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Contents lists available at ScienceDirect

## The Journal of Arthroplasty

journal homepage: [www.arthroplastyjournal.org](http://www.arthroplastyjournal.org)

Health Policy and Economics

## Worsening Arthroplasty Utilization With Widening Racial Variance During the COVID-19 Pandemic

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## ARTICLE INFO

## Article history:

Received 7 December 2021

Received in revised form

25 February 2022

Accepted 1 March 2022

Available online 9 March 2022

## Keywords:

racial disparity  
COVID-19 pandemic  
arthroplasty volume  
elective surgery  
hip arthroplasty  
knee arthroplasty

## ABSTRACT

**Background:** Elective arthroplasty surgery in the United States came to a near-complete halt in the spring of 2019 as a response to the COVID-19 pandemic. Racial disparity has been a long-term concern in healthcare with increased focus during the pandemic. The purpose of this study is to evaluate the effects of COVID-19 and race on arthroplasty utilization trends during the pandemic.

**Methods:** We used 2019 and 2020 Center for Medicare and Medicaid Service fee-for-service claims data to compare arthroplasty volumes prior to and during the COVID-19 pandemic. We compared overall arthroplasty utilization rates between 2019 and 2020 and then sought to determine the effect of race and COVID-19, both independently and combined.

**Results:** There was a decrease in primary total knee arthroplasty (–28%), primary total hip arthroplasty (–14%), primary total hip arthroplasty for fracture (–2%), and revision arthroplasty (–14%) utilization between 2019 and 2020. The highest decrease in overall arthroplasty utilization was in the Hispanic population (34% decrease vs 19% decrease in the White population). We found that a non-White patient was 39.9% ( $P < .001$ ) less likely to receive a total joint arthroplasty prior to COVID-19. The COVID-19 pandemic further exacerbated the pre-existing racial differences in arthroplasty utilization by decreasing the probability of receiving a total joint arthroplasty for non-White patient by another 12.9% ( $P < .001$ ).

**Conclusion:** We found an overall decreased utilization rate of arthroplasty during the COVID-19 pandemic with further decrease noted in all non-White populations. This raises significant concern for worsening racial disparity in arthroplasty caused by the ongoing pandemic.

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The SARS-CoV-2 (COVID-19) pandemic caused a significant disruption in the volume of elective surgeries as the virus spread globally in the winter and spring of 2020. We previously reported a 94% reduction in total knee arthroplasty (TKA) volume and 92% reduction in total hip arthroplasty volume (THA) in the US Medicare population as COVID-19 infections were initially spreading in

March 2020 [1]. Similar findings were reported when the American Association of Hip and Knee Surgeons polled their membership with 92% of surgeons no longer performing elective arthroplasty surgery and 91% of surgeons reporting a significant decrease in surgical volumes by the end of March 2020 [2].

There was an evident detrimental effect on patients' quality of life due to surgical delays. Surveys conducted with patients who were required to delay surgery found the vast majority of participants had a deterioration in overall health [3,4], increased pain and analgesic use [5,6], emotional distress [7], and decreased function and activity levels [6] due to surgical delay. Despite this, 85%–90% of surveyed patients believed the delays to be in their overall best interest and 96% of patients believed they were treated fairly in the process [7,8]. Elective surgery resumed in a staggered fashion

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to <https://doi.org/10.1016/j.arth.2022.03.001>.

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<https://doi.org/10.1016/j.arth.2022.03.001>

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across the United States based on multiple factors to include regional COVID-19 infection rates along with state mandates and directives. Significant efforts were made to safely resume elective arthroplasty surgery to prevent further delays for those in need of surgery while also protecting the patient from contracting COVID-19 [9–13].

Disparities in healthcare have been previously defined as “racial or ethnic differences in the quality of healthcare that are not due to access-related factors or clinical needs, preferences, and appropriateness of intervention” [14]. Racial disparities have been well documented in regards to arthroplasty over the past 20 years with decreased surgical utilization in Hispanic and Black patients in comparison to White patients along with increased length of hospital stay, increased complication rates, and greater utilization of discharge to a facility when arthroplasty is performed [15–18]. Racial disparities have also been reported with regard to the COVID-19 pandemic with increased rates of hospitalizations and mortality seen in the Black population [19,20]. To our knowledge, there are currently no available data on racial disparities in regards to elective arthroplasty utilization during the COVID-19 pandemic.

