ACTA ORTHOPAEDICA et TRAUMATOLOGICA TURCICA
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Research Article

Perioperative risk factor analysis for mortality in patients undergoing total hip arthroplasty: A national database study from Türkiye

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ARTICLE INFO

Article history:
Submitted March 8, 2024
Received in revised form
July 13, 2024
Last revision received form
January 13, 2025
Accepted October 22, 2025
Publication date March 23, 2026

Keywords:
Comorbidity
Mortality
Prevalence
Total hip arthroplasty

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ABSTRACT

Objective: Mortality is a devastating complication after primary total hip arthroplasty (THA). The aim of this study was to investigate the prevalence and risk factors associated with 1-year postoperative mortality in patients undergoing primary THA.

Methods: The authors reviewed the e-health database (e-Nabız) of the Republic of Türkiye Ministry of Health to identify patients who underwent primary THA between January 2016 and June 2022. The study included 98 622 patients with a mean age of 59.9 ± 13.6 years. Hip fractures were excluded. Demographic data, body mass index, and Charlson Comorbidity Index scores were recorded. The incidence of 1-year mortality was investigated. A multivariate Cox regression model was created to identify risk factors for 1-year postoperative mortality.

Results: The postoperative 1-year mortality of patients who underwent primary THA was 2.8%. Cox regression analysis revealed that male gender and advanced age were independent risk factors for 1-year mortality and the risk of 1-year mortality increased with comorbidities such as cancer (hazard ratio (HR) = 2.46; 95% CI = 2.21-2.71), renal disease (HR = 2.29; 95% CI = 2.1-2.5), dementia (HR = 1.83; 95% CI = 1.63-2.05), liver disease (HR = 1.69; 95% CI = 1.25-2.27), heart failure (HR = 1.65; 95% CI = 1.49-1.83), cerebrovascular accident (CVA) (HR = 1.43; 95% CI = 1.3-1.57), and acute myocardial infarction (AMI) (HR = 1.25; 95% CI = 1.07-1.45).

Conclusion: Advanced age, male gender, cancer, renal disease, dementia, liver disease, heart failure, CVA, and AMI were identified as risk factors for 1-year mortality in patients undergoing THA. Meticulous preoperative medical optimization and standardized postoperative care may reduce mortality among patients with these comorbidities.

Level of Evidence: Level III, Prognostic Study.

Introduction

Total hip arthroplasty (THA) has been accepted as the operation of the century due to high success rates and excellent long-term results.[1] According to a projection study based on data from 2000 to 2014, the incidence of primary THA was predicted to increase by 71% and reach 635 000 procedures by 2030 in the United States.[2]

Like all surgeries, THA carries the risk of complications including death.[3-5] Previous studies have reported 1-year mortality rates after THA ranging from 0.91% to 9.6%.[6,7] Despite improvements in surgical techniques, implant designs, anesthesia, and postoperative rehabilitation, mortality remains a major complication among patients undergoing THA. Furthermore, THA is mostly performed for patients above 60 years of age and patients with multiple medical comorbidities, which may also increase the risk of postoperative morbidity and mortality.[8-10] Hence, identifying the risk factors associated with perioperative mortality may help surgeons optimize treatment plans for high-risk patients and reduce mortality rates.

Most studies to date have focused on intraoperative, very early, and late postoperative mortality, with few studies investigating 1-year mortality risk.[3-5,7,8] In the present study, a large cohort was used from a national database to determine the 1-year mortality rate and identify the patient-related risk factors associated with mortality in patients undergoing primary THA.

