

# The Impact of COVID-19 Pandemic on the Epidemiology of Hip and Knee Arthroplasty: A Two-Year Look into the Pandemic from A Single Tertiary Referral General Hospital in Indonesia

Hanan Hanif<sup>1</sup> , Indrayuni Lukitra Wardhani<sup>2</sup> , Lukas Widhiyanto<sup>3</sup> ,  
Mohammad Zaim Chilmi<sup>3\*</sup> 

<sup>1</sup>Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.

<sup>2</sup>Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

<sup>3</sup>Department of Orthopedic and Traumatology, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

## ABSTRACT

**Introduction:** The COVID-19 pandemic has had significant effects on arthroplasty surgeries worldwide. Various studies have described decreased arthroplasty procedures among the most common orthopedic surgeries. This study aimed to analyze the effects of the pandemic on the epidemiology and demography of hip and knee arthroplasty in a tertiary referral general hospital in Indonesia.

**Methods:** This was a retrospective study of medical records data conducted on hip and knee arthroplasty cases from the pre-pandemic (April 2019–March 2020), first-year pandemic (April 2020–March 2021), and second-year pandemic (April 2021–March 2022) periods. Each period was compared for epidemiology and demography data, which included the annual number of arthroplasties, female-to-male ratio, age, duration of hospitalization, and in-hospital post-operative rehabilitation participation. All statistical data calculations were performed using the International Business Machines Corporation (IBM) Statistical Package for Social Sciences (SPSS) version 26.

**Results:** This study observed a statistically significant decrease of 232.00% for hip and 371.43% for knee arthroplasty performed during the first-year pandemic and an increase of 41.86% for hip and 74.07% for knee arthroplasty in the second-year pandemic. A decrease in median age and fluctuation of the female-to-male ratio were observed. The median duration of hospitalization was 80.00% shorter between the pre-pandemic and first-year pandemics and 11.11% shorter between the first and second-year pandemics. Participation in rehabilitation fluctuated during each period. There were four positive cases of COVID-19 and two cases of mortality during the first- and second-year pandemics.

**Conclusion:** The COVID-19 pandemic caused a significant reduction in arthroplasties performed during the first year and a slight increase during the second year. Several changes to the demographics of the patients were also observed between the pre-pandemic and the pandemic periods.

## Highlights:

1. Arthroplasty surgeries were reduced significantly during the COVID-19 pandemic.
2. The number of operations gradually increased between the first and second year of the pandemic.
3. Patients' median age and hospital stays were reduced during the pandemic.

\* Correspondence: [m-zaim-chilmi@fk.unair.ac.id](mailto:m-zaim-chilmi@fk.unair.ac.id)

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**Introduction**

Arthroplasty is a frequent orthopedic surgical operation involving the replacement of single or multiple joints to restore functionality and reduce pain. It is primarily indicated to treat chronic pain in which conservative therapies have failed, although several other indications, such as fractures and malignancy, may also lead to the operation.<sup>1</sup> Hip and knee arthroplasties are some of the most common arthroplasties performed. Before the pandemic, it was estimated that more than one million primary knee and 500 thousand primary hip arthroplasties would be performed in the United States (US) in 2020, with the number growing each year.<sup>2</sup>

The COVID-19 pandemic has produced a significant impact on arthroplasty procedures worldwide.<sup>2-5</sup> Previously, among the most common surgeries performed, the pandemic had lowered the number of arthroplasties performed worldwide. Studies worldwide have found significant decreases in arthroplasty procedures due to the pandemic.<sup>4-15</sup> As an orthopedic surgery requiring substantial contact between the surgeon and the patient, new protocols to reduce the infection have negatively impacted arthroplasty.<sup>15</sup> Postponement or cancellation of elective operations was rampant during the pandemic, alongside stricter procedures and guidelines. Some hospitals prioritized care for COVID-19-infected patients and reallocated the available resources there.<sup>4</sup>

Although several years have passed since the start of the pandemic, literature on the effect of the COVID-19 pandemic on the epidemiology and demography of hip and knee arthroplasty procedures remains scarce in parts of the world, including in Indonesia. This will lead to a poorer understanding of the effect of the pandemic on the surgical procedure. Therefore, this study aimed to describe the effects of the COVID-19 pandemic on the epidemiology of hip and knee arthroplasties in a tertiary referral general hospital in Indonesia in order to provide an understanding of the effects of a global pandemic on an operative medical procedure.<sup>5,6,7</sup>