The purpose of this study is to provide an update on the arthroplasty volume trend in the Medicare population as elective surgeries recommenced after the elective surgery moratorium in the United States and to determine if any racial differences exist in surgical utilization during the COVID-19 pandemic.

## Materials and Methods

### Data Source

We used 100% Center for Medicare and Medicaid Service (CMS) fee-for-service inpatient and outpatient claims data, and Medicare enrollment data spanning 2019 through 2020. We identified April 2020 as the first full month after the onset of the COVID-19 pandemic, and therefore set April 1, 2020 as the start date for the COVID-19 period. Since at the time of our analysis, the claims data extended through December 31, 2020, we examined cases admitted by December 18 to ensure we could capture the full length of stay. We examined the same time period of cases (April 1 to December 18 admissions) in 2019 as in 2020 to ensure comparability between the years. The study included primary THAs and TKAs that were coded as inpatient using diagnosis-related group 469 and 470, and outpatient using primary Current Procedural Terminology (CPT) code 27447 for TKAs and 27130 for THAs. The study also included revision of hip and knee replacement using diagnosis-related group 466 and 467 for inpatient, CPT 27486 and 27487 for outpatient knee revisions, and CPT 27134, 27137, and 27138 for outpatient hip revisions. Within the inpatient setting, we identified hip and knee procedures through each case’s primary International Classification of Diseases 10th Revision (ICD-10) Procedure codes. We also identified if a case was a hip fracture through its primary ICD-10 diagnosis code. We then divided our data into the following groups: primary TKAs, primary non-fracture THAs, primary fracture THAs, and combined revision arthroplasty of hip or knee.

### Race and Ethnicity

We defined race and ethnicity using the race variable from the Medicare beneficiary enrollment data. Race and ethnicities include White, Black, Hispanic, Asian, other, and unknown. We grouped Black, Hispanic, Asian, and other into the non-White racial group to compare with the White racial group. We also separately compared Black, Asian, Hispanic, and other non-White groups to the White patient group.

**Table 1**

Changes in TJA Procedure Rates per 1,000 Medicare Beneficiaries by Racial Group Before and During the COVID-19 Pandemic.

Racial Group	2019 April-December	2020 April-December	Change (%)
All primary and revision TJAs	11.92	9.52	–20%
White	12.92	10.42	–19%
Non-White	6.66	4.72	–29%
Black	7.10	5.12	–28%
Hispanic	5.50	3.62	–34%
Asian	4.84	3.28	–32%
Other minorities	7.65	5.59	–27%
Unknown	11.40	9.19	–19%
Primary TKA	6.45	4.67	–28%
White	6.91	5.06	–27%
Non-White	3.98	2.50	–37%
Black	4.02	2.57	–36%
Hispanic	3.77	2.26	–40%
Asian	3.27	1.87	–43%
Other non-White	4.66	3.09	–34%
Unknown	6.57	4.92	–25%
Primary THA non-fracture	3.56	3.05	–14%
White	3.90	3.36	–14%
Non-white	1.69	1.32	–22%
Black	2.08	1.64	–21%
Hispanic	0.89	0.65	–27%
Asian	0.73	0.57	–22%
Other non-White	1.77	1.43	–19%
Unknown	4.08	3.51	–14%
Primary THA fracture	1.36	1.33	–2%
White	1.52	1.48	–2%
Non-White	0.62	0.60	–3%
Black	0.55	0.55	1%
Hispanic	0.58	0.49	–16%
Asian	0.70	0.70	–1%
Other non-White	0.89	0.81	–9%
Unknown	0.35	0.42	21%
Revision (hip + knee)	0.55	0.47	–14%
White	0.58	0.51	–13%
Non-White	0.37	0.29	–21%
Black	0.45	0.35	–22%
Hispanic	0.27	0.22	–17%
Asian	0.14	0.14	–1%
Other non-White	0.33	0.26	–22%
Unknown	0.41	0.34	–17%

THA, total hip arthroplasty; TJA, total joint arthroplasty; TKA, total knee arthroplasty.

