High but Inequitable COVID-19 Vaccine Uptake Among Rehabilitation Patients

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ABSTRACT

Introduction: There is a paucity of studies evaluating vaccine uptake in adults with neurological and musculoskeletal medical conditions. We sought to evaluate the rates of COVID-19 vaccine uptake in patients seen in an outpatient rehabilitation clinic.

Methods: We conducted a retrospective, single center study of adults seen at an outpatient rehabilitation clinic from December 1, 2020, through June 30, 2021, with an active Wisconsin Immunization Registry record. The primary outcome was completion of a COVID-19 primary vaccine series.

Results: Of 1362 patients, 83.3% completed a COVID-19 vaccination series. Younger patients had increased odds of not completing a COVID-19 vaccination series (mean [SD] 46.7 [14.7] vs 54.3 [15.8]; OR 1.03; 95% CI, 1.02-1.04; $P < 0.001$). Those who identified as non-White (1.88; 95% CI, 1.16-3.04; $P = 0.010$) or current smoker (1.85, 95% CI, 1.85-2.79; $P = 0.004$) had increased odds of not completing a COVID-19 vaccination series. Those who resided in rural ZIP codes (1.81; 95% CI, 1.35-2.43; $P < 0.001$), had not received a 2019-2020 influenza vaccine (5.13; 95% CI, 3.79-6.96; $P < 0.001$), or had lower comorbidity scores (2.95; 95% CI, 1.98-4.41; $P < 0.001$) had higher odds of not completing a COVID-19 vaccination series.

Conclusions: There was a high rate of COVID-19 vaccine uptake among patients seen in a rehabilitation clinic, though racial, ethnic, and geographic differences did exist. Further studies are needed to determine why these disparities exist and investigate interventions to increase vaccine uptake in these populations.

INTRODUCTION

The COVID-19 pandemic led to important health and social implications for patients with neurological and musculoskeletal conditions, including restricted access to important health care services. Patients with a disability who were admitted with COVID-19 infection had longer hospital stays and higher readmission rates compared to those without disabilities.[1]

Physiatrists and other physicians who treat people with neurological and musculoskeletal conditions across their lifespans form relationships with patients while focusing on preserving and maximizing function and participation in the community. They advocate for their patients, and discuss optimizing health, including being up to date with their health maintenance. Thus, these physicians should play a pivotal role in strongly recommending a COVID-19 vaccine primary series and appropriate boosters to their patients.

The National Institutes of Health (NIH) defines health care disparities as preventable differences in health status and outcomes that adversely affect certain populations. Research on health care disparities examines the influence of environment, social determinants, and other underlying mechanisms leading to differences in health outcomes.[2] Health care disparities are found in patients with neurological and musculoskeletal conditions commonly seen by physiatrists. Racial health disparities disproportionately affect Black persons in access and referrals to rehabilitation, community reintegration, and overall functional outcomes in those with neurorehabilitation and musculoskeletal

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conditions in the United States. This may result in worse outcomes in patients with neurological and musculoskeletal diagnoses, including greater physical activity limitations in patients with stroke, more recurrent urinary tract infections and pressure injuries in patients with spinal cord-injured, and greater postoperative complications and mortality after joint arthroplasty and hip fractures.[3]

Racial, ethnic, and socioeconomic disparities in COVID-19 vaccine uptake exist within the general population.[4-6] It also has been shown that geographic disparities exist in COVID-19 vaccine uptake, with people who reside in a rural ZIP code being less likely to have completed a COVID-19 vaccine primary series.[7] Furthermore, a study from the Centers for Disease Control and Prevention (CDC) showed adults with a disability had lower COVID-19 vaccine uptake compared to those without a disability, even though those with a disability reported less hesitancy to vaccination.[8]

There is a paucity of studies evaluating adult vaccine uptake in patients seen in a rehabilitation clinic; one retrospective chart review of 60 patients with spinal cord injury reported that only 55% had received an influenza vaccine, though recommendations for the general population and spinal cord injury guidelines specifically recommend immunization for all patients.[9] Physicians of all specialties often see patients with physical and cognitive disabilities and should be aware of potential barriers to vaccination.

The aim of our study was to evaluate the rates of COVID-19 vaccine uptake in adult patients with neurological or musculoskeletal chronic medical conditions who are commonly seen in a rehabilitation clinic. We hypothesized that racial, ethnic, and geographic disparities in COVID-19 vaccine uptake would exist among our patients.

