Hispanic, non-Hispanic White, and Other [American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, two or more races, unknown races]), annual household income (< $25,000 and ≥ $25,000), Medicare and Medicaid dual eligibility (non-dual, full eligible, partial eligible, and qualified Medicare beneficiary (QMB) eligible only). We also included living status (alone, not alone), residential area (metropolitan, non-metropolitan), and the US Census regions (West, Midwest, Northeast, South). Unable to get medical care because of COVID-19 pandemic was a binary variable with yes/no. Clinical variables included depression history (yes, no), and COVID-19 history between 11/2020-3/2021 (yes, no). Additional items included the information source that participants rely on about the COVID-19 (traditional news sources: (TV, radio, websites, and newspapers), social media, friends or family members, guidance from government officials and health care providers).

**Statistical Analysis**

Analyses were performed on weighted data using Stata, version 17. For all analyses, we applied recommended sampling weights to account for the complex survey design provided by the MCBS to produce nationally representative estimates. Descriptive statistics included frequencies and weighted percentages with corresponding 95% confidence interval (CI) of each variable. Then, we examined sample characteristics by cancer history. We built multivariable logistic regression models to measure the association between cancer history and vaccine hesitancy adjusting for covariates. We present weighted adjusted odds ratios (OR) with their corresponding 95% CI and p-values. We further evaluated reasons for COVID-19 vaccine hesitancy by presenting weighted percentages and 95% CI. Conventional approaches were used to define statistical significance (2-sided p-values less than 0.05). The variance estimation method of balanced repeated replication (BRR) using Fay’s adjustment of 0.3 is used in our analyses.

**Results**

**Sample Characteristics and Vaccine Hesitancy**

A total of 3,034 community-living Medicare beneficiaries were included in this study that corresponds to a population estimate of 16,406,838 Medicare beneficiaries with characteristics presented in Table 1 and Table 2. Overall, 12.7% were non-Hispanic Black, 11.1% Hispanic (inclusive of all racialized groups), 70.0% non-Hispanic White and the remaining 6.2% distributed across other racialized group categories. These Medicare beneficiaries were predominantly female (57.6%), aged 65 years or older (71.3%), had ≥ $25,000 annual income (54.5%), and resided in metropolitan areas (77.7%) (Table 1). Overall, 16.3% of Medicare beneficiaries reported having a cancer history and 83.7% did not have a cancer history. A total of 39.6% were hesitant about getting COVID-19 vaccine and 7.2% reported inability to get medical care due to COVID-19 (Table 2).

**Sample Characteristics by Cancer History**

As Table 3 shows, those with cancer history were more likely than those without to be older (75 years or older: 31.6% vs. 20.3%, p < 0.001), female (65.6% vs. 56.0%, p < 0.001), have a history of depression (37.0% vs. 31.8%, p = .051) and be unable to get medical care because of COVID-19 (10.0% vs. 7.2%, p = .023).
ongoing health conditions, lack of recommendation from a doctor, and doctor recommending against COVID-19 vaccination as reasons for not getting the vaccine.

### Association Between COVID-19 Vaccine Hesitancy and History of cancer

Table 5 shows that those with cancer history were less likely to be hesitant to get vaccinated than those without cancer history (OR = 0.80, 95% CI: 0.64, 0.99, p = .050). The odds of vaccine hesitancy were lower among Hispanic beneficiaries compared to non-Hispanic Whites. The odds of vaccine hesitancy were higher among female beneficiaries, those with lower income, and living in non-metropolitan areas compared to their counterparts. The odds of vaccine hesitancy were also higher among those who used social media and the Internet, relied on friends or family members and health care providers comparing to beneficiaries who used traditional news source to learn about COVID-19. Moreover, Medicare beneficiaries living in the Northeast and Midwest regions had lower odd of vaccine hesitancy compared to those living in the South (Table 5).

