[Chest Infections Original Research]

CHEST

Impact of SARS-CoV-2 Vaccine Rollout on Hispanic and Non-Hispanic Admission and Mortality Trends

An Interrupted Time Series Analysis

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BACKGROUND: Challenges with SARS-CoV-2 vaccine prioritization, access, and hesitancy have influenced vaccination uptake.

RESEARCH QUESTION: Was the impact of SARS-CoV-2 vaccine rollout on COVID-19 monthly admission and mortality trends different between Hispanic and non-Hispanic populations?

STUDY DESIGN AND METHODS: We used interrupted time series analysis to conduct an ancillary study of the Viral Infection and Respiratory Illness Universal Study registry supplemented by electronic health record data from five participating Mayo Clinic sites in Florida, Arizona, Minnesota, and Wisconsin. We included hospitalized patients with COVID-19 admitted between April 2020 and December 2021. Our primary outcome was the impact of vaccine rollout on admission trends. Our secondary outcome was the impact of vaccine rollout on mortality trends.

RESULTS: This interrupted time series analysis includes 6,442 patients. Vaccine rollout was associated with improved monthly hospital admission trends among both Hispanic and non-Hispanic patients. Among Hispanic patients, prevaccine rollout, monthly admissions increased by 12.9% (95% CI, 8.1%-17.9%). Immediately after vaccine rollout, patient admissions declined by −66.3% (95% CI, −75.6% to −53.9%). Postvaccine rollout, monthly admissions increased by 3.7% (95% CI, 0.2%-7.3%). Among non-Hispanic patients, prevaccine rollout, monthly admissions increased by 35.8% (95% CI, 33.4%-38.1%). Immediately after vaccine rollout, patient admissions declined by −75.2% (95% CI, −77.6% to −72.7%). Postvaccine rollout, monthly admissions increased by 5.6% (95% CI, 4.5%-6.7%). These prevaccine rollout admission trends were significantly different ($P < .001$). Postvaccine rollout, the change in admission trend was significantly different ($P < .001$). The associated beneficial impact from vaccine rollout on monthly hospital admission trends among Hispanic patients was significantly lower. The trend in monthly mortality rate was fourfold greater (worse) among Hispanic patients (8.3%; 95% CI, 3.6%-13.4%) vs non-Hispanic patients (2.2%; 95% CI, 0.6%-3.8%), but this was not related to vaccine rollout.

INTERPRETATION: SARS-CoV-2 vaccine rollout was associated with improved COVID-19 admission trends among non-Hispanic vs Hispanic patients. Vaccine rollout did not influence mortality trends in either group, which were four times higher among Hispanic patients. Improved vaccine rollout may have reduced disparities in admission trends for Hispanic patients, but other factors influenced their mortality trends. CHEST 2024; ■(■):■-■

KEY WORDS: admission trend; COVID-19; disparities; ethnicity; Hispanic; interrupted time series analysis; ITS; mortality trend; non-Hispanic; SARS-CoV-2

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Take-Home Points

Study Question: Did SARS-CoV-2 vaccine rollout differentially impact Hispanic and non-Hispanic COVID-19 monthly patient hospital admission and mortality trends?

Results: This interrupted time series analysis including 6,442 patients and demonstrated disparities in the impact of SARS-CoV-2 vaccine rollout on Hispanic vs non-Hispanic patient admission trends. Mortality trends were not impacted by vaccine rollout but were worse among Hispanic patients (8.3% vs 2.2%).

Interpretation: There were significant disparities among Hispanic populations who saw a reduced beneficial impact from the vaccine rollout on monthly hospital admissions when compared with non-Hispanic populations. However, as with all studies using interrupted time series analysis, we could not account for confounding factors unrelated to the vaccine rollout that may have contributed to our findings. Concerningly, despite being younger and having fewer comorbidities, mortality trends from COVID-19 were significantly worse among Hispanic patients in time series analysis, but this was not related to vaccine rollout.

Inequality is a growing problem in the United States; however, the SARS-CoV-2 pandemic brought the nation's attention to widespread societal inequity and the inadequacy of the public health infrastructure to handle such a crisis and protect vulnerable populations and communities.[1-6]

Racial and ethnic disparities have been documented in rates of COVID-19 exposure, infection, and access to testing and vaccination.[7-9] Several state-based and single-center studies have also demonstrated evidence of racial and ethnic disparities in COVID-19 hospitalizations, morbidity, and mortality outcomes and even increased disparities in life expectancy during the course of the pandemic.[10-13]

Despite the rapid development of an effective vaccine, rollout and dissemination presented many logistical challenges because of the initial limited supply of vaccines.[14] This meant that population risk stratification to prioritize vaccine distribution and allocation occurred.[15] Widespread debate centered on how distribution should occur among groups with different risk factors and how those risk factors were determined.[16-18]