METHODS

Study Setting

We performed a retrospective, single center study evaluating COVID-19 vaccine uptake among adults seen at an outpatient rehabilitation clinic from December 1, 2020, through June 30, 2021. The study met the requirement for quality improvement as determined by the University of Wisconsin-Madison and, therefore, was deemed exempt from Institutional Review Board review.

Study Population and Design

An electronic health record (EHR) (EPIC Corporation, Verona, Wisconsin) query was performed to identify patients meeting the following inclusion criteria: age 18 years and older and seen by a physiatrist during the study period. Patients were excluded if they had an inactive Wisconsin Immunization Registry (WIR) record and/or residence outside Wisconsin. Unvaccinated patients who died during the study period also were excluded since they may not have had an opportunity to complete a COVID-19 primary series.

Sociodemographic characteristics, Charlson Comorbidity Index (CCI), receipt of influenza vaccine (2019-2020 season), and receipt of COVID-19 vaccine (including vaccine type) were manually abstracted from the EHR. Scores from the CCI are based on a number of comorbidities, each given a weighted integer from 1 to 6 based on the severity of the morbidity.[10] Patients were classified into groups based on their primary rehabilitation diagnosis: stroke, spinal cord injury, brain injury (including traumatic, nontraumatic, and developmental/intellectual disability), multiple sclerosis, and other. Guardianship was determined by the presence of an activated health care power of attorney, which was abstracted from the patient's chart.

Sociodemographic classification included patient age, sex, race, ethnicity, and ZIP code of permanent residence at the time of data collection. Race was defined using the existing structure of the EHR data as self-identified by the patient, where White, Black, Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander race are defined categorically, and Hispanic ethnicity is a modifier. Given the small sample size of certain racial and ethnic groups, patients were aggregated into 2 larger cohorts: non-Hispanic White patients and all racial and ethnic groups except non-Hispanic White patients.

Using ZIP codes, the cohort was divided into urban (population ≥ 10 000) or rural (population <10 000).[11] We excluded ZIP codes that are nonresidential (eg, only post office box or commercial organization addresses), ZIP codes with populations less than 500, or those located outside of Wisconsin. To further investigate disparities within rural and urban communities, we used a novel rural-urban geodisparity model that includes 6 categories (rural underserved, rural, rural advantaged, urban underserved, urban, and urban advantaged) that incorporate information on regional health care capacity and health needs in Wisconsin ZIP Code Tabulation Areas. The categories were determined using rates of poverty, uninsured, Medicaid, educational attainment, access to health care providers, and perceived health status.[11] The Wisconsin ZIP Code Tabulation Areas and their corresponding categories are available at https://www.hipxchange.org/RuralUrbanGroups.

Wisconsin Immunization Registry

The WIR is a statewide computerized Internet database that was developed to record and track immunization records of Wisconsin residents. The WIR is provided by the Wisconsin Department of Health and Family Services and has been available since May 2000.[12] Immunization history was back-loaded from January 1995. Immunizations provided by both public and private providers in Wisconsin are uploaded into the registry, and 98.5% of Wisconsin adults have an active WIR record.[13] Studies have demonstrated that the WIR captures 97% of vaccines administered in Wisconsin.[14] It is directly incorporated into the University of Wisconsin Hospital and Clinics EHR.

The WIR has been used previously in other studies to evaluate influenza and COVID-19 vaccine uptake in other patients seen in specialty clinics.[15,16]

Outcomes

Our primary outcome was to evaluate the rates of completing a COVID-19 primary series in adults with neurological and musculoskeletal conditions commonly seen in a rehabilitation clinic. We considered those who had completed a COVID-19 primary series if they had received 2 doses of an mRNA vaccine–BNT162b2 (Pfizer-BioNTech) or mRNA-1273 (Moderna)–or 1 dose of Ad26.COV2.S, the Janssen adenovirus vector-based vaccine. Secondary outcomes included evaluating disparities in completing a COVID-19 series in relation to race, ethnicity, guardianship, geographic area of residence, past influenza vaccination uptake, insurance, and diagnosis.

Statistical Analysis

Data for those who were fully vaccinated and those who were not fully vaccinated were summarized by N (%), mean (SD), or median (IQR). Rate of COVID-19 vaccine uptake was estimated by percentage and 95% CI. Secondary outcomes of association between patient characteristics and vaccine status were assessed via univariable logistic regression and summarized by odds ratio (OR) and 95% CI. All analyses were conducted in R for statistical computing version 4.0 (R Core Team, 2020) and a 5% significance level.