---

**Table 1** Socio-demographic characteristics of community-dwelling Medicare beneficiaries

| Characteristics              | Unweighted frequencies | Weighted Percentage | Weighted 95% CI |
|-----------------------------|------------------------|---------------------|----------------|
| Age                         |                        |                     |                |
| <65                         | 985                    | 28.7                | 27.2–30.2      |
| 65–74                       | 1,084                  | 49.2                | 47.2–51.2      |
| ≥75                         | 965                    | 22.1                | 20.6–23.8      |
| Sex                         |                        |                     |                |
| Male                        | 1,273                  | 42.4                | 40.1–44.7      |
| Female                      | 1,761                  | 57.6                | 55.3–59.9      |
| Race and Ethnicity          |                        |                     |                |
| Non-Hispanic White          | 2,063                  | 69.9                | 67.6–72.2      |
| Non-Hispanic Black          | 416                    | 12.8                | 11.1–14.6      |
| Hispanic                    | 374                    | 11.1                | 9.5–12.9       |
| Other                       | 181                    | 6.2                 | 4.8–8.1        |
| Income                      |                        |                     |                |
| < $25,000                   | 1,569                  | 45.5                | 43.0–48.0      |
| ≥$25,000                    | 1,465                  | 54.5                | 52.0–57.0      |
| Residing Area               |                        |                     |                |
| Metro                       | 2,278                  | 77.7                | 74.9–80.3      |
| Non-metro                   | 756                    | 22.3                | 19.8–25.1      |
| US census regions           |                        |                     |                |
| Northeast                   | 540                    | 17.5                | 15.5–19.8      |
| Midwest                     | 646                    | 21.9                | 19.7–24.3      |
| South                       | 1,292                  | 41.4                | 38.5–44.3      |
| West                        | 556                    | 19.2                | 16.3–22.3      |
| Living status               |                        |                     |                |
| Alone                       | 687                    | 21.3                | 19.4–23.4      |
| Not alone                   | 2,347                  | 78.7                | 76.6–80.6      |
| Information source          |                        |                     |                |
| Traditional                 | 1,500                  | 48.6                | 46.2–51.1      |
| Social                      | 356                    | 11.7                | 10.3–13.2      |
| Government                  | 195                    | 7.0                 | 6.0–8.3        |
| Family/friends              | 375                    | 11.6                | 10.0–13.4      |
| Healthcare provider         | 608                    | 21.1                | 19.4–22.8      |

**Table 2** Clinical characteristics of community-dwelling Medicare beneficiaries

| Characteristics              | Unweighted frequencies | Weighted Percentage | Weighted 95% CI |
|-----------------------------|------------------------|---------------------|----------------|
| Cancer history              |                        |                     |                |
| Yes                         | 525                    | 16.3                | 14.8–18.0      |
| No                          | 2,509                  | 83.7                | 82.1–85.2      |
| Vaccine hesitancy           |                        |                     |                |
| Positive intent to get vaccinated | 1,805              | 60.4                | 57.7–63.1      |
| Hesitant get vaccinated     | 1,229                  | 39.6                | 36.9–42.4      |
| Medicare-Medicaid dual eligibility in 2020 |                   |                     |                |
| Nondual                     | 2,086                  | 75.5                | 73.4–77.5      |
| Fully dual eligible         | 584                    | 14.6                | 13.0–16.3      |
| Partially dual eligible     | 178                    | 5.1                 | 4.2–6.1        |
| QMB eligible only           | 186                    | 4.9                 | 3.9–6.1        |
| Unable to get medical care because of COVID-19 |                   |                     |                |
| Yes                         | 223                    | 7.2                 | 6.1–8.4        |
| No                          | 2,811                  | 92.8                | 91.6–93.9      |
| Depression History          |                        |                     |                |
| Yes                         | 1,035                  | 32.6                | 30.3–34.9      |
| No                          | 1,999                  | 67.4                | 65.1–69.7      |
| Had COVID-19 since 11/1/2020|                        |                     |                |
| Yes                         | 220                    | 7.3                 | 6.0–8.8        |
| No                          | 2,814                  | 92.7                | 91.2–94.0      |