Furthermore, challenges with vaccine access, hesitancy, and sometimes distrust of the medical and immigration system influenced who was protected as SARS-CoV-2 variants continued to strain medical systems.[7,19,20] Much has been written both in the United States and elsewhere about vaccine hesitancy and whether this is a phenomenon that is more pervasive among racial and ethnic minorities.[21] Vaccine uptake may relate more to vaccine accessibility and availability and other factors among racial and ethnic minorities than hesitancy.[22-27] Given all of the aforementioned factors, it is plausible that vaccine rollouts will have differential impacts on diverse groups.

The objective of this work was to leverage two datasets (Viral Infection and Respiratory Illness Universal Study [VIRUS] network and Mayo Clinic health care systems datasets) to examine how vaccine rollout in diverse states influenced trends in monthly hospital admission and mortality because of COVID-19 among Hispanic vs non-Hispanic populations during the pandemic. We used interrupted time series analysis (ITS) to explore this phenomenon. This statistical methodology is helpful for understanding the impact of interventions and government policy in a quasi-experimental research design and is especially relevant in the context of a pandemic and to understand the impact of vaccination strategies on population health.[28-31]

Our hypothesis was that vaccine rollout would influence hospital admission and mortality trends differently when comparing Hispanic vs non-Hispanic populations. In addition, ITS would demonstrate less favorable admission and mortality trends among Hispanic patients when compared with non-Hispanic patients.

ABBREVIATIONS: ITS = interrupted time series analysis; VIRUS = Viral Infection and Respiratory Illness Universal Study

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Study Design and Methods

Study Design, Setting, and Participants

This was a multisite registry-based cohort study using data from the VIRUS registry supplemented by electronic health record data. This study included five Mayo hospitals: three academic medical centers in Minnesota, Florida, and Arizona and two community hospitals in Minnesota and Wisconsin. The Mayo Clinic enterprise has 2,680 licensed hospital beds and 392 regular ICU beds spanning 20 campuses in four states. Not all health care system sites participated in the VIRUS registry, hence the inclusion of only the five participating sites as previously stated.[32]

The institutional review board approved the study as exempt (Nos. 22-001511 and 20-002610). Our study was also approved as an ancillary study by the VIRUS investigators. Additionally, approval was obtained from the Institutional SARS-CoV-2/COVID-19 Research Task Force. Informed consent was waived under Common Rule 45 CFR 46.116. We used ITS analysis and time series analysis to scrutinize the effect of vaccine rollout on monthly hospital admission and mortality trends and compared these outcomes between self-identified Hispanic and non-Hispanic populations. We included hospitalized adult patients admitted between April 2020 and December 2021.

VIRUS COVID-19 Registry

The VIRUS COVID-19 Registry was established by the Society of Critical Care Medicine Discovery Network in April 2020.[33] This is a global COVID-19 registry that tracks ICU and hospital care patterns in near real time. It is a prospective, cross-sectional, observational study and registry of all eligible adult and pediatric patients who are admitted to a hospital with confirmed or clinically diagnosed COVID-19 infection (clinicaltrials.gov identifier: NCT04323787).[34-37]

Patients from five Mayo Clinic locations participating in the VIRUS registry were included in this analysis. All patients enrolled between April 2020 and December 2021 were evaluated for inclusion. Patients from Mayo Clinic participating locations who did not provide research authorization were excluded, and readmissions of previously enrolled patients. In addition, patients < 18 years of age and those for whom hospital admission dates were missing were excluded. Patients whose self-reported ethnicity data were unavailable were also removed from the analysis (e-Fig 1).

Data Acquisition and Variable Definitions

The VIRUS registry database was used to retrieve de-identified information about several variables of interest such as baseline characteristics (eg, demographics) and admission-specific information (eg, hospital mortality, ICU admission). To provide improved granularity, we complemented the data already obtained by the VIRUS registry with Mayo electronic health record data. The Mayo Clinic Data Explorer tool, which includes data on all Mayo Clinic hospitals, was used to find data variables including the date of hospital admission. Mayo Clinic Anesthesia Clinical Research Unit resources were used for variables that were unavailable or had a high missing rate (eg, Charlson Comorbidity Index score) (e-Appendix 1).

Ethnicity (categorized as Hispanic and non-Hispanic) based on self-reporting was ascertained from VIRUS data. Publicly accessible data were used to determine vaccine rollout dates in the states where the hospitals were located. Vaccine rollout started in December 2020 in all included states. Prevaccine rollout included April 2020 through December 2020; postvaccine rollout included January 2021 through December 2021.