RESULTS

We identified 1362 patients who met the inclusion criteria. Most identified as female (55.9%), non-Hispanic (97.1%), and White (91.1%) (Table 1); and most were fully vaccinated: 1134/1362 (83.3%) completed a COVID-19 vaccination series, including 1045 (92.2%) who received an mRNA vaccine.

Predictors for Not Completing a COVID-19 Vaccine Series

Younger individuals had increased odds, per year younger, of not completing a COVID-19 vaccine series (mean 46.7 vs 54.3; OR 1.03; 95% CI, 1.02-1.04; $P < 0.001$). Those with a lower comorbidity score also had increased odds of not completing a COVID-19 vaccine series when compared to CCI greater than 2 (CCI 1-2: OR 2.20; 95% CI, 1.57-3.09; $P < 0.001$ and CCI 0: OR 2.95; 95% CI, 1.98-4.41; $P < 0.001$). There was a significant increase in the odds of not completing a COVID-19 vaccine series in non-White patients compared to White patients (OR 1.88; 95% CI, 1.16-3.04; $P = 0.010$) and current smokers compared to never smokers (OR 1.85; 95% CI, 1.22-2.79, $P = 0.004$). Additionally, the odds of not completing a COVID-19 vaccine series for those who did not receive a 2019-2020 flu vaccine were over 5 times higher (OR 5.13; 95% CI, 3.79-6.96; $P < 0.001$). See Table 2.

Table 1. Baseline Demographics

	Full Cohort (N = 1362)
Age (mean+ SD)	53.0 + 15.9
Female	762 (55.9%)
Race	
American Indian/Alaskan Native	8 (0.6%)
Asian	20 (1.5%)
Black	66 (4.8%)
White	1241 (91.1%)
Native Hawaiian/Pacific Islander	1 (0.1%)
Other	26 (1.9%)
Ethnicity	
Hispanic/Latino	40 (2.9%)
Charlson Comorbidity Index: median (IQR)	2.0 (1.0 – 4.0)
0	225 (16.5%)
1-2	545 (40.0%)
>2	592 (43.5%)
Insurance	
Private/HMO	604 (44.3%)
Medicare/Medicaid	739 (54.3%)
Uninsured	10 (0.7%)
Other	9 (0.7%)
Smoking status	
Never	771 (57.6%)
Former	410 (30.1%)
Current	157 (11.5%)
Guardianship	
Own Guardian	1181 (86.7%)
Urban Area Total (N = 12 excluded) †	942 (69.2%)
Urban underserved	48 (3.5%)
Urban	121 (8.9%)
Urban advantaged	773 (56.8%)
Rural underserved	35 (2.6%)
Rural	245 (18.0%)
Rural advantaged	128 (9.4%)
Diagnoses	
Stroke	128 (9.4%)
Spinal Cord Injury	113 (8.3%)
Brain Injury	302 (22.2%)
Multiple Sclerosis	55 (4.0%)
Other	764 (56.1%)
Influenza vaccine uptake (2019-2020)	892 (65.5%)
COVID-19 vaccine uptake	1134 (83.3%)
mRNA vaccine	1045 (92.2% of vaccinated)

[a]12 patients were excluded from the urban-rural subgroupings because they lived in a location with a population <500 or had a post office box as an address.

Geographic Disparities

Most patients resided in urban areas (n = 942, 69.8%) and advantaged areas (n = 901, 66.7%), but geographic disparities in completing a COVID-19 vaccine series existed. Those who resided in a rural ZIP code had an 81% increase in odds of not completing a COVID-19 vaccine series compared to those in an urban ZIP code (OR 1.81; 95% CI, 1.35-2.43; $P < 0.001$). Those residing in urban, urban underserved, rural advantaged, or rural underserved areas had significantly higher odds of not completing a COVID-19 vaccine series compared to those living in an urban advantaged area ([urban: OR 2.26; 95% CI, 1.40-3.63; $P = 0.001$]; [urban underserved: OR 2.78; 95% CI, 1.42-5.46; $P = 0.003$]; [rural advantaged: OR 1.91; 95% CI, 1.18-3.10; $P = 0.009$]; [rural: OR 2.17; 95% CI, 1.50-3.15; $P < 0.001$]; [rural underserved: OR 3.91; 95% CI, 1.88-8.13; $P < 0.001$]). See Table 2.

DISCUSSION

To our knowledge, this is the first US study to describe COVID-19 vaccination rates in a rehabilitation population. Although we found high rates of COVID-19 vaccine uptake in our population, there were racial, ethnic, and geographic disparities. This finding is important because it suggests that physiatrists and other physicians who see patients with neurological and musculoskeletal conditions should consider race, ethnicity, and geographic location as important factors when optimizing education around vaccination, as well as when recommending COVID-19 vaccination and counseling on COVID-19 boosters.