**Reasons for not Getting COVID-19 Vaccine**

As Table 4 shows that among the total sample the most common reason for being hesitant to get COVID-19 vaccine was that the vaccine could have side effects or was viewed as not safe (19.2%), followed by not trusting what government says about vaccine (11.4%), low perceived risk (10.2%), and medical reasons preventing them from getting COVID-19 vaccines (7.2%). Compared to participant without cancer history, those with cancer history were more likely to report
| Characteristics                  | Cancer History |   |   |   |   | P-value |
|----------------------------------|----------------|---|---|---|---|---------|
|                                  | Yes            | No |    |    |    |         |
|                                 | Weighted % (95% CI) | Weighted % (95% CI) |         |
| Vaccine hesitancy                |                |                | 0.048   |
| Positive intent to get vaccinated | 64.8 (59.8–69.4) | 59.6 (56.6–62.4) |         |
| Hesitant get vaccinated           | 35.2 (30.6–40.2) | 40.4 (37.6–43.4) |         |
| Age                              |                |                | 0.000   |
| <65                              | 23.0 (18.9–27.8) | 29.8 (28.1–31.5) |         |
| 65–74                            | 45.4 (41.0–49.9) | 49.9 (47.6–52.3) |         |
| ≥75                              | 31.6 (27.2–36.3) | 20.3 (18.7–22.0) |         |
| Sex                              |                |                | 0.001   |
| Male                             | 34.4 (29.4–39.7) | 44.0 (41.6–46.4) |         |
| Female                           | 65.6 (60.3–70.6) | 56.0 (53.6–58.4) |         |
| Race and Ethnicity               |                |                | 0.116   |
| Non-Hispanic White               | 73.5 (69.1–77.4) | 69.2 (66.6–71.7) |         |
| Non-Hispanic Black               | 9.2 (6.4–13.0)  | 13.4 (11.7–15.4) |         |
| Hispanic                         | 10.0 (7.4–13.4) | 11.3 (9.5–13.4)  |         |
| Other                            | 7.3 (5.0–10.6)  | 6.0 (4.5–8.2)    |         |
| Income                           |                |                | 0.161   |
| <$25,000                         | 41.6 (35.9–47.5) | 46.3 (43.5–49.0) |         |
| ≥$25,000                         | 58.5 (52.5–64.5) | 53.8 (51.0–56.5) |         |
| Medicare-Medicaid dual eligibility in 2020 |                |                | 0.684   |
| Nondual                          | 76.8 (71.1–81.6) | 75.3 (72.8–77.5) |         |
| Fully dual eligible              | 13.0 (9.6–17.2)  | 14.9 (13.1–16.8) |         |
| Partially dual eligible          | 5.9 (3.8–8.9)   | 4.9 (4.0–6.0)    |         |
| QMB eligible only                | 4.4 (2.6–7.5)   | 5.0 (3.9–6.3)    |         |
| Residing Area                    |                |                | 0.766   |
| Metro                            | 78.4 (73.4–82.8) | 77.6 (74.4–80.5) |         |
| Non-metro                        | 21.6 (17.3–26.7) | 22.4 (19.5–25.6) |         |
| US census regions                 |                |                | 0.785   |
| Northeast                        | 18.6 (15.1–22.8) | 17.3 (15.2–19.7) |         |
| Midwest                          | 20.2 (15.9–25.4) | 22.2 (20.0–24.6) |         |
| South                            | 41.4 (35.8–47.3) | 41.4 (38.3–44.6) |         |
| West                             | 19.7 (16.0–24.0) | 19.0 (16.0–22.5) |         |
| Living status                     |                |                | 0.235   |
| Alone                            | 23.8 (19.3–29.0) | 20.9 (18.9–23.0) |         |
| Not alone                        | 76.2 (71.0–80.7) | 79.2 (77.0–81.2) |         |
| Unable to get medical care because of COVID-19 |                |                | 0.040   |
| Yes                              | 9.9 (7.0–13.8)  | 6.6 (5.5–7.9)    |         |
| No                               | 90.1 (86.2–93.0) | 93.4 (92.1–94.5) |         |
| Depression History               |                |                | 0.051   |
| Yes                              | 36.8 (31.8–42.1) | 31.8 (29.5–34.1) |         |
| No                               | 63.2 (57.9–68.2) | 68.2 (65.9–70.5) |         |
| Had COVID-19 since 11/1/2020     |                |                | 0.512   |
| Yes                              | 8.1 (5.6–11.6)  | 7.1 (5.8–8.7)    |         |
| No                               | 91.9 (88.4–94.4) | 92.9 (91.2–94.2) |         |
| Information source               |                |                | 0.435   |
| Traditional                      | 49.2 (43.9–54.4) | 48.5 (45.8–51.3) |         |
| Social                           | 12.2 (9.0–16.4)  | 11.6 (10.2–13.1) |         |
| Government                       | 7.0 (4.7–10.4)  | 7.0 (5.9–8.4)    |         |
| Family/friends                   | 8.7 (6.4–11.8)  | 12.2 (10.4–14.2) |         |
| Healthcare provider              | 22.9 (18.9–27.3) | 20.7 (18.8–22.8) |         |
In the first four months from the launch of the COVID-19 vaccines for community-living Medicare beneficiaries, 40% were hesitant to get vaccinated. The results showed that vaccine hesitancy was higher among beneficiaries without cancer history, women, those younger than 65 years old, those with lower household income and living in non-metropolitan areas. Hispanics participants were less likely to be hesitant than self-reported non-Hispanic Whites.