To maintain consistency, state-specific vaccination statistics were gathered from a single online source, which was then validated by checking the pertinent states' official public resources.[38]

Outcomes

Our primary outcome was the difference in monthly hospital admission trends between Hispanic and non-Hispanic patients related to vaccine rollout. Our secondary outcome was the difference in monthly hospital mortality trends between Hispanic and non-Hispanic patients related to vaccine rollout.

Statistical Analyses

Hospital Admission: To evaluate the effect of the SARS-CoV-2 vaccine on monthly hospital admissions, the individual patient records, in the VIRUS registry, were aggregated by year/month of hospital admission. This rendered a data file of the count of monthly admissions from April 2020 to December 2021. Accordingly, the study covered a 21-month study period, 9 months prior to and 12 months after the vaccine rollout (month 10 corresponded to the beginning of the postvaccine rollout period). Segmented Poisson regression analysis of interrupted time series data was used to evaluate the effect of the vaccine intervention. First, the monthly admission data were graphed to visually display both the immediate and longitudinal effect. A segmented Poisson regression model was then developed that included the level (intercept) and time trend (slope) before the rollout, the change in level (intercept) at rollout, and the change in time trend (slope) after the rollout. These terms assessed the immediate intervention effect (level change immediately after rollout) and longitudinal effect (time trend change in the postrollout period). Accordingly, the prevaccine rollout trend is the change in admissions per month over the 9 months before rollout, the level change is the direct change in admissions at rollout, and the trend change is the difference in the slope of admissions after the rollout compared with the slope before the rollout. Next, we evaluated the effect of ethnicity (Hispanic vs non-Hispanic) on the level and trend change by including interaction terms in the model. The statistical significance of these interaction terms indicated ethnic differences in the aforementioned main effect terms. After the estimation of statistically significant interaction terms, separate interrupted time series models were calculated for each ethnic group. Separate models simplified the estimation of ITS coefficients, SEs, and CIs. Furthermore, separated models facilitated the reporting of the model terms and transformation of coefficients to percentages. Finally, the data were tested for first-order autocorrelation using Durbin-Watson tests. To perform this test, a linear model was fit to the count data. The Durbin-Watson test statistic was 1.76 ($P = .47$), which was evidence of no autocorrelations. To interpret the results, the aforementioned models regression coefficients were transformed to percentage using the function $[\exp(\text{beta}) - 1] \times 100$. CIs for the percentages were also calculated.

Hospital Mortality: The aforementioned statistical methods were used with the addition of the number of monthly hospital admissions as an offset term for the Poisson regression models. Therefore, the mortality models estimate the monthly mortality rate during the study period.

All data management and analyses were performed using R version 4.1.2 (The R Foundation for Statistical Computing). All tests were two-tailed with $P < .05$ considered statistically significant.

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Results

Baseline Characteristics of Included Patients

Table 1 reports comparisons between the ethnic groups before and after vaccine rollout based on demographic and clinical characteristics. The total number of patients included in the study was 6,442 (5,837 non-Hispanic and 605 Hispanic patients). Overall, when we combined all Hispanic patients, they were significantly younger ($P < .001$), had lower Charlson Comorbidity Index scores ($P < .001$), and requested full code status more frequently ($P = .001$) than non-Hispanic patients. The proportions of male and female patients and the mean SOFA scores were similar in both groups (e-Table 1).

Hospital Admissions: Ethnic Comparisons

The mean number ± SD of monthly hospital admissions (over the study period) among Hispanics and non-Hispanic patients was 29 ± 21 and 278 ± 212, respectively. Table 2 reports the comparison between ethnic groups on the effect of the vaccine rollout on monthly hospital admissions using interaction terms in the ITS analysis. These terms report the ethnic differences in prevaccine rollout monthly admission trend, immediate vaccine rollout effect, and postvaccine rollout changes in trends. As shown, the interaction term for prevaccine rollout monthly trend was statistically significant ($P < .001$), as was the postvaccine rollout trend change ($P < .001$). However, the difference in the immediate effect of vaccine rollout was not significant ($P = .069$), indicating that the immediate effect of the rollout was similar in both ethnic groups. Also reported are the three main ITS terms for the reference group (non-Hispanic patients), which were all statistically significant ($P < .001$). Therefore, the data in Table 2 suggest that the vaccine rollout effect differed between the ethnic groups and that non-Hispanic patients experienced a significant decline in admission level (immediate effect) and postvaccine rollout admission trend (trend change). Therefore, separate ITS models were developed for Hispanic and non-Hispanic patients.