**Methods**

This was a retrospective descriptive study conducted at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, from September 2022 to March 2023. This study was approved by the Medical Research Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia (No. 0966/LOE/301.4.2/VII/2022). A retrospective survey of the medical records of hip and knee arthroplasty cases was conducted. Patients from 4 April 2019–20 March 2022 (36 months; 12 months pre-COVID-19 pandemic, 12 months in the first-year pandemic, and 12 months in the second-year pandemic) were included. The criterion for inclusion was based on the availability of surgical procedures, including total hip replacement, bipolar hemiarthroplasty, and total knee replacement, both primary and revision. The sampling technique used was convenience sampling.

Several variables were observed in this study. Data from patients' medical records were gathered, analyzed, and presented into the number of primary and revision hip and knee arthroplasties of each period, age, female-to-male ratio, type of surgery, length of hospital stay including waiting time and post-op in-hospital recovery time, duration of operation, in-hospital post-operative rehabilitation, COVID-19 positive cases, and mortality.

Data categorization was performed using Google Sheets.<sup>16</sup> Data visualization was performed using Microsoft Excel 2021.<sup>17</sup> The differential analysis tests were conducted using the Chi-Square test for data with the categorical scale and the non-parametric Kruskal-Wallis's test for data with the numeric scale. Spearman's ranking was used to conduct correlation tests. All statistical tests were performed using the International Business Machines Corporation (IBM) Statistical Package for Social Sciences (SPSS) version 26,<sup>18</sup> with a statistical significance level of  $p = 0.05$ .

**Results**

A total of 218 primary and revision hip and knee arthroplasties performed at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, from 4 April 2019 to 20 March 2022 were included. The annual number can be seen in Table 1.

Table 1. The annual number of arthroplasty cases

Arthroplasty Cases	Period			Total
	Pre-Pandemic	1 <sup>st</sup> Year Pandemic	2 <sup>nd</sup> Year Pandemic	
<b>Hip</b>				
THR	18	6	12	36
Bipolar hemiarthroplasty	54	17	26	97
THR revision	11	2	5	18
<b>Knee</b>				
TKR	31	5	25	61
TKR revision	2	2	2	6
<b>Total</b>	<b>116</b>	<b>32</b>	<b>70</b>	<b>218</b>

\*Pre-pandemic: 4/2019–3/2020; 1<sup>st</sup> year pandemic: 4/2020–3/2021; 2<sup>nd</sup> year pandemic: 4/2021–3/2022; THR: Total hip replacement; TKR: Total knee replacement

Source: Research data, processed

This study showed a statistically significant decrease of primary and revision hip and knee arthroplasty performed to 232.00% and 371.43% in the first-year pandemic compared to the pre-pandemic period ( $p = 0.001$ ) and an increase of 41.86% and 60.00% in the second-year pandemic compared to the first-year pandemic period ( $p = 0.005$ ). Mean surgeries performed monthly were down from the pre-pandemic 9.6 to 2.6 during the first-year pandemic and up to 5.8 during the second-year pandemic. Monthly hip and knee arthroplasty performed at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, can be seen in Figure 1.