The current study findings showed that participants with cancer history were less hesitant to get vaccinated than those without cancer history. Similar findings were reported by the Kaiser Family Foundation (KFF) survey that was conducted in December 2020 which was near the same time as the MCBS COVID-19 survey. KFF found that 71% of the general population would probably or definitely get the vaccine if it were available for free and was deemed safe to get it. KFF also reported that 78% of the households with serious health conditions that also include cancer would probably or definitely get the vaccine [20]. To overcome COVID-19 vaccine hesitancy among both individuals with and without cancer history, there is a critical need for targeted appropriate messaging emphasizing the effectiveness of COVID-19 vaccine and adverse outcomes of COVID-19 infection.

The current study also found that COVID-19 vaccine hesitancy was higher among women than men which is consistent with other reports [21, 22]. The literature suggests that women are more likely than men to fear COVID-19 infection and follow public health recommendations, the findings of the higher vaccine hesitancy rate among women across studies were somewhat contradictory [21, 22]. Some other studies reported that women are at higher risk for adverse events (e.g., rare blood clotting) compared to men, which might contribute to vaccine hesitancy to subsets of women [23, 24]. The history of women being excluded from participating in trials and health research have been offered as another possible reason for higher hesitancy in COVID-19 vaccine [25]. Together, these findings suggest the importance of gender-responsive evidence to address knowledge gaps in vaccine hesitancy and potential gender-related health disparities. Future efforts should also include gender-disaggregated data for further investigation of trends, incorporating intersectional lens (e.g., structural racism for women with color), and mitigation strategies.

Racial and ethnic differences in COVID-19 vaccine uptake and hesitancy have been reported previously [8, 26, 27]. We found that Hispanic beneficiaries were less likely to report vaccine hesitancy compared to non-Hispanic White beneficiaries. Currently, there are mixed findings when comparing vaccine hesitancy between Hispanic and non-Hispanic White individuals. Some studies report that racially and ethnically minoritized participants were more likely to report COVID-19 vaccine hesitancy, while other studies report the opposite [28–32]. The different findings may be because of studying different population (e.g., age) and using different sampling designs. In addition, no statistically significant difference between White and Black beneficiaries on the COVID-19 vaccine hesitancy was found in the current study. This result is consistent with more recent findings that COVID-19 vaccine hesitancy has decreased rapidly among Black communalities [33]. Therefore, ongoing efforts to reduce the COVID-19 vaccine disparity may need to be expand beyond Black community [33]. Future solutions to address vaccine hesitancy should be culturally-tailored within different racial communities [26].