Hospital Admissions: Hispanic Patients

Hospital admission trends for Hispanic patients are reported in Table 3 and shown in Figure 1A. The mean ± SD number of monthly hospital admissions was 36 ± 25 and 24 ± 16 prevaccine and postvaccine rollout, respectively. Table 3 reports that prevaccine rollout, monthly admissions increased by b1 = 0.12 or 12.9% (95% CI, 8.1%-17.9%). Immediately after vaccine rollout, patient admissions declined by b2 = −1.09 or −66.3% (95% CI, −75.6% to −53.9%). Postvaccine rollout, monthly admissions were increased by b1 + b3 = 0.04 or 3.7% (95% CI, 0.2%-7.3%).

Hospital Admissions: Non-Hispanic Patients

Hospital admission trends for non-Hispanic patients are reported in Table 4 and shown in Figure 1B. The mean ± SD number of monthly non-Hispanic hospital admissions was 293 ± 260 and 266 ± 179 prevaccine and postvaccine rollout, respectively. Table 4 reports that prevaccine rollout, monthly admissions increased by b1 = 0.31 or 35.8% (95% CI, 33.4%-38.1%). Immediately after vaccine rollout, patient admissions declined by b2 = −1.40 or −75.2% (95% CI, −77.6% to −72.7%). Postvaccine rollout, monthly admissions increased by b1 + b3 = 0.05 or 5.6% (95% CI, 4.5%-6.7%).

Hospital Mortality Rate: Ethnic Comparisons

Table 5 reports the comparison of ethnic groups on the effect of the vaccine rollout on monthly hospital mortality rates using interaction terms in ITS analysis. These terms report the ethnic differences in trend prevaccine rollout monthly mortality rate, immediate vaccine rollout effect, and postvaccine rollout trend changes in mortality rates. As shown, none of the interaction terms were statistically significant, indicating that the effect of the vaccine rollout on hospital mortality rate was similar in both ethnic groups. Also reported are the three main ITS terms for the reference group (non-Hispanics) which again were all nonsignificant. Because the vaccine rollout did not impact the trend in hospital mortality in different ways for Hispanic and non-Hispanic patients, we then examined whether the overall time series trends differed between Hispanic and non-Hispanic patients. A times series model was fitted with an ethnicity interaction term ($P = .017$), suggesting that Hispanic and non-Hispanic patients differ in their overall mortality trends. Therefore, we developed two separate time trend models for Hispanic and non-Hispanic patients.

Mortality Rate: Hispanic Patients

Prevaccine rollout there were 321 Hispanic patient admissions resulting in 18 deaths. After vaccine rollout, there were 284 Hispanic patient admissions resulting in 32 deaths. Therefore, the prevaccine rollout and postvaccine rollout mortality rate, per 100 Hispanic patient admissions, was 5.6 and 11.3, respectively. Hospital mortality trends for Hispanics are shown in

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TABLE 1] Baseline Characteristics of the Study Populations Prevaccine and Postvaccine Rollout Q22

Characteristic	Before Vaccine Rollout (n = 2,960)		After Vaccine Rollout (n = 3,482)		Total (N = 6,442)
	Non-Hispanic Patients (n = 2,639; 89.2%)	Hispanic Patients (n = 321; 10.8%)	Non-Hispanic Patients (n = 3,198; 91.8%)	Hispanic Patients (n = 284; 8.2%)	
Sex					
Male	1,521 (57.6)	187 (58.3)	1,865 (58.3)	149 (52.5)	3,722 (57.8)
Female	1,118 (42.4)	134 (41.7)	1,333 (41.7)	135 (47.5)	2,720 (42.2)
Age, y	65 ± 17	53 ± 17	63 ± 17	52 ± 16	63 ± 17.2
Race					
White	2,200 (83.4)	220 (68.5)	2,894 (90.5)	208 (73.2)	5,522 (85.7)
African American	116 (4.4)	1 (0.3)	88 (2.8)	2 (0.7)	207 (3.2) Q23
Asian	111 (4.2)	1 (0.3)	89 (2.8)	1 (0.4)	202 (3.1)
Other or unknown	212 (8)	99 (30.8)	127 (4)	73 (25.7)	511 (7.9) Q24
Code status (n = 6,438)					
Full code	2,211 (83.8)	297 (92.5)	2,715 (85)	258 (90.8)	5,481 (85.1)
DNR/DNI/both	398 (15.1)	17 (5.3)	400 (12.5)	17 (6)	832 (12.9)
Unknown	30 (1.1)	7 (2.2)	79 (2.5)	9 (3.2)	125 (1.9) Q25
ARDS (admission) (n = 5,672)					
Yes	308 (11.7)	74 (23.1)	310 (12.2)	38 (21.3)	730 (12.9)
No	2,331 (88.3)	247 (76.9)	2,224 (87.8)	140 (78.7)	4,942 (87.1)
Charlson Comorbidity Index (n = 6,431)	5 ± 4	3 ± 3	5 ± 4	4 ± 3	4.9 ± 3.7
SOFA (n = 6,434)	2 ± 3	3 ± 4	2 ± 3	3 ± 4	2.4 ± 3

Values are No. (%) or mean ± SD.