Table 2. Summary of the findings

Variables	Periods			Differences			p-value	Spearman Correlation
	04/19 – 03/20 (a)	04/20 – 03/21 (b)	04/21 – 03/22 (c)	b – a	c – a	c – b		
Total Number of Hip Arthroplasty	83	25	43	-232.00%	-93.02%	41.86%	0.001*	-0.470
Male	26	6	15	-333.33%	-73.33%	60.00%	0.645	-0.017
Female	57	19	28	-200.00%	-103.57%	32.14%		
Total Number of Knee Arthroplasty	33	7	27	-371.43%	-22.22%	74.07%	0.005*	-0.106
Male	7	3	4	-133.33%	-75.00%	25.00%	0.266	0.063
Female	26	4	23	-550.00%	-13.04%	82.61%		
Female to Male Ratio	2.55	2.25	2.74	-13.33%	6.93%	17.88%	0.967	0.074
Type of Surgery								
Bipolar hemiarthroplasty	54	17	26	-217.65%	-107.69%	34.62%	0.899	0.020
THR	18	6	12	-200.00%	-50.00%	50.00%		
THR revision	11	2	5	-450.00%	-120.00%	60.00%		
TKR	31	5	25	-520.00%	-24.00%	80.00%	0.156	0.036
TKR revision	2	2	2	0.00%	0.00%	0.00%		
Median Age	67	64.5	62	-3.88%	-8.06%	-4.03%	0.331	-0.087
Median age of male (hip)	68	62.5	55	-8.80%	-23.64%	-13.64%	0.211	0.061
Median age of female (hip)	68	66	59	-3.03%	-15.25%	-11.86%		
Median age of male (knee)	60	17	58	-252.94%	-3.45%	70.69%	0.028*	0.287
Median age of female (knee)	64.5	58.5	63	-10.26%	-2.38%	7.14%		
Median LOS	18	10	9	-80.00%	-100.00%	-11.11%	0.000*	-0.525
Median LOS of male (hip)	17.5	15	9	-16.67%	-94.44%	-66.67%	0.000*	-0.224
Median LOS of female (hip)	19	10	11	-90.00%	-72.73%	9.09%		
Median LOS of male (knee)	16	21	10	23.81%	-60.00%	-110.00%	0.000*	-0.582
Median LOS of female (knee)	15.5	9	7	-72.22%	-121.43%	-28.75%		
Median Waiting Time	12.5	6	5	-108.33%	-150.00%	-20.00%	0.001*	-0.511
Median Recovery Time	5	4	4	-25.00%	-25.00%	0.00%	0.198	-0.121
Median Duration of Operation	180	190	180	5.26%	0.00%	-5.56%	0.562	0.064
In-Hospital Post-Op Rehabilitation								
Number of participants (hip and knee)	40	14	24	-185.71%	-66.67%	41.67%		
Median recovery time	5	5.5	4.5	9.09%	-9.09%	22.22%		
COVID-19 Positive	N/A	3	1	N/A	N/A	-200.00%		
Mortality	5	0	2	-500.00%	-150.00%	200.00%		

THR: Total hip replacement; TKR: Total knee replacement; LOS: Length of stay; \*: Statistically significant  
 Source: Research data, processed

For hip revision, a 450% decrease was found in the first-year pandemic and increased by 60% in the second year. There was no difference between the three periods for knee revision.

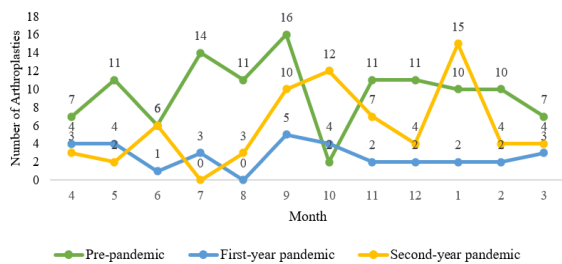


Figure 1. Comparison of monthly hip and knee arthroplasty performed between each period

The median age of hip and knee arthroplasty patients decreased by 3.88% (from 67 to 64.5) between pre-pandemic and first-year pandemic and 4.03% (from 64.5 to 62) between the first and second-year pandemic. However, this difference was not statistically significant ( $p = 0.331 > 0.05$ ).

The female-to-male ratio decreased by 13.33% between the pre-pandemic and first-year pandemic and increased by 17.88% between the first- and second-year pandemic. This was not found to be statistically significant ( $p = 0.967 > 0.05$ ).

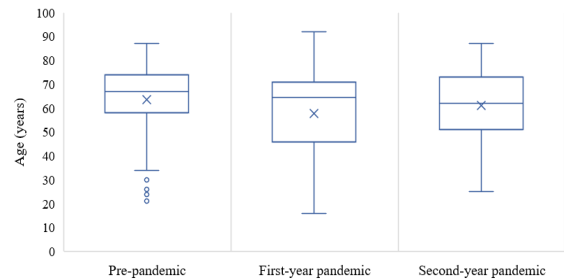


Figure 2. Comparison of the age of all patients

The median length of hospital stay was 80.00% shorter (from 17.5 days to 15 days) between pre-pandemic and first-year pandemic and 11.11% shorter (from 15 days to 9 days) between the first- and second-year pandemic. This was seen as statistically significant ( $p = 0.000 < 0.05$ ).