We found that COVID-19 vaccine hesitancy was more prevalent in individuals with lower income, and those who lived in non-metropolitan areas. These data are consistent
Table 5  Multivariable logistic regression explaining vaccine hesitancy

| Characteristics                          | Vaccine hesitancy OR (95% CI) | P-value |
|------------------------------------------|-------------------------------|---------|
| **Cancer history**                       |                               |         |
| No                                       | 1 [Reference]                 |         |
| Yes                                      | 0.80 (0.64–1.00)              | 0.050   |
| **Age**                                  |                               |         |
| <65                                      | 1 [Reference]                 |         |
| 65–74                                    | 0.80 (0.65–0.99)              | 0.042   |
| ≥75                                      | 0.80 (0.63–1.02)              | 0.076   |
| **Sex**                                  |                               |         |
| Male                                     | 1 [Reference]                 |         |
| Female                                   | 1.44 (1.18–1.76)              | 0.000   |
| **Race and Ethnicity**                   |                               |         |
| Non-Hispanic White                       | 1 [Reference]                 |         |
| Non-Hispanic Black                       | 0.96 (0.72–1.29)              | 0.801   |
| Hispanic                                 | 0.71 (0.50–0.99)              | 0.050   |
| Other                                    | 1.25 (0.83–1.87)              | 0.281   |
| **Income**                               |                               |         |
| ≥$25,000                                 | 1 [Reference]                 |         |
| < $25,000                                | 1.30 (1.06–1.61)              | 0.014   |
| **Medicare-Medicaid dual eligibility in 2020** |                           |         |
| Fully dual eligible                      | 1 [Reference]                 |         |
| Nondual                                  | 0.93 (0.69–1.24)              | 0.600   |
| Partially dual eligible                  | 1.11 (0.75–1.65)              | 0.599   |
| QMB eligible only                        | 0.72 (0.46–1.13)              | 0.154   |
| **Residing Area**                        |                               |         |
| Metro                                    | 1 [Reference]                 |         |
| Non-metro                                | 2.04 (1.63–2.55)              | 0.000   |
| **US census regions**                    |                               |         |
| South                                    | 1 [Reference]                 |         |
| Northeast                                | 0.45 (0.34–0.59)              | 0.000   |
| Midwest                                  | 0.74 (0.56–0.97)              | 0.030   |
| West                                     | 0.87 (0.56–1.34)              | 0.522   |
| **Living status**                        |                               |         |
| Not alone                                | 1 [Reference]                 |         |
| Alone                                    | 1.05 (0.81–1.36)              | 0.737   |
| **Unable to get medical care because of COVID-19** |                           |         |
| No                                       | 1 [Reference]                 |         |
| Yes                                      | 0.98 (0.66–1.45)              | 0.904   |
| **Depression History**                   |                               |         |
| No                                       | 1 [Reference]                 |         |
| Yes                                      | 0.92 (0.76–1.12)              | 0.398   |
| **Had COVID-19 since 11/1/2020**         |                               |         |
| No                                       | 1 [Reference]                 |         |
| Yes                                      | 0.80 (0.54–1.17)              | 0.245   |
| **Information source**                   |                               |         |
| Traditional                              | 1 [Reference]                 |         |
| Social                                   | 2.38 (1.80–3.15)              | 0.000   |
| Government                               | 0.61 (0.38–1.00)              | 0.051   |
| Family/friends                           | 2.62 (1.86–3.70)              | 0.000   |
| Healthcare provider                      | 1.61 (1.28–2.02)              | 0.000   |

with multiple national surveys before and throughout the pandemic. Previous studies showed that the vaccine hesitancy rate was higher among individuals living in rural areas of the U.S. In fact, 35% of people living in rural areas reported vaccine hesitancy [34, 35]. The geographical differences in vaccine hesitancy rates were highlighted in the
would provide them with information in line with their preferences. People who prefer alternative sources of information that are not widely available may be more inclined to attend to information from the social media, which may espouse biased opinions with more frequency. The social media has a significant role in the organization of American life; nonetheless, the homogenization of multi-cultural groups into races and an umbrella Hispanic ethnicity is a common limitation identified in publicly available datasets. We acknowledge that there is important sociocultural nuance that meaningfully distinguishes between people within racialized groups and therefore more research is needed that better accounts for diversity within samples. Despite these limitations, the present study is strengthened by its population-based methodology that has a large representative sample of community-living Medicare beneficiaries.