TABLE 2] Interrupted Time Series Analysis Admission Trends Per Month

	Coefficient[a]	SE	*P* Value
Pre-VR level (intercept)	3.86	0.064	< .001
Pre-VR monthly trend	0.31	0.009	< .001
Level of change after VR (immediate effect)	−1.40	0.049	< .001
Trend change after VR	−0.25	0.010	< .001
Ethnicity (Hispanic vs non-Hispanic patients)	−0.94	0.155	< .001
Difference in pre-VR monthly trend between ethnic groups	−0.19	0.024	< .001
Difference in level of change after VR (immediate effect) between ethnic groups	0.31	0.169	.069
Difference in trend change after VR between ethnic groups	0.17	0.030	< .001

VR = vaccine rollout.
[a]To interpret the results, the model's regression coefficients were transformed to percentage using the function [exp(beta) − 1] × 100.

Figure 2 and reported in Table 6. The trend in monthly mortality rate increased significantly by b1 = 0.08 or 8.3% (95% CI, 3.6%-13.4%) per month (P = .008).

Hospital Mortality Rate: Non-Hispanic Patients

Prevaccine rollout, there were 2,639 non-Hispanic patient admissions resulting in 191 deaths. After vaccine rollout, there were 3,198 non-Hispanic patient admissions resulting in 268 deaths. Therefore, the prevaccine and postvaccine rollout mortality rate, per 100 non-Hispanic admissions, was 7.2. and 8.4, respectively. Hospital mortality trends for non-Hispanic patients are shown in Figure 2 and reported in Table 7. The trend in monthly mortality rate increased significantly by b1 = 0.02 or 2.2% (95% CI, 0.6%-3.8%) per month (P < .001).

Comparison of Trends

The difference in the aforementioned mortality trends was statistically significant (P = .017) using the interaction term in the aforementioned time series model. The trend in monthly mortality rate was fourfold greater (worse) (8.3%; 95% CI, 2.6%-13.4%) among Hispanic patients vs (2.2%; 95% CI, 0.6%-3.8%) non-Hispanic patients, but this was not related to vaccine rollout.

TABLE 3] Monthly Trends in Hospital Admission Before and After VR Among Hispanic Patients

	Coefficient[a]	SE	*P* Value
Intercept	2.92	0.14	< .001
Pre-VR monthly trend	0.12	0.02	< .001
Level of change after VR (immediate effect)	−1.09	0.16	< .001
Trend change after VR	−0.08	0.03	.003

VR = vaccine rollout.
[a]To interpret the results, the model's regression coefficients were transformed to percentage using the function [exp(beta) − 1] × 100.

Discussion

This ITS study was conducted as ancillary analysis on data collected within the scope of the VIRUS COVID-19 registry for five participating Mayo Clinic hospitals. We examined and compared the impact of vaccine rollout on COVID-19 monthly admission and mortality trends between Hispanic and non-Hispanic populations. The impact of the vaccine rollout differed between Hispanic and non-Hispanic patients when scrutinizing monthly admission trends; therefore, ITS analysis was applied but the vaccine rollout did not differentially impact the trends in hospital mortality, hence time series analysis was conducted on the data.

Among both Hispanic and non-Hispanic patients, the immediate effect of the vaccine rollout was a decline in monthly admissions, and the difference in the immediate effect of vaccine rollout was not significant, indicating that the immediate effect of the rollout was similar for both ethnic groups. However, prevaccine and postvaccine rollout monthly admission trends between groups were significantly different. Among Hispanic patients, prevaccine rollout monthly admissions increased by 12.9%. Immediately after vaccine rollout, patient admissions declined by −66.0%. Postvaccine rollout, monthly admissions increased by 3.7%. Among non-Hispanic patients, prevaccine rollout, monthly admissions increased by 35.8%. Immediately after vaccine rollout, patient admissions declined by −75.2%. Postvaccine rollout, monthly admissions increased by 5.6%. This demonstrates that the vaccine rollout impacted Hispanic and non-Hispanic populations differently, with non-Hispanic patients seeing an associated greater