Those who had not completed a COVID-19 vaccination series in this study population were more likely to be younger, identify as non-White, be a current smoker, and have a lower CCI. Additionally, patients who did not receive an influenza vaccine during the 2019-2020 vaccine season were less likely to receive a COVID-19 vaccine. Many of these factors are consistent with those reported for the COVID-19 vaccine uptake in the general population, which implies that these disparities are not unique to the rehabilitation population.[7,17]

We also found that geographic disparities existed in vaccination uptake. Patients who lived in rural areas of Wisconsin were less likely to get vaccinated than those living in urban areas. A recent CDC report showed that the prevalence of adults with

Table 2. Predictors of Completion of a COVID-19 Series

	Completed COVID-19 Vaccine Series[a] (n = 1134)	Did Not Complete COVID-19 Vaccine Series (n = 228)	Odds Ratio (95% CI)	*P* value
Age per year younger	54.3 ± 15.8	46.7 ± 14.7	1.03 (1.02 – 1.04)	< 0.001
Female	634 (55.9%)	128 (56.1%)	1.01 (0.76 – 1.34)	0.949
Race				
White	1043 (92.0%)	198 (86.8%)	reference	
Non-White	70 (6.2%)	25 (11.0%)	1.88 (1.16 – 3.04)	0.010
Ethnicity				
Hispanic/Latino	33 (2.9%)	7 (3.1%)	reference	
Non-Hispanic	1091 (96.2%)	215 (94.3%)	0.93 (0.41 – 2.13)	0.862
Insurance				
Private/HMO	490 (43.2%)	114 (50.0%)	reference	
Medicare/Medicaid	634 (55.9%)	105 (46.1%)	0.71 (0.53 – 0.95)	0.022
Uninsured	5 (0.4%)	5 (2.2%)	4.30 (1.22 – 15.10)	0.023
Other	5 (0.4%)	4 (1.8%)	3.44 (0.9 – 13.01)	0.069
Smoking status				
Never	648 (57.1%)	124 (53.4%)	reference	
Former	343 (30.2%)	67 (29.4%)	1.02 (0.74 – 1.41)	0.901
Current	117 (10.3%)	41 (18.0%)	1.83 (1.22 – 2.74)	0.003
Guardianship				
Own guardian	982 (86.6%)	199 (87.3%)	reference	
Not own guardian	152 (13.4%)	29 (12.7%)	0.94 (0.62 – 1.44)	0.781
Influenza vaccination 2019-2020				
Yes	816 (72.0%)	76 (33.3%)	reference	
No	318 (28.0%)	152 (66.7%)	5.13 (3.79 – 6.96)	< 0.001
Diagnoses				
Stroke	107 (9.4%)	21 (9.2%)	reference	
Spinal cord injury	93 (8.2%)	20 (8.8%)	1.10 (0.56 – 2.15)	0.790
Brain injury	253 (22.3%)	49 (21.5%)	0.99 (0.56 – 1.73)	0.963
Multiple sclerosis	51 (4.5%)	4 (1.8%)	0.40 (0.13 – 1.22)	0.108
Other	630 (55.6%)	134 (58.8%)	1.08 (0.65 – 1.79)	0.754
Area of residence				
Urban Advantaged	682 (60.1%)	91 (40.0%)	reference	
Urban	93 (8.2%)	28 (12.3%)	2.26 (1.40 – 3.63)	0.001
Urban Underserved	35 (2.8%)	13 (5.7%)	2.78 (1.42 – 5.46)	0.003
Rural Advantaged	102 (9.0%)	26 (11.4%)	1.91 (1.18 – 3.10)	0.009
Rural	190 (16.8%)	55 (24.1%)	2.17 (1.50 – 3.15)	< 0.001
Rural Underserved	23 (2.0%)	12 (5.3%)	3.91 (1.88 – 8.13)	< 0.001
Urban vs rural				
Urban	810 (71.4%) 71.4%?	132 (57.9%)	reference	
Rural	315 (27.8%) 27.8%?	93 (40.8%)	1.81 (1.35 – 2.43)	< 0.001
Charlson Comorbidity Index (CCI)				
Per unit decrease	2.0 (1.0 – 4.0)	2.0 (0.8 – 3.0)	1.23 (1.14-1.33)	< 0.001
CCI Grouped				
> 2	531 (46.8%)	61 (26.8%)	reference	
1 – 2	435 (38.4%)	110 (48.2%)	2.20 (1.57-3.09)	< 0.001
0	168 (14.8%)	57 (25.0%)	2.95 (1.98-4.41)	< 0.001

Abbreviations: HMO, health maintenance organization.