Material and methods

In this retrospective study, the e-health database (e-Nabız), a digital health platform provided by the Republic of Türkiye Ministry of Health, was used to identify patients who underwent primary THA between January 2016 and June 2022.[11] In adherence to the principles outlined in the Declaration of Helsinki,[12] the study was conducted upon receiving ethical approval from the Ethics Committee of İstanbul Medipol University (Approval no: E-10840098-202.3.02-5201) on 14th of August 2025. Given the retrospective nature of the study, the requirement for individual informed consent was waived. Nevertheless, robust protocols were

Cite this article as: *Artuç M, Birinci M, Hakyemez ÖS, et al. Perioperative risk factor analysis for mortality in patients undergoing total hip arthroplasty: A national database study from Türkiye. Acta Orthop Traumatol Turc., 2026; 60(2), 0052, doi:10.5152/j.aott.2026.24052.*

implemented to ensure the maximum protection of patients' health information privacy and to maintain strict confidentiality standards.

The database of e-health used in this study provided relevant information from a wide range of healthcare institutions, including both public and private facilities, as well as secondary and tertiary healthcare centers and university hospitals, including more than 1000 hospitals in the 81 provinces of Türkiye. To establish the study population, patients who underwent THA were initially identified using Health Services Implementation Regulation codes. From among these identified patients, those with etiologies such as coxarthrosis, other joint disorders, osteonecrosis, and Paget's disease of bone were included in the study, while patients with proximal femur fractures were excluded. The patients' diagnoses were determined using the International Classification of Diseases, Tenth Revision (ICD-10) codes recorded in the database.[13]

Demographic data including age, gender, and body mass index were noted. Comorbidities such as acute myocardial infarction (AMI), heart failure, peripheral vascular disease (PVD), cerebrovascular accident (CVA), dementia, chronic obstructive pulmonary disease (COPD), rheumatic disease, liver disease, diabetes mellitus (DM), renal disease, cancer, leukemia, lymphoma, and human immunodeficiency virus (HIV) were identified and categorized using the ICD-10 codes. The age-adjusted Charlson Comorbidity Index (CCI) was utilized for their classification.[14] The authors investigated the 1-year mortality and identified the patient-related risk factors associated with mortality in patients undergoing primary THA.

Statistics

Data were analyzed using IBM SPSS Statistics 25.0 (IBM Corp., Armonk, NY, USA). Quantitative variables are presented as mean ± standard deviation, while qualitative variables are represented as numbers (n), frequencies, or ratios. The normal distribution of the data was analyzed with skewness and kurtosis tests. Pearson chi-square tests were used to compare categorical variables, and independent sample *t*-tests were used for parametric variables. A Cox regression model was employed to predict the risk of mortality over a 1-year period, providing hazard ratio (HR) estimates accompanied by the 95% CI for enhanced statistical reliability. A HR quantifies the relative risk of an event occurring in 1 group compared to another over time. For example, an HR greater than 1 indicates an increased risk, while an HR less than 1 suggests a decreased risk. A 95% CI provides a range within which the true value of the hazard ratio is likely to fall. Values of $P < .05$ were accepted as reflecting statistical significance.

Results

Demographic data

Of the total 98 622 patients, 61 976 were female (62.8%) and 36 645 were male (37.2%) with a mean age of 59.9 ± 13.6 years (range: 18-112 years) (Table 1). The mean CCI score was 3.48 (range: 0-20).

HIGHLIGHTS

- The 1-year mortality rate following primary total hip arthroplasty (THA) was 2.8%.
- Advanced age and male sex were independent predictors of mortality.
- Cancer, renal disease, and heart failure increased mortality risk after THA.
- Dementia, liver disease, and cerebrovascular disease were significant risk factors.
- Acute myocardial infarction was strongly associated with 1-year mortality.

Table 1. Demographic data and comorbidities of the patients undergoing primary total hip arthroplasty

Variable	Number of patients (%)
Gender	
Male	36 645 (37.2)
Female	61 976 (62.8)
Diagnosis	
Osteoarthritis	73 078 (74.1)
Osteonecrosis	1974 (2.0)
Other	23 570 (23.9)
Comorbidities	
Acute myocardial infarction	3013 (3.1)
Heart failure	6009 (6.1)
Peripheral vascular disease	6536 (6.6)
Cerebrovascular accident	10 014 (10.2)
Dementia	3254 (3.3)
Chronic obstructive pulmonary disease	26 921 (27.3)
Rheumatic disease	16 065 (16.3)
Liver disease	693 (0.7)
Diabetes mellitus	28 506 (28.9)
Renal disease	9281 (9.4)
Complex diabetes	14 434 (14.6)
Cancer	7456 (7.6)
Leukaemia	392 (0.4)
Lymphoma	334 (0.3)
Liver failure	3989 (4.0)
Metastatic solid tumour	1 (0.0)
HIV	38 (0.0)

HIV, human immunodeficiency virus.