**Limitation**

The current study has several limitations that should be reported. First, the study sample was limited to only community-living Medicare beneficiaries aged 65 years or older and those aged 64 and younger with certain disabling conditions, therefore, study findings may not be generalizable to beneficiaries who do not live in community setting. Second, the cross-sectional data make it difficult to investigate the vaccine hesitancy over time as COVID-19 vaccines became more available across the US. Thus, longitudinal studies are needed to assess vaccine hesitancy over time. Third, all variables included in this study were self-reported and might be subject to recall bias. In addition, some important variables that may be associated with vaccine hesitancy were missing such as other chronic conditions including obesity, lung disease and education attainment and employment status and that could have affected the study findings. Other factors not examined but need to explore in the future include: perceived COVID susceptibility (i.e., risk perception), as well as level of trust in COVID-19 information sources and health care providers. Fourth, the MCBS Public Use File did not provide detailed information on the distribution of sociocultural identities within racial and ethnic groups. Race is a social variable in health research given its role in the organization of American life; nonetheless, the homogenization of multi-cultural groups into races and an umbrella Hispanic ethnicity is a common limitation identified in publicly available datasets. We acknowledge that there is important sociocultural nuance that meaningfully distinguishes between people within racialized groups and therefore more research is needed that better accounts for diversity within samples. Despite these limitations, the present study is strengthened by its population-based methodology that has a large representative sample of community-living Medicare beneficiaries.
Increasing the knowledge among clinicians and confidence about vaccine benefits among high-risk and more hesitant individuals are urgently needed to increase the vaccine uptake. Understanding associated factors of vaccine hesitancy will help policy makers to inform targeted communication efforts and develop culturally tailored health polices to increase COVID-19 vaccination uptake.

Supplementary Information  The online version contains supplementary material available at https://doi.org/10.1007/s10900-022-01174-5.

Authors’ Contributions  HP Conceptualization, Methodology; HP, ZN, SN Writing- Original Draft; HP, ZN, DV, LN, SN Writing-Review and Editing.

Funding Information  No funding was received for this article.

Data Availability  The data that support the findings of this study are openly available in Centers for Medicare & Medicaid Services at https://www.cms.gov/Research-Statistics-Data-and-Systems/Downloadable-Public-Use-Files/MCBS-Public-Use-File.

Code Availability  Stata, version 17.

Declarations

Conflict of Interest  The authors declare no conflict of interest.

Ethics Approval  We used publicly available data and, therefore, did not require institutional review board approval in accordance with the exempt criteria under 45 Code of Federal Regulations part 46.102.

Consent to Participate  Not applicable as we conducted secondary data analyses.