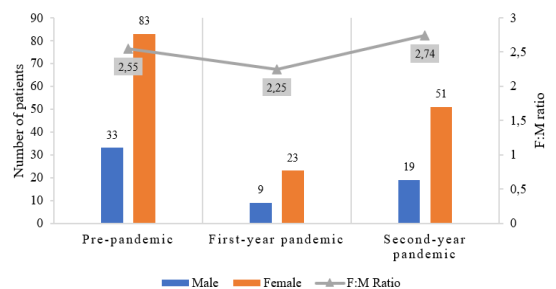


Figure 3. Comparison of the female-to-male ratio between each period

The time of waiting from hospital entry to the operation room was decreased by 108.33% (from 12.5 days to 6 days) between pre-pandemic and first-year pandemic and 20.00% (from 6 days to 5 days) between first- and second-year pandemic and was also seen as statistically significant ( $p = 0.001 < 0.05$ ).

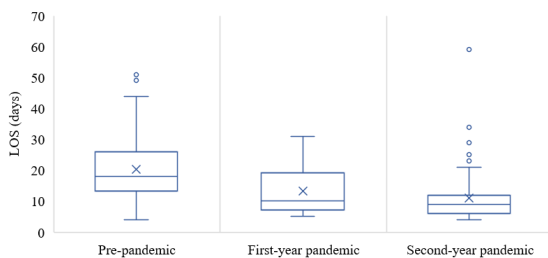


Figure 4. Comparison of length of stay (LOS) of all patients

A slight decrease in median post-op in-hospital recovery time was identified (from 5 days pre-pandemic to 4 days post-pandemic). However, it was not statistically significant ( $p = 0.198 < 0.05$ ). The median duration of operation was found to be slightly higher during the first-year pandemic, but it returned to the pre-pandemic period level during the second year. Other findings include four cases of COVID-19-positive patients and two cases of mortality during the pandemic period.

The number of patients participating in in-hospital post-operative rehabilitation decreased by 185.71% in the first-year pandemic and increased by 41.67% in the second year. Not all patients in every period were participating. There was a fluctuation in median recovery time for all patients who participated in the rehabilitation throughout the study timeframe, which was longer in the first-year pandemic and shorter in the second-year pandemic compared to the pre-pandemic period. The summary of all findings can be seen in [Table 2](#).

## Discussion

This study was based in Indonesia, which experienced several lockdown periods during the pandemic. Since the discovery of the first case in March 2020,<sup>19</sup> several national lockdown periods (large-scale social restrictions/PSBB and the community activities restrictions enforcement/PPKM and its equivalent) had been commenced, which mandated any non-essential activities to be suspended and people to remain in their homes.<sup>20</sup> This study compared the volume and profile of hip and knee arthroplasty patients for 12 months in the pre-pandemic, first-year, and second-year pandemic periods in a single tertiary general referral hospital. This study retrospectively analyzed the medical records available at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

Several studies around the world have previously observed a fall in arthroplasty volume due to the pandemic. In the US, it was estimated that hip and knee arthroplasties might fall by 75-100% due to the pandemic, and up to 86%

were canceled.<sup>2,21</sup> A study reported a decline of hip and knee arthroplasties in Poland of 30% for primary and 40% for revision surgery during the first-year pandemic.<sup>6</sup> This study presented a decrease in the annual number of hip and knee arthroplasties and its revision during the first-year pandemic to 232.00% and 371.43%, respectively. This decrease was statistically significant ( $p = 0.001$  and  $p = 0.005 < 0.05$ ). On a monthly basis, the mean arthroplasty performed decreased from the pre-pandemic number of 9.6 to 2.6. One of the explanations for this sharp decline may come from the fact that Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, is a regional referral center for COVID-19, and resources were being reallocated to serve patients of COVID-19, leading to the postponement and cancellation of elective surgeries. Other factors may be the unwillingness of patients to visit the hospital amid the pandemic and the whole lockdown situation. A comparable but less dramatic decrease was reported in two centers in Poland, with 26% fewer knee and 44% fewer hip arthroplasties performed during the pandemic.<sup>9</sup> In Singapore and Italy, a reduction of 74% and 76.5%, respectively, of arthroplasty was observed during the early pandemic period.<sup>4,10</sup> An 82.53% drop in arthroplasty was observed in an Indian study.<sup>11</sup> An Austrian study observed an 18.6% decrease in primary arthroplasty and 15.8% in revision arthroplasty.<sup>12</sup> In Romania, a decrease of up to 55.47% for primary and 69.14% for revision arthroplasty was reported.<sup>13</sup> A decrease of up to 20% was reported in a study in the Netherlands and Denmark.<sup>14</sup>