### Statistical Analysis

We calculated the total arthroplasty volume per 1,000 Medicare beneficiaries by different racial groups. We then compared the total arthroplasty rate between April 1 and December 18 in 2019 and 2020. The percentage change in arthroplasty rate during COVID was then calculated. A generalized linear model assuming a binomial distribution at beneficiary-year level was fitted with the dependent variable being if a beneficiary underwent arthroplasty surgery between April and December during the given year. We adjusted for the non-White indicator, the during-COVID indicator, the non-White indicator interacted with during-COVID, age, gender, CMS-hierarchical condition categories risk score, and Medicare-Medicaid dual enrollment status to study the differential effect of COVID-19 on operation rate changes across different racial populations. Bonferroni corrections were applied to *P*-values. We controlled for the CMS-hierarchical condition categories risk score because it is a measure reflecting the expected future health costs for each patient based on the patient demographics and chronic illnesses. Medicare-Medicaid dual enrollment was controlled for as a proxy for economic status of the beneficiary. The coefficient of the non-White indicator captures the pre-existing racial disparities in total joint arthroplasty (TJA) operation rate between White and

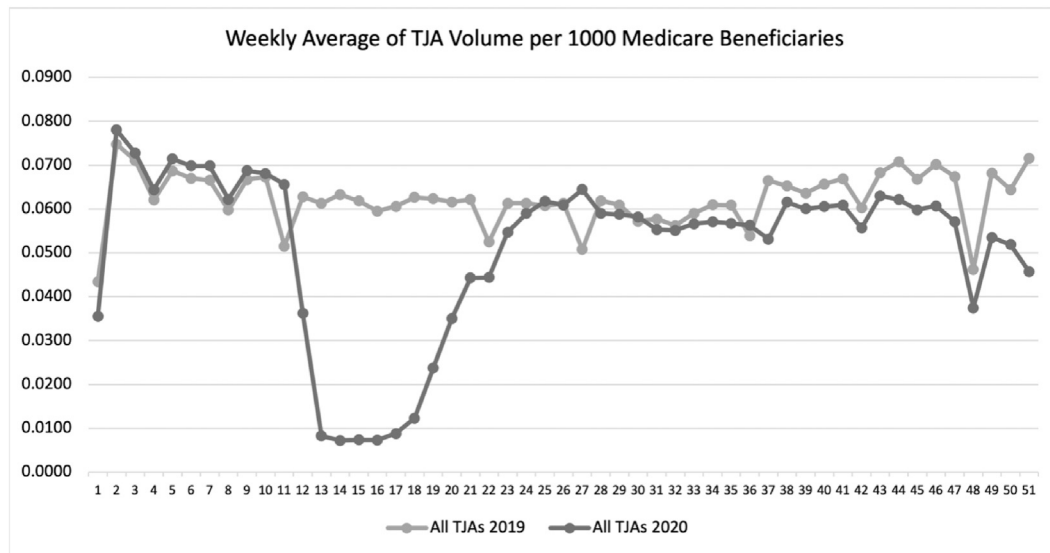


Fig. 1. Weekly average of TJA volume per 1,000 Medicare beneficiaries. TJA, total joint arthroplasty.

non-White. The coefficient of the non-White indicator and during-COVID indicator captures the impact of COVID-19 on TJAs across the Medicare population. The coefficient of the interaction term between non-White and during-COVID is our estimate of the impact of the COVID-19 pandemic on racial disparities between White and the non-White racial population, meaning that compared to the White racial group, how much did the arthroplasty operation rate change due to COVID-19 in the non-White racial population.