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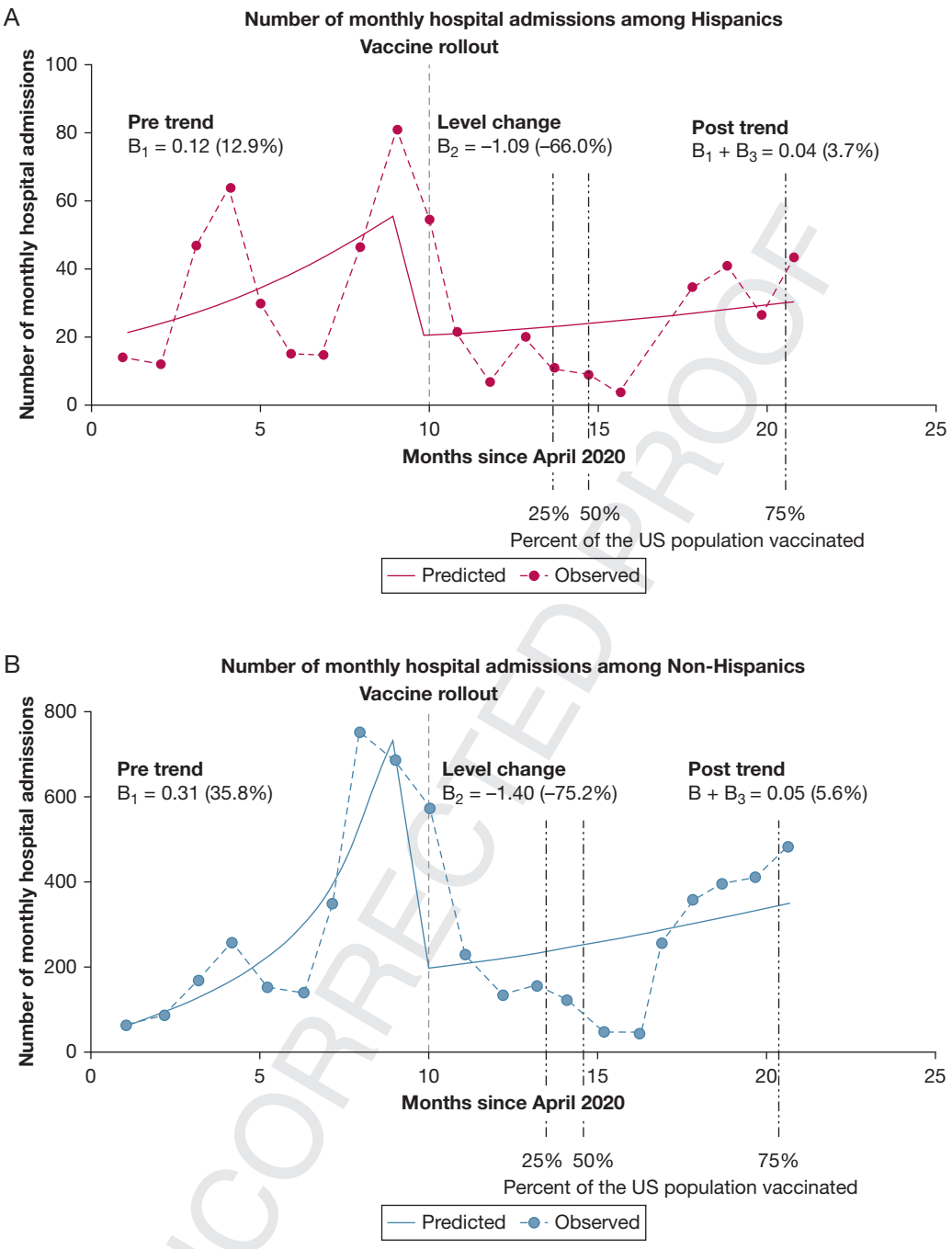

Figure 1 – *A, Number of monthly hospital admissions among Hispanic patients. B, Number of monthly hospital admissions among non-Hispanic patients.*

beneficial impact on monthly admission trends than Hispanic patients. These data also highlight the impact of the vaccine rollout on overall monthly hospital admission trends.

When we examined the mortality trends using time series analysis, it is notable that there were statistically significant differences in the mortality trends between Hispanic and non-Hispanic patients, with Hispanic patients having a mortality rate of 8.3% per month vs 2.2% for non-Hispanic patients. This fourfold difference in mortality is alarming and underscores the evidence about worse COVID-19 outcomes among Hispanics populations.[8,13,39] However, these differences were not associated with vaccine rollout. Differences may relate to exposure, lack of access to medical care

TABLE 4] Monthly Trends in Hospital Admission Before and After VR Among Non-Hispanics Patients

	Coefficient[a]	SE	*P* Value
Intercept	3.86	0.06	< .001
Pre-VR monthly trend	0.31	0.01	< .001
Level of change after VR (immediate effect)	−1.40	0.05	< .001
Trend change after VR	−0.25	0.01	< .001

VR = vaccine rollout.
[a]To interpret the results, the model's regression coefficients were transformed to percentage using the function [exp(beta) − 1] × 100.

causing delays in care, and potential underlying comorbidities.[39] Given the significantly younger age and lower Charlson Comorbidity Index scores among the Hispanic group, these differences remain even more disquieting.