Comorbidities affecting postoperative mortality after THA

The 1-year mortality rate after elective primary THA was 2.8% (2720 of 98 622). Table 1 shows the preexisting comorbidities of the patients. The most frequent comorbidities in the entire cohort were DM (28.9%), COPD (27.3%), rheumatic disease (16.3%), CVA (10.2%), renal disease (9.4%), cancer (7.6%), heart failure (6.1%), dementia (3.3%), and AMI (3.1%). Cox regression analysis identified cancer (HR = 2.46; 95% CI = 2.21-2.71), renal disease (HR = 2.29; 95% CI = 2.1-2.5), dementia (HR = 1.83; 95% CI = 1.63-2.05), liver disease (HR = 1.69; 95% CI = 1.25-2.27), heart failure (HR = 1.65; 95% CI = 1.49-1.83), CVA (HR = 1.43; 95% CI = 1.3-1.57), and AMI (HR = 1.25; 95% CI = 1.07-1.45) as patient-related risk factors associated with death in the first postoperative year (Figure 1). Chronic pulmonary disease, PVD, DM, leukemia, lymphoma, liver failure, rheumatic diseases, and HIV were not statistically significant risk factors for 1-year mortality ($P > .05$) (Figure 1).

Discussion

This large cohort study of 98 622 patients undergoing THA revealed a 1-year postoperative mortality rate of 2.8%. Advanced age, male gender, cancer, renal disease, dementia, liver disease, heart failure, AMI, and CVA were found to be predictive risk factors for 1-year mortality.

In the study, it was observed that cancer was one of the major risk factors for mortality after THA. Patients with a history of cancer had a 2.5-fold higher risk of death than patients without cancer after THA (HR = 2.46; 95% CI = 2.21-2.71). This increase in mortality may be related to elevated postoperative complication rates in cancer patients. For example, Karam et al highlighted the increased rates of postoperative ischemic cardiac events (odds ratio (OR) = 2.10; 95% CI = 1.13-3.90) and deep vein thrombosis (DVT) (OR = 1.72; 95% CI = 1.20-2.47) in cancer patients after THA,[15] while Beksaç et al reported that the risk of developing proximal DVT or pulmonary embolism (PE) was 4.2% among patients with a history of cancer compared to 1.65% for patients without cancer.[16] Other important causes of death among cancer patients include infection and organ invasion by neoplastic cells, which causes multiple organ failure as a