## Results

In total, 389,780 and 303,553 TJAs were identified between April and December for 2019 and 2020, respectively. There has been an overall 20% decrease in arthroplasty utilization per 1,000 Medicare beneficiaries when comparing 2019 to 2020. There was a decrease in the utilization of primary TKA (−19%), primary THA (−14%), primary THA for fracture (−2%), and revision arthroplasty (−14%) between 2019 and 2020 (Table 1, Fig. 1). We found that the most recently available 2020 TJA utilization rates across all procedure types have not returned to the baseline rates reported prior to the COVID-19 pandemic (Figs. 1 and 2).

The decreased utilization of arthroplasty during the COVID-19 pandemic was noted across all racial groups but was more pronounced in all non-White populations when compared to the White population for each arthroplasty type evaluated. The pooled results from all arthroplasty procedures found the highest decrease in utilization in the Hispanic population (34% decrease compared to a 19% decrease in the White population), TKA utilization most decreased in the Asian population (43% decrease compared to a 27% decrease in the White population), THA for non-fracture utilization most decreased in the Hispanic population (27% decrease compared to a 14% decrease in the White population), THA for fracture utilization most decreased in the Hispanic population (16% decrease compared to a 2% decrease in the White population), and revision TJA utilization most decreased in the Black population (22% decrease compared to a 13% decrease in the White population).

By fitting a logistic regression at Medicare fee-for-service beneficiary level with receiving a TJA as a dependent variable, we were able to quantify the effect of race and COVID-19 both independently and combined. Overall, we found that a non-White patient (pooling all non-White groups) was 39.9% (95% confidence interval

[CI] −40.6 to −39.2,  $P < .001$ ) less likely to receive a TJA prior to the COVID-19 pandemic. This effect was especially pronounced for the Asian population (−53.3%, 95% CI −55.0 to −51.6,  $P < .001$ ) and the Hispanic population (−41.2%, 95% CI −43.1 to −39.1,  $P < .001$ ). The pre-existing racial difference between White and non-White was −32.6% (95% CI −33.6 to −31.6,  $P < .001$ ) for TKA, −49.2% (95% CI −50.3 to −48.0,  $P < .001$ ) for THA non-fracture, −57.2% (95% CI −58.9 to −55.5,  $P < .001$ ) for THA fracture, and −39.4% (95% CI −42.4 to −36.2,  $P < .001$ ) for TJA revision cases (Table 2).

By studying the interaction between COVID-19 and non-White racial groups, we were able to quantify the differential effect of the COVID-19 pandemic on each non-White population. The effect of COVID-19 on the pooled non-White racial group was −12.9% (95% CI −14.5 to −11.3,  $P < .001$ ), meaning that with the TJA volume decreasing for both populations, non-White patients had an additional 12.9% less probability of receiving a TJA due to COVID-19, exacerbating the pre-existing racial differences in utilization. There was a significant decrease in utilization within each non-White racial group (Black, Hispanic, Asian, and other non-White patients) when compared to the White population, with the most significant difference in the Hispanic population (−19.4%, 95% CI −23.6 to −14.9,  $P < .001$ ) followed by Asian patients (−16.2%, 95% CI −20.9 to −11.2,  $P < .001$ ) and Black patients (−11.8%, 95% CI −13.9 to −9.8,  $P < .001$ ). Analysis of the procedure groups found a similar racial exacerbation of decreased utilization for non-White (−14.9%, 95% CI −16.9 to −12.8,  $P < .001$ ) within TKA, THA non-fracture (−10.0%, 95% CI −13.0 to −6.8,  $P < .001$ ), and TJA revisions (−8.9%, 95% CI −15.6 to −1.6,  $P = .02$ ). For THA fracture cases, however, no significant exacerbations were found due to COVID-19 (−0.4%, 95% CI −5.9 to 5.5,  $P = .90$ ). Within the non-White population, Asian patients had the biggest decrease within TKA (−21.7%, 95% CI −27.1 to −15.8,  $P < .001$ ), Hispanic patients had the biggest decrease within THA non-fracture (−17.5%, 95% CI −27.3 to −6.2,  $P < .001$ ), and Black patients had the biggest decrease within TJA revisions (−10.0%, 95% CI −17.8 to −1.5,  $P = .02$ ) (Table 3).