When considering uptake of the vaccine after rollout, although vaccination rates may be lower among Hispanic populations than non-Hispanic populations nationally, there are multiple reasons beyond concerns about vaccine safety. Uncertainties about immigration status and policies may lead some to delay or avoid vaccination appointments.[40] It is important that health services researchers consider all potential influential factors to support inclusive solutions for populations that may not speak English and often have other social determinants of health risk factors. It is also worth noting that the vaccine rollout does not relate to one specific vaccine; however, the predominant vaccines being initiated were messenger RNA vaccines.

ITS is a useful statistical analytic approach to understand the impact of preventive strategies on outcomes.[41,42] ITS can also be used to study the impact of hospital-wide interventions including with antimicrobial stewardship and videoconferencing initiatives.[43,44] ITS is widely used in public health to examine strategies for identifying TB and to understand how stay at home orders during COVID-19 might influence motor vehicle accidents and crime in cities.[45,46]

We identified other studies that had used ITS methodology to explore whether lockdown measures flattened the curve of COVID-19 infections and mortality.[47,48] One study also used ITS to measure the effect of stay at home orders on the third wave of COVID-19 infections, but this did not evaluate hospitalizations as we have done in this study.[29]

Study Strengths

This is the first study that has used ITS to examine the effect of SARS-CoV-2 vaccine rollout on hospital admissions and mortality with a focus on differences in ethnic demographic characteristics in the United States. Despite much anecdotal evidence that minority populations had poor access to vaccinations, no studies have examined how this impacted severe COVID-19 infections using ITS. We leveraged two datasets to gather granular data so we could reliably and accurately determine our outcomes. This was a multisite study across four states with similar vaccine rollout schedules but diverse population characteristics. In addition, our study included tertiary/quaternary care academic centers with large numbers of ICU and hospital beds and smaller community hospitals that had a limited number of ICU beds but cared for patients with COVID-19 on the floor.

Study Limitations

This study includes patients admitted to the same health care system although across different states. The findings therefore may differ from other health care systems with different proportions of diverse populations and different approaches to vaccination outreach for these groups. Because of the largest cohort of patients being

TABLE 5] Interrupted Time Series Analysis Mortality Trends Per Month

	Coefficient[a]	SE	*P* Value
Pre-VR level (intercept)	−2.70	0.24	< .001
Pre-VR monthly trend	0.01	0.034	.75
Level of change after VR (immediate effect)	−0.15	0.17	.36
Trend change after VR	0.03	0.04	.45
Ethnicity (Hispanic vs non-Hispanic patients)	−1.22	0.75	.10
Difference Pre-VR monthly trend	0.15	0.10	.14
EthHisp level of change after VR (immediate effect)	−0.34	0.57	.56
EthHisp trend change after VR	−0.09	0.12	.42

VR = vaccine rollout.
[a]To interpret the results, the model's regression coefficients were transformed to percentage using the function [exp(beta) − 1] × 100.

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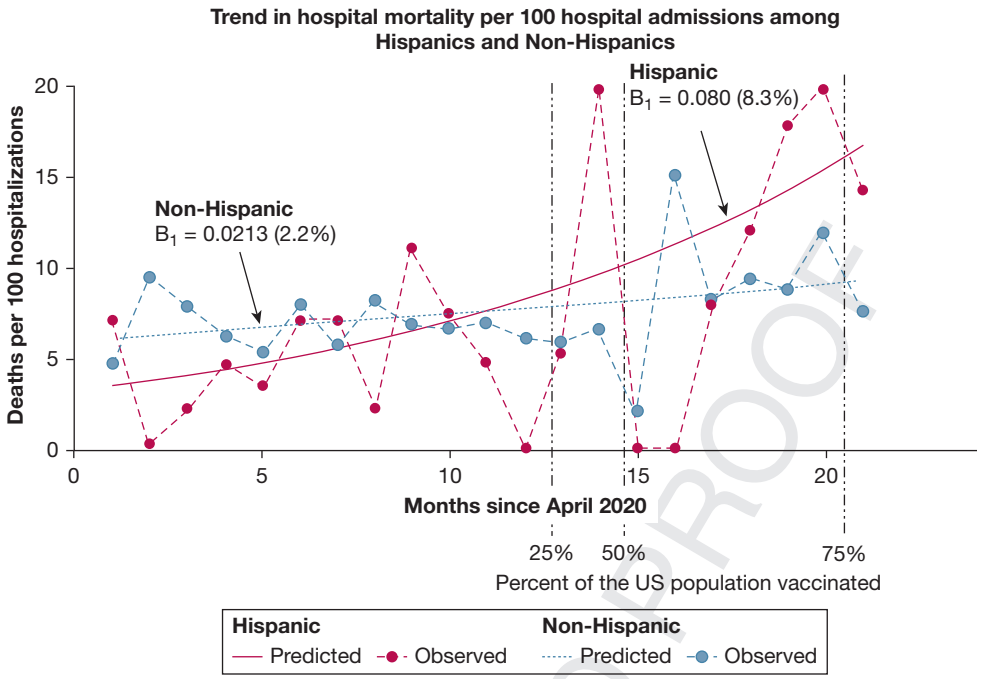