[a]We considered those who had completed a COVID-19 primary series if they had received 2 doses of an mRNA vaccine (BNT162b2 [Pfizer-BioNTech] or mRNA-1273 [Moderna], or 1 dose of Ad26.COV2.S, the Janssen adenovirus vector-based vaccine.

a disability in the United States is significantly higher in rural areas versus large metropolitan areas.[18] Studies prior to the pandemic have shown that health care disparities exist among people living in rural and urban areas. Those living in rural areas may have reluctance to seek health care due scarcity of services, lack of trained physicians, insufficient public transportation, or poor availability of broadband internet services.[19]

In addition to those living in rural areas, those living in underserved geographic locations in Wisconsin were less likely than those in urban advantaged areas to be vaccinated. People who live in underserved geographic location – whether rural or urban – may face barriers, such as lower access to transportation or medical care, as well as less flexibility in work schedules to access health care.

Our findings also showed racial and ethnic disparities in COVID vaccination rates in the rehabilitation clinic. Previous studies have shown that racial and ethnic disparities exist in the care provided to patients seen in a rehabilitation clinic.[3] Verduzco-Gutierrez et al addressed the intersection between race and disability during the COVID-19 pandemic and called for more research to identify gaps in care to this vulnerable population.[20] One such area to address the gaps in care may be in ensuring our patients are up to date with recommended adult vaccines, as illness prevention can be as important as treatment. A cross sectional study of over 140 000 patients hospitalized in the United States showed that people from racial and/or ethnic minority groups experienced higher COVID-19–associated hospitalization, intensive care unit admission, or in-hospital death during the first year of the US COVID-19 pandemic.[21] This further highlights the importance of prevention and improved access and education around the COVID-19 vaccination for these groups. These two interventions are key since several studies have shown that health care provider recommendations are strongly associated with a patient's receipt of vaccines.[22]

Our findings showed disparities in patients related to race, ethnicity, and geographic location. We advocate that physicians should be aware of these disparities and be prepared to discuss recommendations for COVID-19 vaccinations. Physiatrists often have ongoing health care relationships with their patients due to the chronic conditions they treat and can initiate the vaccination conversation, advocate for their patients, and address barriers to vaccination.

Bazan and Akgün reviewed racial/ethnic inequalities in COVID-19 illness and vaccination rates.[23] Suggested strategies to improve vaccination rates include improved access to vaccination sites, customized information regarding vaccination, and discussions with trusted community members, including medical professionals.[8,23] In a call to action for influenza vaccination for persons with disabilities, Peacock et al suggested that effective communication with people with disabilities and their caregivers and offering vaccinations in places where people with disabilities spend their time, such as where they live or work – often in congregate settings – may increase vaccination rates.[24] The CDC offers free online materials to ensure that people with disabilities are able to access COVID-19 vaccines, including pictorial storylines communicating about COVID-19 and vaccination, and a Disability Information and Access Line to connect callers to local services.[25] Physicians are familiar with partnering with other specialties, therapies, and community support agencies for their patients' care. Working with these groups to identify any barriers to vaccination, such as communication, scheduling a vaccination appointment, transportation, or discussions with guardians is possible from within a rehabilitation clinic setting.

Strengths and Limitations

Our study has several strengths that make our findings generalizable to other centers. We were able to verify vaccine uptake using a statewide immunization registry, whereas other vaccine coverage studies often rely on participant survey responses.[26,27] We used a novel rural-urban geodisparity model that incorporates information on health care resources and needs in different geographic settings. Utilization of this model showed significant variation in vaccination status both between overall rural and urban areas, as well as within the traditional binary rural and urban categories.

There were also several limitations to our study. Race and ethnicity were defined within the social constructs of the EHR, and some racial ethnic groups had relatively small numbers and, thus, were combined for the analysis. This unintentionally implies a generalized experience and may mask unique differences among various racial and ethnic groups. Other limitations included lack of documentation of whether patients were offered vaccines, reasons for incomplete vaccination schedule, and short study duration. Additionally, our study population likely overrepresented patients with adequate health insurance coverage, as being seen in clinic was among the inclusion criteria.

CONCLUSIONS

We found a high rate of COVID-19 vaccine uptake among patients seen in a rehabilitation clinic. However, we found racial/ethnic and geographic disparities in vaccine uptake. Further studies are needed to evaluate how to address these disparities in order to improve vaccine uptake in these populations.

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