## Discussion

The impact of COVID-19, with the resultant moratorium placed on elective procedures in the United States, had an immediate and dramatic effect on arthroplasty surgery. Bedard et al [21] estimated

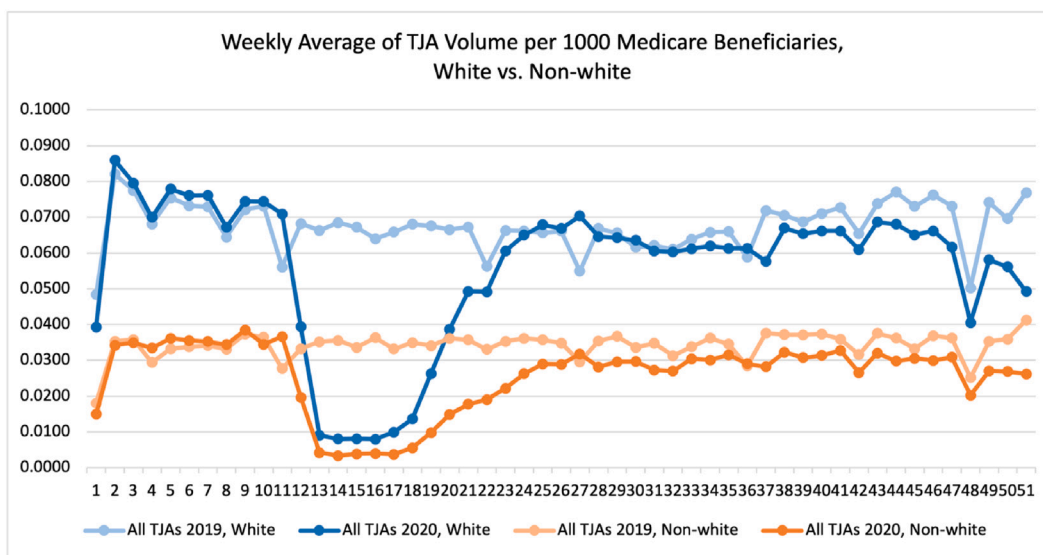


Fig. 2. Weekly average of TJA volume per 1,000 Medicare beneficiaries, White vs non-White.

30,000 primary hip and knee arthroplasty cancellations on a weekly basis due to the restrictions that were imposed during the elective surgery moratorium. We have found that arthroplasty utilization significantly improved with the return to elective

surgery, but there has been a sustained decrease in surgical volume that has persisted throughout the COVID-19 pandemic that has not yet returned to prepandemic utilization rates.

**Table 2**  
Estimated Between-Group Differences in TJA Procedure Rates Prior to COVID-19 for Each Racial Group Compared to the White Population.<sup>a</sup>

Racial Group	Difference	95% CI	P-Value
<b>All primary and revision TJAs</b>			
Non-White	-39.9%	-40.6 to -39.2	<.001
Black	-37.6%	-38.6 to -36.7	<.001
Hispanic	-41.2%	-43.1 to -39.1	<.001
Asian	-53.3%	-55.0 to -51.6	<.001
Other non-White	-35.1%	-36.9 to -33.3	<.001
<b>Primary TKA</b>			
Non-White	-32.6%	-33.6 to -31.6	<.001
Black	-33.3%	-34.5 to -32.0	<.001
Hispanic	-24.5%	-27.5 to -21.5	<.001
Asian	-39.8%	-42.4 to -37.1	<.001
Other non-White	-26.4%	-28.9 to -23.8	<.001
<b>Primary THA non-fracture</b>			
Non-White	-49.2%	-50.3 to -48.0	<.001
Black	-40.0%	-41.5 to -38.3	<.001
Hispanic	-68.0%	-70.6 to -65.3	<.001
Asian	-75.9%	-78.1 to -73.6	<.001
Other non-White	-50.0%	-52.7 to -47.1	<.001
<b>Primary THA fracture</b>			
Non-White	-57.2%	-58.9 to -55.5	<.001
Black	-63.6%	-65.5 to -61.5	<.001
Hispanic	-56.3%	-60.8 to -51.4	<.001
Asian	-56.3%	-60.4 to -51.7	<.001
Other non-White	-32.2%	-37.6 to -26.3	<.001
<b>Revision (hip + knee)</b>			
Non-White	-39.4%	-42.4 to -36.2	<.001
Black	-31.8%	-35.7 to -27.6	<.001
Hispanic	-47.5%	-54.9 to -39.0	<.001
Asian	-71.6%	-77.2 to -64.6	<.001
Other non-White	-41.7%	-49.0 to -33.3	<.001