Figure 2 – *Trend in hospital mortality per 100 hospital admissions among Hispanic and non-Hispanic patients.*

from the Midwest, we had a large proportion of non-Hispanic patients. About 10% of the total cohort was Hispanic. Furthermore, although we could measure the impact of vaccine rollout on our primary outcome and secondary outcomes, we did not account for vaccine uptake or vaccination status in our analysis. We are currently conducting analysis to understand individual vaccination status and outcomes (eg, hospital admission, health care utilization, mortality). Additionally, given that we are aware that SARS-CoV-2 variants causing subsequent waves of COVID-19 and temporal trends in recovery from these exacerbations might coincide with vaccine rollouts, inferences from our findings should be tempered by knowledge about these other confounding factors. Moreover, we did not allow for a wash-in period to account for time from vaccine rollout to second doses and full efficacy. This would have excluded large numbers of patients (over one-quarter from each ethnic group) from December 2020 to January 2021. However, if we had excluded these patients, it is possible our study but might have generated different insights. Future research should include larger numbers of patients from diverse states and health care systems and consider a wash-in period to confirm our findings.

Because of the ITS study design, a further limitation is that we could not separate the effect of other nonpharmaceutic measures (eg, mask wearing, quarantine) on our outcomes nor could we definitively assess causation beyond the association we have measured.[29] It is possible that the outcomes we measured reflect other factors (eg, essential worker status, inability to work from home, difficulty obtaining safe masks, multigenerational homes with insufficient space for isolating positive family members).[49] There are many potential confounding factors within the populations we studied that may have influenced our findings, and causality cannot be completely determined based on our study design. As the pandemic progressed (beyond the time period when our study was

TABLE 6] Time Series Mortality Trends Among Hispanic Patients

	Coefficient[a]	SE	*P* Value
Intercept	−3.46	0.35	< .001
Overall trend	0.08	0.02	< .001

[a]To interpret the results, the model's regression coefficients were transformed to percentage using the function [exp(beta) − 1] × 100.

TABLE 7] Time Series Mortality Trends Among Non-Hispanic Patients

	Coefficient[a]	SE	*P* Value
Intercept	−2.81	0.11	< .001
Overall trend	0.02	0.01	< .001

[a]To interpret the results, the model's regression coefficients were transformed to percentage using the function [exp(beta) − 1] × 100.

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conducted), different variants did not demonstrate such noticeable disparities in outcomes, possibly related to geography and the spreading of the virus in rural areas in which fewer Hispanic people reside.[50] The patient populations may not be representative of the local communities; however, state policies during the height of the pandemic facilitated patient transfers within feasible geographic locations to Mayo Clinic sites even if patients did not usually attend that health care system.[51] Therefore, we think our findings are important, potentially generalizable, and provide useful insights for health policy guidance. We would also like to acknowledge that by using ethnicity, we did not take account of other potentially minoritizing factors among non-Hispanic patients that might have yielded different findings.

Interpretation

This ITS study examined the impact of the SARS-CoV-2 vaccine rollout on Hispanic and non-Hispanic patient monthly admission and mortality rates. The study highlighted significant disparities among Hispanic populations whose outcomes were associated with a reduced beneficial impact from the vaccine rollout when compared with non-Hispanic populations. However, as with all studies using ITS, we could not account for confounding factors unrelated to the vaccine rollout that may have contributed to our findings.

Concerningly, despite being younger and having fewer comorbidities, mortality trends from COVID-19 were significantly worse among Hispanic patients in time series analysis, but this was not associated with vaccine rollout.

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Q9

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Q10

Financial/Nonfinancial Disclosures

Q11

None declared.

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Q12

Q13

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Additional information: The e-Appendix, e-Figure, and e-Table are available online under "Supplementary Data."

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Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21

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