There have been several studies available regarding the effects of the pandemic on hip and knee arthroplasty in Indonesia. One study by Santoso, *et al.* (2020) reported that the monthly performance of hip and knee arthroplasty decreased around the start of the pandemic in March 2020 and reached the lowest in May 2020.<sup>6</sup> A gradual return to the pre-pandemic level was observed during the subsequent month and peaked in September 2020. Postponement and rescheduling of operations were stated as the reason for the decrease. In another study by Sumargono, *et al.* (2021), it was stated that the total knee replacement (TKR) procedure decreased in monthly performance from 15.2 pre-pandemic to 6.3 during the pandemic, with a low record in April 2020.<sup>15</sup> The figure would later return to the pre-pandemic level in December 2020. The substantial difference in the results of this study might be caused by the fact that both studies were conducted in a non-COVID-19 referral, orthopedic-specialized hospital.

Due to the nature of this study reaching the second year of the pandemic, it analyzed the changes between the first- and second-year pandemic. The lockdown situation gradually improved as various new protocols for preventing COVID-19 infection were established. This was reflected by the increase of hip arthroplasty by 41.86% and knee arthroplasty by 74.07%, although the number has still not reached the pre-pandemic level. The mean number of arthroplasties performed each month increased from 2.6 to 5.8. However, the number decreased again during the last two months of this study timeframe. This was comparable with the study by Moldovan, *et al.* (2023) in Romania.<sup>13</sup>

The rates of hip revision decreased by 450.00% between the pre-pandemic and the first year of the pandemic period but increased by 60.00% between the first- and second-year pandemic. The rates of knee revision, however, did not change and remained the same throughout all periods. A different result was found in Poland, with a 30% decrease in hip revision but a 100% increase in knee revision.<sup>9</sup>

There was no significant change in patients' demography before and after the pandemic. A statistically insignificant ( $p = 0.331 > 0.05$ ) decrease in the median age of the patients was found in all three periods. This decrease was likely caused by the concern of elderly patients being infected during hospitalization. One thing to note was the significant decrease in male knee arthroplasty patients between pre-pandemic and first-year pandemic. The fall from 60 to 17 years old was likely caused by the small amount of data in this study cohort of knee arthroplasty during the first-year pandemic, in which only three male patients were present. Two patients were 16 and 19 years old and underwent primary TKR due to malignant osteosarcoma, while the third was 17 years old and underwent revision TKR due to wound dehiscence. Contrary to the results of this study, some studies reported a slight increase in the mean age of their cohort during the pandemic.<sup>6,9</sup>

A fluctuation in the female-to-male ratio was observed throughout the study timeframe. However, regardless of the period, the number of women undergoing arthroplasty in this study was higher than that of men. Kazubski, *et al.* (2021) reported a decrease of 22.96% in the ratio due to the pandemic,<sup>9</sup> while Santoso, *et al.* (2020) reported an increase in the ratio.<sup>6</sup>

Four (1.8%) patients confirmed positive for COVID-19 in this study cohort, with three (0.7%) hip patients during the first year and one (0.8%) knee patient during the second year of the pandemic. This may be due to the fact that the patients at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, were required to be tested and screened for COVID-19 symptoms upon admission. According to the national protocols, symptomatic or positive patients will be asked to do self-quarantine at home or quarantine facilities. As Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, was a referral hospital for COVID-19 cases, symptomatic patients may also be directed toward the specialized facility. Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, only allows patients who are negative for the virus and its symptoms to undergo arthroplasty procedures to prevent the further spreading of the disease to either staff members or other patients. Agrawal, *et al.* (2021) found six (12.8%) positive cases of COVID-19 in their study, with one recorded mortality.<sup>22</sup>

This study recorded two (4.6%) incidences of mortality during the second-year pandemic period, all from the hip arthroplasty cohort. The cause of death of both patients was determined to be septic shock unrelated to the arthroplasty. No known relation with COVID-19 was reported in all mortalities. The patients were found to possess multiple comorbidities and were being treated for

their comorbid at the time of death. Compared to the pre-pandemic period, this number was decreased. A study found no significant increase in arthroplasty mortality rate due to the pandemic.<sup>23</sup>

The median duration of operation did not show any significant changes between non-pandemic and pandemic periods. This could mean no significant changes were made to the surgical protocols at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