CI, confidence interval; CMS, Center for Medicare and Medicaid Service; HCC, hierarchical condition categories; THA, total hip arthroplasty; TJA, total joint arthroplasty; TKA, total knee arthroplasty.

<sup>a</sup> Estimates were made from the logistic regression model at beneficiary-year level, adjusted for age, gender, CMS-HCC risk score, and Medicare-Medicaid dual enrollment status. Bonferroni corrections were applied to P-values. Coefficients were converted as the percentage differences in probability of receiving a TJA for minorities compared to White. The comparisons were made based on April through December data for 2020 and 2019.

**Table 3**  
Estimated Exacerbation of Pre-Existing Between-Group Differences in TJA Utilization Rates During COVID-19 for Each Racial Group Compared With the White Population.<sup>a</sup>

Racial Group	Difference	95% CI	P-Value
<b>All primary and revision TJAs</b>			
Non-White	-12.9%	-14.5 to -11.3	<.001
Black	-11.8%	-13.9 to -9.8	<.001
Hispanic	-19.4%	-23.6 to -14.9	<.001
Asian	-16.2%	-20.9 to -11.2	<.001
Other non-White	-9.6%	-13.4 to -5.6	<.001
<b>Primary TKA</b>			
Non-White	-14.9%	-16.9 to -12.8	<.001
Black	-14.0%	-16.6 to -11.3	<.001
Hispanic	-20.0%	-25.1 to -14.6	<.001
Asian	-21.7%	-27.1 to -15.8	<.001
Other non-White	-9.7%	-14.6 to -4.6	<.001
<b>Primary THA non-fracture</b>			
Non-White	-10.0%	-13.0 to -6.8	<.001
Black	-9.0%	-12.6 to -5.2	<.001
Hispanic	-17.5%	-27.3 to -6.2	<.001
Asian	-11.1%	-22.8 to 2.4	.10
Other non-White	-5.9%	-13.5 to 2.3	.15
<b>Primary THA fracture</b>			
Non-White	-0.4%	-5.9 to 5.5	.90
Black	3.6%	-4.3 to 12.2	.38
Hispanic	-12.5%	-25.4 to 2.6	.10
Asian	7.1%	-7.0 to 23.4	.34
Other non-White	-10.1%	-20.5 to 1.6	.09
<b>Revision (hip + knee)</b>			
Non-White	-8.9%	-15.6 to -1.6	.02
Black	-10.0%	-17.8 to -1.5	.02
Hispanic	-3.7%	-23.0 to 20.5	.74
Asian	9.1%	-20.3 to 49.4	.59
Other non-White	-10.0%	-26.6 to 10.3	.31

CI, confidence interval; CMS, Center for Medicare and Medicaid Service; HCC, hierarchical condition categories; THA, total hip arthroplasty; TJA, total joint arthroplasty; TKA, total knee arthroplasty.

<sup>a</sup> Estimates were made from the logistic regression model at beneficiary-year level, adjusted for age, gender, CMS-HCC risk score, and Medicare-Medicaid dual enrollment status. Bonferroni corrections were applied to P-values. Coefficients were converted as the percentage differences in probability of receiving a TJA for minorities compared to White. The comparisons were made based on April through December data for 2020 and 2019.