References

1. Coronavirus Resource CenterCenter (2022). U.S. Trends. John Hopkins University of Medicine. [cited 2022 May 12]. Available at https://coronavirus.jhu.edu/.
2. Chavez-MacGregor, M., et al. (2022). Evaluation of COVID-19 mortality and adverse outcomes in US patients with or without Cancer. JAMA Oncol, 8(1), 69–78.
3. Jordan, R. E., et al. (2020). Covid-19: risk factors for severe disease and death. Bmj, 368, m1198.
4. Tsai, R., et al. (2022). COVID-19 Vaccine Hesitancy and Acceptance among individuals with Cancer, Autoimmune Diseases, or other Serious Comorbid Conditions: cross-sectional, internet-based survey. JMIR Public Health Surveill, 8(1), e29872.
5. U.S. Food & Drug Administration (2020). FDA Takes Key Action in Fight Against COVID-19 By Issuing Emergency Use Authorization for First COVID-19 Vaccine. [cited 2022 January 15]. Available at https://www.fda.gov/news-events/press-announcements/fda-takes-key-action-fight-against-covid-19-issuing-emergency-use-authorization-first-covid-19.
6. Kaiser Family Foundation (KFF) (2022). Latest Data on COVID-19 Vaccination by Race/Ethnicity. [cited 2022 May 30]. Available at https://www.kff.org/coronavirus-covid-19/issue-brief/latest-data-on-covid-19-vaccinations-by-race-ethnicity/.
7. Lathrop, K. I., et al. (2022). Declining the COVID-19 vaccination: an evaluation of why some high-risk cancer patients decline vaccination. Cancer Research, 82, 14–17.
8. McFadden, S. M., et al. (2022). Confidence and hesitancy during the early roll-out of COVID-19 Vaccines among Black, Hispanic, and undocumented immigrant Communities: a review. J Urban Health, 99(1), 3–14.
9. Dror, A. A., et al. (2020). Vaccine hesitancy: the next challenge in the fight against COVID-19. European Journal Of Epidemiology, 35(8), 775–779.
10. Kumar, D., et al. (2022). Understanding the phases of vaccine hesitancy during the COVID-19 pandemic. Isr J Health Policy Res, 11(1), 16.
11. MacDonald NE and Sage Working Group on Vaccine Hesitancy. (2015). Vaccine hesitancy: definition, scope and determinants. Vaccine, 33(34), 4161–4164.
12. Bhagianadh, D., & Arora, K. (2022). COVID-19 vaccine hesitancy among Community-Dwelling older adults: the role of information sources. J Appl Gerontol, 41(1), 4–11.
13. Reiter, P. L., et al. (2020). Acceptability of a COVID-19 vaccine among adults in the United States: How many people would get vaccinated? Vaccine. 38(42): 6500–6507.
14. Brenan, M. (2021). Satisfaction With U.S. Vaccine Rollout Surges to 68%. [cited 2022 April 10]. Available at: https://news.gallup.com/poll/342431/satisfaction-vaccine-rollout-surges.aspx?utm_source=alert&utm_medium=email&utm_content=morelink&utm_campaign=syndication.
15. Huettman, E. (2021). Covid Vaccine Hesitancy Drops Among All Americans, New Survey Shows. 2021 [cited 2022 April 10]. Available https://khn.org/news/article/covid-vaccine-hesitancy-drops-among-americans-new-kff-survey-shows/.
16. Peng, X., et al. (2021). Prevalence and impact factors of COVID-19 vaccination hesitancy among breast Cancer survivors: a Multicenter cross-sectional study in China. Frontiers in Medicine, 8, 741204.
17. Villareal-Garza, C., et al. (2021). Attitudes and factors Associated with COVID-19 vaccine hesitancy among patients with breast Cancer. JAMA Oncol, 7(8), 1242–1244.
18. Mejri, N., et al. (2022). Understanding COVID-19 vaccine hesitancy and resistance: another challenge in cancer patients. Supportive Care In Cancer, 30(1), 289–293.
19. Centers for Medicare & Medicaid Services (2021). 2021 Medicare current beneficiary survey COVID-19 winter supplement public use file. [cited 2022 January 4]. Available at https://www.cms.gov/Research-Statistics-Data-and-Systems/Downloadable-Public-Use-Files/MCBS-Public-Use-File.
20. Hamel, L. E., et al. (2020). KFF COVID-19 Vaccine Monitor: December 2020. Kaiser Family Foundation (KFF). [cited 2022 May 10]. Available at https://www.kff.org/coronavirus-covid-19/report/kff-covid-19-vaccine-monitor-december-2020/.
21. Galasso, V., et al. (2020). Gender differences in COVID-19 attitudes and behavior: Panel evidence from eight countries. Proc Natl Acad Sci U S A, 117(44), 27285–27291.
22. Zintel, S., et al. (2022). Gender differences in the intention to get vaccinated against COVID-19: a systematic review and meta-analysis. Z Gesundh Wiss:1–25.
23. Greinacher, A., et al. (2021). Thrombotic Thrombocytopenia after ChAdOx1 nCoV-19 vaccination. New England Journal Of Medicine, 384(22), 2092–2101.
24. Vassallo, A., et al. (2021). Sex and gender in COVID-19 Vaccine Research: substantial evidence gaps remain. Front Glob Womens Health, 2, 761511.
25. Bogart, L. M., et al. (2022). COVID-19 vaccine intentions and Mistrust in a National Sample of Black Americans. Journal Of The National Medical Association, 113(6), 599–611.
26. Bagasra, A. B., et al. (2021). Racial differences in institutional trust and COVID-19 vaccine hesitancy and refusal. *BMC Public Health, 21*(1), 2104.