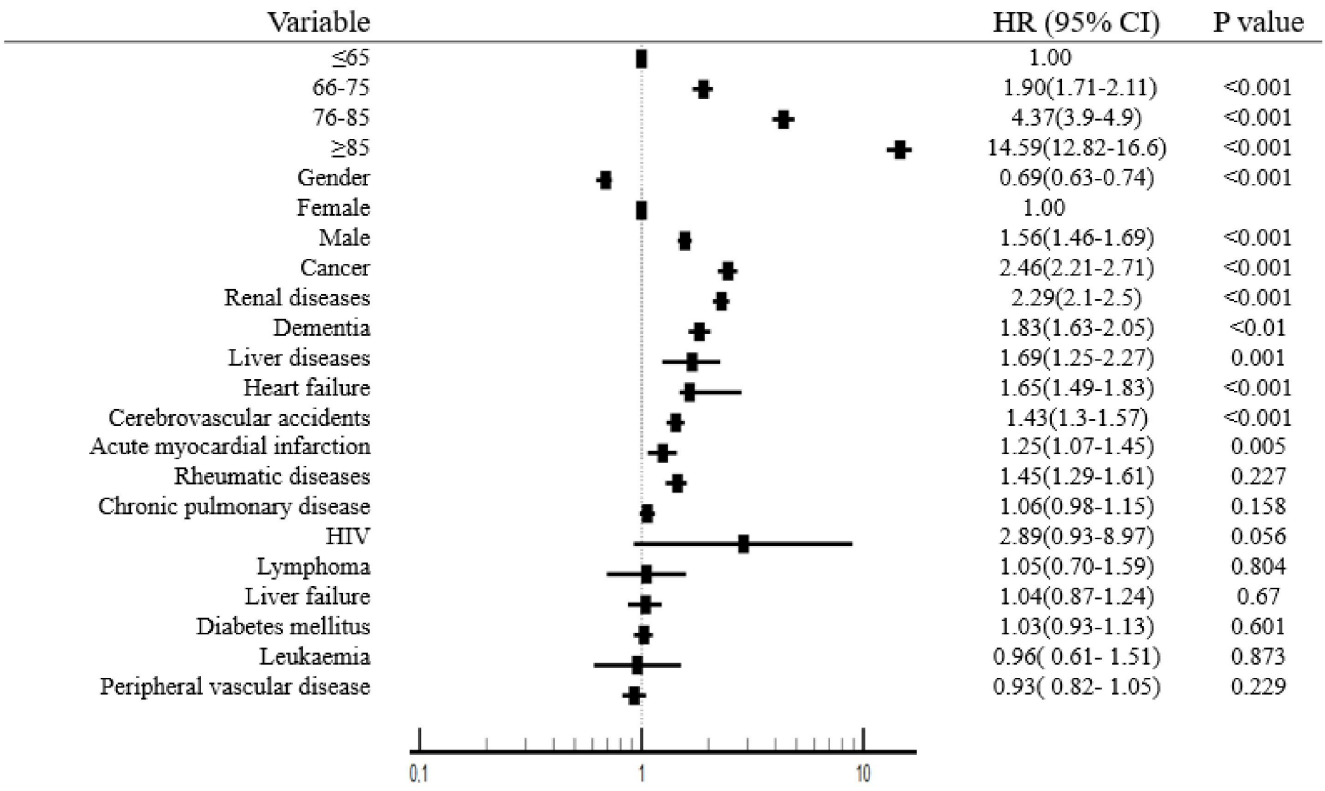


Figure 1. Forest plot showing the patient-related risk factors associated with mortality in patients undergoing primary total hip arthroplasty.

result.[17] Therefore, clinicians should be alert to postoperative complications when performing THA in cancer patients.

Renal disease appears to be another predictor for mortality after THA. In a study conducted by Boniello et al with 66 839 patients who had undergone THA, chronic renal disease (OR=2.5; 95% CI=1.55-4.07; $P < .001$) was an independent risk factor for mortality following THA.[18] Several other studies have reported similar findings, showing that chronic renal disease increases early postoperative mortality rates by approximately twofold.[19-21] In the study, values of HR=2.29 and 95% CI=2.1-2.5 were obtained, consistent with previous studies. From a previous study by Jämsä et al, it is known that the stages of renal disease and combinations of renal disease with other comorbidities are associated with postoperative mortality.[22] They suggested that patients with stage 1 to 3 chronic renal disease would be good candidates for surgery because of long life expectancy. However, in stages 4 and 5 and among patients with both diabetes and stage 3 chronic renal disease, mortality increases significantly. Therefore, surgeons should evaluate these cases carefully before proceeding to surgery.[22] Postoperative complications such as periprosthetic joint infections were also increased, even in patients with stage 1 to 3 renal disease.[23] Therefore, surgeons should also recognize the importance of patient selection.