A decrease in the total length of hospitalization was identified throughout the three periods. This was caused mainly by the decrease in the in-hospital waiting time for the operation. Several factors may have caused this, (1) Reduced patients' number could lead to faster time to operation due to decreased queue size, (2) Pandemic health protocols required patients to spend less time in the hospital, and (3) COVID-19 prioritization requires the waiting time to be faster. However, patients' recovery time appears to be not significantly affected by the pandemic. This means that patients from pre-pandemic and pandemic periods spend a relatively equal amount of time before discharge. This study is comparable to previous studies.<sup>9,11,15</sup> However, one study saw a rise in the re-admission rate, which may correlate with the decreased recovery time.<sup>11</sup> Some studies, however, reported a contrasting result with an increase in the average length of hospital stay.<sup>22</sup> A study in Romania reported a comparable result in which the length of hospitalization decreased during the first-year pandemic and increased in the second year.<sup>11</sup>

Patients' participation in the in-hospital post-operative rehabilitation program decreased during the first-year pandemic. It increased in the second-year pandemic, although it had not reached the pre-pandemic level. This decrease may be caused by the patient's unwillingness to participate, reluctance to undergo longer hospitalization, lack of information, and pandemic regulation. In addition, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, mandated a one-day one-service regulation during the pandemic, which prevent patients from participating in the rehab. The recovery time of those who participated in the in-hospital post-op rehab also fluctuated between each period, with an increase in the first-year pandemic and a decrease in the second-year pandemic. This may be caused by the dynamic changes in the situation during the pandemic, which leads to the regulations being subject to frequent changes.

### Strength and Limitations

This study has several strengths and limitations. One strength is the fact that this study analyzed arthroplasty cases for up to two years after the pandemic. This means that the result could be useful for predicting the future volume of arthroplasty post-COVID-19 pandemic. The limitations are the fact that the data were obtained from only one center and the retrospective design of this study, which may limit the relevancy of the result. Dynamic changes during the pandemic may also contribute to the relevancy of this study.

## Conclusion

This study found a significant reduction in hip and knee arthroplasty surgeries in the first year of the COVID-19 pandemic compared to the previous period. A slight increase in the number of surgeries was observed in the second-year pandemic, although it has still not reached the pre-pandemic level. A significant decrease in the median length of hospitalization was also found during the first and second year of the pandemic. Slight changes, but not statistically significant, were observed in the patients' female-to-male ratio and median age. The duration of the operation fluctuated slightly, but no significant changes were observed. The participation of patients in the in-hospital post-op rehabilitation was observed to fluctuate. Future studies should include more centers and variables in order to provide a more generalized result.

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## Conflict of Interest

The authors declared there is no conflict of interest.

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This study did not receive any funding.

## Ethical Clearance

The study was approved by the Medical Research Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia (No. 0966/LOE/301.4.2/VII/2022) on 12-07-2022.

## Authors' Contributions

Designed the study and drafted the manuscript: HH and ILW. Collected data and performed background literature review: HH. Performed statistical analysis: HH. Supervised results and discussion: ILW, LW, and MZC. All authors reviewed and approved the final version of the manuscript.