27. Dada, D., et al. (2022). Strategies that promote equity in COVID-19 Vaccine Uptake for Black Communities: a review. *J Urban Health, 99*(1), 15–27.

28. Nguyen, L. H., et al. (2022). Self-reported COVID-19 vaccine hesitancy and uptake among participants from different racial and ethnic groups in the United States and United Kingdom. *Nature Communications, 13*(1), 636.

29. Sullivan, M. C., et al. (2022). Race, trust, and COVID-19 vaccine hesitancy in people with opioid use disorder. *Health Psychology, 43*(2), 115–120.

30. Ingram, S. A., et al. (2021). Hesitancy and malignancy: vaccine hesitancy among individuals with cancer. *Journal of Clinical Oncology, 39*(28 Suppl), 148–148.

31. Beleche, T., et al. (2021). *COVID-19 vaccine hesitancy: demographic factors, Geographic patterns, and Changes over Time*. Washington, DC: Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services.

32. King, W. C., et al. (2021). Time trends, factors associated with, and reasons for COVID-19 vaccine hesitancy: a massive online survey of US adults from January-May 2021. *PLoS One, 16*(12), e0260731.

33. Padamsee, T. J., et al. (2022). Changes in COVID-19 Vaccine Hesitancy among Black and White individuals in the US. *JAMA Network Open, 5*(1), e2144470–e2144470.

34. Hamel, L., et al. (2020). KFF COVID-19 Vaccine Monitor December 2020. [cited 2022 May 25] Available at https://www.kff.org/coronavirus-covid-19/report/kff-covid-19-vaccine-monitor-december-2020/

35. Hudson, A., & Montelpare, W. J. (2021). Predictors of Vaccine Hesitancy: Implications for COVID-19 Public Health Messaging. *Int J Environ Res Public Health, 18*(15).

36. Geimpel, J. G., et al. (2020). The urban-rural gulf in American political behavior. *Political Behavior, 42*, 1343–1368.

37. Scala, D. J., & Johnson, K. M. (2017). Political polarization along the rural-urban Continuum? The geography of the Presidential Vote, 2000–2016. *The ANNALS of the American Academy of Political and Social Science, 672*(1), 162–184.

38. Kerr, J., et al. (2021). Political polarization on COVID-19 pandemic response in the United States. *Pers Individ Dif, 179*, 110892.

39. De Freitas, L., et al. (2021). Public trust, information sources and vaccine willingness related to the COVID-19 pandemic in Trinidad and Tobago: an online cross-sectional survey. *Lancet Reg Health Am, 3*, 100051.

40. Charron, J., et al. (2020). Influence of information sources on vaccine hesitancy and practices. *Med Mal Infect, 50*(8), 727–733.

41. Kata, A. (2010). A postmodern Pandora's box: anti-vaccination misinformation on the internet. *Vaccine, 28*(7), 1709–1716.

42. Romer, D., & Jamieson, K. H. (2020). Conspiracy theories as barriers to controlling the spread of COVID-19 in the U.S. *Social Science And Medicine, 263*, 113356.

43. Soveri, A., et al. (2021). Unwillingness to engage in behaviors that protect against COVID-19: the role of conspiracy beliefs, trust, and endorsement of complementary and alternative medicine. *Bmc Public Health, 21*(1), 684.

44. Hahn, R. A., & Stroup, D. F. (1994). Race and ethnicity in public health surveillance: criteria for the scientific use of social categories. *Public Health Reports, 109*(1), 7–15.

45. Foster, M. W. (2009). Looking for race in all the wrong places: analyzing the lack of productivity in the ongoing debate about race and genetics. *Human Genetics, 126*(3), 355–362.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.