Dementia was identified as a risk factor associated with 1-year mortality in the study (HR=1.83; 95% CI=1.63-2.05). Similar results were reported by other researchers.[24,25] Nüesch et al showed that dementia increased the mortality rate after total joint replacement by approximately 2 times (HR=1.99; 95% CI=1.22-3.25).[24] In 2016, Michet et al reported that mental diseases such as dementia were risk factors for postoperative mortality after both THA (standardized mortality ratio (SMR)=1.40, 95% CI=1.08-1.80) and total knee arthroplasty (SMR=1.49, 95% CI=1.19-1.85).[25] The reasons for these findings were unclear, but they may have been related to less cooperation with instructions and delirium after THA, which could increase the risk of complications such as dislocations and periprosthetic fractures. Thus, a multimodal approach such as effective perioperative analgesia, rational use of sedative medications, and staff training may reduce the incidence of complications after THA surgery.

According to the study, another important risk factor for mortality is liver disease (HR=1.69; 95% CI=1.25-2.27). In a systematic review by Onochie et al, the mean perioperative mortality rate increased from 0.2% to 4.1% in patients with liver disease ($P < .001$) after THA.[26] Seol et al reported that cirrhotic patients had threefold higher rates of medical complications and twofold higher rates of operative site complications than patients without cirrhosis.[27] It is well known that the risk of major bleeding is high in patients with liver disease, and major bleeding requires more blood transfusions and may increase the risk of infection. All of these factors may increase the risk of mortality after THA. Hence, team-based management is of paramount importance in optimizing the treatment of patients with liver disease during the perioperative period. The risk of venous thromboembolism and bleeding should be carefully balanced. Potent anticoagulants should not be administered to these patients.

Previous studies have shown that cardiovascular diseases including heart failure and myocardial infarction were common causes of death after THA.[28,29] In a retrospective study of 10 123 patients, Rhee et al found that congestive heart failure (OR=3.8; 95% CI=2.1-6.8) and myocardial infarction (OR=2.1; 95% CI=0.9-5.2) increased the mortality rate following THA.[28] Statistically significant effects of heart failure (HR=1.65; 95% CI=1.49-1.83) and AMI (HR=1.25; 95% CI=1.07-1.45) on mortality were found as well. Although the precise mechanisms of increased postoperative mortality associated with cardiovascular diseases are still unknown, most of these patients

were older and had multiple comorbidities. Therefore, their postoperative complication rates were higher compared to patients without cardiovascular diseases.[30]

In this study, CVA was also found to be a risk factor associated with 1-year mortality (HR=1.43; 95% CI=1.3-1.57). Similar results were reported in other studies.[19,28] For example, Bozic et al found that cerebrovascular disease elevated postoperative mortality rate by 1.4 times (HR=1.40).[19] In the population-based study of Memtsoudis et al, including 6 901 324 patients, cerebrovascular disease was the second most important risk factor for perioperative mortality after lower extremity arthroplasty.[29] Ledfor et al evaluated the mortality rate of patients who had prior cerebrovascular events with sequelae and reported the mortality as 2%. They attributed this finding to the increased rate of medical complications and the recurrence of cerebrovascular events.[31] Therefore, preoperative counseling for risk stratification and optimal perioperative anticoagulant therapy to reduce CVA recurrence is crucial.

The mortality rate after THA was found to be increased among elderly patients in many previous studies.[7,20,32-34] Parvizi et al reported that the mortality rate of patients over 70 years of age (0.44%; 51 of 11 542 patients) was more than 2 times higher than that of patients under 70 (0.20%; 39 of 19 172 patients) ($P < .0002$).[34] In a systematic review of 32 studies, Berstock et al highlighted increasing age as one of the common risk factors together with male gender and comorbidities for early mortality after THA.[35] In the study, the mortality rate increased almost twice (HR=1.90) in the age group of 66-75 years, 4 times (HR=4.37) in the age group of 76-85, and 14 times (HR=14.59) in the age group of >85 compared to patients under 65 years of age (Figure 1). These findings may be related to lower resistance to surgical stress and higher prevalence of cardiovascular, respiratory, and neurological comorbidities among elders, which increase mortality. Although this is not a modifiable comorbidity, preoperative optimization in elderly patients can reduce mortality by identifying risks and managing comorbidities.