## References

- Singh JA. Epidemiology of Knee and Hip Arthroplasty: A Systematic Review. *Open Orthop J* 2011; 5: 80–85. [PubMed]
- Bedard NA, Elkins JM, Brown TS. Effect of COVID-19 on Hip and Knee Arthroplasty Surgical Volume in the United States. *J Arthroplasty* 2020; 35: S45–S48. [PubMed]
- Thaler M, Khosravi I, Hirschmann MT, et al. Disruption of Joint Arthroplasty Services in Europe during the COVID-19 Pandemic: An Online Survey within the European Hip Society (EHS) and the European Knee Associates (EKA). *Knee Surg Sports Traumatol Arthrosc* 2020; 28: 1712–1719. [PubMed]
- Decruz J, Prabhakar S, Ding BTK, et al. The COVID-19 Pandemic in Singapore: What Does It Mean for Arthroplasty? *Acta Orthop* 2020; 91: 551–555. [PubMed]
- Blum P, Putzer D, Liebensteiner MC, et al. Impact of the Covid-19 Pandemic on Orthopaedic and Trauma Surgery - A Systematic Review of the Current Literature. *In Vivo* 2021; 35: 1337–1343. [PubMed]
- Santoso A, Persada G, Anwar IB, et al. Effect of Coronavirus Disease-19 Pandemic to the Volume of Total Hip and Knee Arthroplasty Surgical Service: Experience from a Single Tertiary Orthopedic Hospital in Indonesia. *Open Access Maced J Med Sci* 2020; 8: 642–645. [Journal]
- Chen AZ, Shen TS, Bovonratwet P, et al. Total Joint Arthroplasty during the COVID-19 Pandemic: A Scoping Review with Implications for Future Practice. *Arthroplast Today* 2021; 8: 15–23. [PubMed]
- Czubak-Wrzosek M, Czubak J, Grzelecki D, et al. The Effect of the COVID-19 Pandemic on Total Hip and Knee Arthroplasty Surgical Volume in 2020 in Poland. *International Journal of Environmental Research and Public Health* 2021; 18. [PubMed]
- Kazubski K, Tomczyk Ł, Kopczyński B, et al. The Epidemiology of Hip and Knee Primary and Revision Arthroplasties during the COVID-19 Pandemic. *Healthc (Basel, Switzerland)* 2021; 9. [PubMed]
- D'Apolito R, Faraldi M, Ottaiano I, et al. Disruption of Arthroplasty Practice in an Orthopedic Center in Northern Italy during the Coronavirus Disease 2019 Pandemic. *J Arthroplasty* 2020; 35: S6–S9. [PubMed]
- Khanna V, Nashikkar PS, Mahajan R, et al. Impact of COVID-19 Pandemic on Arthroplasty Services and Early Experience after Resuming Surgeries at a 'Non COVID' Center. *J Clin Orthop Trauma* 2021; 21: 101515. [PubMed]
- Simon S, Frank BJH, Aichmair A, et al. Impact of the 1st and 2nd Wave of the COVID-19 Pandemic on Primary or Revision Total Hip and Knee Arthroplasty-A Cross-Sectional Single Center Study. *J Clin Med* 2021; 10. [PubMed]
- Moldovan F, Gligor A, Moldovan L, et al. An Investigation for Future Practice of Elective Hip and Knee Arthroplasties during COVID-19 in Romania. *Medicina (Kaunas)* 2023; 59. [PubMed]
- Latijnhouwers D, Pedersen A, Kristiansen E, et al. No Time to Waste; The Impact of the COVID-19 Pandemic on Hip, Knee, and Shoulder Arthroplasty Surgeries in the Netherlands and Denmark. *Bone Jt Open* 2022; 3: 977–990. [PubMed]
- Sumargono E, Anastasia M, Saleh I, et al. Total Knee Replacement Epidemiology in a Single Secondary Hospital before and after the COVID-19 Pandemic: A Descriptive Comparative Study. *Hip Knee J* 2021; 2. [ResearchGate]
- Page L, Brin S. Google Sheets, <https://google.com/sheets> (2006).
- Gates B, Allen P. Excel, <https://office.microsoft.com/excel> (2021).
- Nie NH, Bent DH, Hull CH. Statistical Package for the Social Sciences (SPSS), <https://www.ibm.com/support/pages/downloading-ibm-spss-statistics-26> (2018).
- Setiawaty V, Kosasih H, Mardian Y, et al. The Identification of First COVID-19 Cluster in Indonesia. *Am J Trop Med Hyg* 2020; 103: 2339–2342. [PubMed]
- Ahdika A, Primandari AH, Adlin FN. Considering the Temporal Interdependence of Human Mobility and COVID-19 Concerning Indonesia's Large-Scale Social Distancing Policies. *Qual Quant* 2023; 57: 2791–2810. [PubMed]
- Brown TS, Bedard NA, Rojas EO, et al. The Effect of the COVID-19 Pandemic on Electively Scheduled Hip and Knee Arthroplasty Patients in the United States. *J Arthroplasty* 2020; 35: S49–S55. [PubMed]

22. Agrawal Y, Vasudev A, Sharma A, *et al.* Morbidity and Mortality in Patients undergoing Lower Limb Arthroplasty Surgery during the Initial Surge of the COVID-19 Pandemic in the UK at a Single-Speciality Orthopaedic Hospital. *Bone Jt Open* 2021; 2: 323–329. [[PubMed](#)]
23. Lim EJ, Kim M, Kim CH. Impact of the COVID-19 Pandemic on Mortality Following Hip and Knee Joint Arthroplasty Surgeries: A Systematic Review and Meta-Analysis. *J Pers Med* 2022; 12. [[PubMed](#)]