The COVID-19 pandemic has also been disruptive for patients in need of arthroplasty due to social and psychological factors beyond the physical limitations from surgical restrictions. The uncertainty of not knowing when their surgical procedure would be rescheduled was the highest source of anxiety for patients awaiting surgery. This caused more anxiety than financial issues, the risk of contracting COVID-19, and concerns of job security. An overwhelming majority of patients (90%) in this survey wished to reschedule surgery as soon as permitted [8]. Despite this, we found that patients have not yet returned to pre-pandemic surgical utilization levels which is likely a multifactorial issue.

We found a decreased utilization of all arthroplasty procedure types prior to the pandemic in all non-White patient groups when compared to the White population (Table 2). Racial disparity has been well documented in decreased arthroplasty utilization of non-White groups prior to the COVID-19 pandemic [15–18] and our results are consistent with these findings. We then determined the exacerbation of this effect based on procedure type when comparing White patients to non-White patient groups during the pandemic (Table 3). We found an exacerbation in decreased utilization of TKA for all non-White racial groups with a worsening in THA utilization for Black and Hispanic patients but not Asian and other non-White patients and exacerbation effect for revision TJA in Black patients only. However, there was no exacerbation effect seen in THA for fracture in all non-White groups or in revision arthroplasty for Hispanic, Asian and other non-Whites. This suggests a worsening in racial disparity due to the current COVID-19 pandemic as there is worsening utilization in the procedure groups that are considered elective but procedures that are typically more urgent in nature, such as THA for fracture, had similar decreased utilization rates when comparing White to non-White groups. The cause for racial disparity is multifactorial and includes socioeconomic factors, discriminatory healthcare practices, geographic, and cultural differences in seeking care [14]. Racial disparity has also been identified as an ongoing issue of concern in the Black population due to the pandemic with increased morbidity and mortality noted from COVID-19 in this patient population [19,20]. This racial effect appears to have also affected the arthroplasty community as we found a worsening surgical utilization in all non-White racial groups during the COVID pandemic with a slower return to arthroplasty surgery as elective procedures were resumed.

The racial differences reported from this study and others during the pandemic does not appear to be universal across all facets of the health system with COVID-19 vaccination status as an example. The Centers for Disease Control and Prevention publishes race/ethnicity of the vaccinated patients with the most recent data available from November 15, 2021 with identified racial status for 63% of vaccinated patients. Of this subset, the percentage of people who had received at least one dose of the vaccine based on race (61% White, 11% Black, 17% Hispanic, 6% Asian) closely matched the racial make-up of the United States (61% White, 12% Black, 17% Hispanic, 6% Asian) [22,23]. The findings that vaccination levels based on racial status closely match the US population is different from our findings and others [19,20] and raises interesting questions about causation that currently remain unanswered.

There are limitations to this study. This is based on Medicare data and does not include patients who do not have Medicare insurance and so may not adequately reflect the arthroplasty volume trends throughout the population in the United States. We have made significant efforts to minimize any confounding effects on the results with our statistical analysis, but this study provides trends due to the use of a retrospective database and does not allow for proof of causation in regards to the effect of the COVID-19 pandemic on arthroplasty volume. This analysis also found a clear

relationship between patient race and arthroplasty utilization among the non-White population but this does not explicitly demonstrate a racial disparity as we cannot provide the underlying cause(s) for our findings based on the available data. Despite this, we have made significant efforts to control for confounding factors which may be responsible for racial effect.

The determination of causation will require an extensive analysis of potential contributing factors, such as geographic location, state-based COVID restrictions, regional population density, and COVID vaccination rates, to determine if our findings are due to ongoing racial disparity. The intent of this research was to first establish if the COVID pandemic has impacted arthroplasty utilization based on race. We have been able to confirm this and further work is now required to determine the underlying cause(s) for these findings.

## Conclusion

The utilization of arthroplasty procedures in the US Medicare population has improved with the resumption of elective surgery but has not returned to pre-COVID levels. There has been an overall 20% decrease in arthroplasty utilization when comparing pre-COVID utilization to the same period in 2020 following the restart of elective surgery. Our results identified decreased arthroplasty utilization in all non-White populations prior to COVID-19 that has been further exacerbated due to the pandemic.

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