Previous studies indicated that male gender was a predictor for mortality after THA.[20,32,35] Similarly, in the study, 1.5 times higher risk of mortality was found for male patients than female patients after THA (HR=1.56). In 2005, Viña et al emphasized that women live longer than men.[36] This may be related to differences in sex steroids that impart hormonal protection to women.[37]

There were a number of limitations in this study. The most important limitation is its retrospective nature, as the quality of the data depends on the accuracy and completeness of the clinical record. Thus, there is a risk of information bias, as the research was based on data collected retrospectively from a national database. The influence of confounding variables and selection bias cannot be ruled out in studies involving larger patient populations. Another limitation of this study is missing data which prevents us from evaluating the severity of diseases, such as whether the patients had a history of cancer or active malignant disease, whether the patients had a prior history of stroke or experienced a stroke event after undergoing THA, whether the patient had a history of myocardial infarction or AMI occurred after surgery, and detailed clinical records about patients' American Society of Anesthesiologists (ASA) scores were not accessed, which were also considered one of the main risk factors for mortality in previous studies. Furthermore, the study focused on patient-related risk factors, and the impact of surgeon-related factors such as surgeon experience, clinical preferences, incision techniques, approaches, postoperative protocols, implant properties, and postoperative complications such as periprosthetic joint infection, dislocation, revision surgery, postoperative DVT and PE on mortality could not be captured, since ICD-10 codes were used for obtaining information from the national registry. Moreover, the cause of death could not be identified in the data available.

The limitations inherent in using a national database were acknowledged, and it was agreed that potential coding errors may impact data reliability. While every record could not be independently verified due to the retrospective nature of the study and the scale of the dataset, the use of standardized ICD-10 coding ensured consistency in identifying diagnoses and comorbidities. Although the means to directly cross-reference the database with clinical records were not available, robust inclusion and exclusion criteria were adopted to mitigate the potential impact of misclassification. In addition, large-scale national databases like e-Nabız are regularly audited to ensure a baseline level of accuracy.

The absence of granular data, such as cancer staging or the specifics of myocardial infarction (e.g., timing, acute vs. chronic), was a limitation imposed by the scope of the available dataset. These variables could not be assessed due to the lack of such detailed clinical annotations within the e-Nabız system. Future studies could greatly benefit from incorporating additional clinical parameters to stratify patients more precisely. For instance, cancer patients could be categorized by staging systems (e.g., TNM classification) and whether the malignancy was active, in remission, or metastatic. For myocardial infarction, capturing the time elapsed since the infarction or distinguishing between ST-elevation and non-ST-elevation MI could provide deeper insights into mortality risk. Prospective studies with access to detailed patient records or supplementary data sources would be ideal for such stratification.

Additionally, this study was a multicenter study with a large number of patients. Even though the study outcomes cannot be validated at an individual level, this should not affect the analysis of mortality, as date of death was obtained correctly through record linkage. Hence, sufficiently long-term patient follow-up and independent outcome assessment may reduce retrospective study bias. The Cox regression analysis was used to reduce the effects of confounding variables and the CCI was used in the study to minimize the error and achieve more accurate results. Therefore, the results provide valuable information on patient-related risk factors for mortality after THA.

This large cohort study has demonstrated that advanced age, male gender, cancer, renal disease, dementia, liver disease, heart failure, AMI, and CVA are patient-related risk factors for 1-year mortality after primary THA. The 1-year mortality rate in this cohort was 2.8%. Appropriate perioperative medical optimization, team-based management, meticulous patient care, and selection may reduce mortality rates after THA. Prospective validation efforts, such as random sampling to compare database records with detailed patient files and employing automated tools or machine-learning algorithms for error detection in multicenter datasets, would significantly enhance data reliability in future studies. Among the limitations of the study, the lack of detailed information on the disease severity and the effect of comorbidity management on mortality may shed light on future studies. Future studies could focus on stratifying patients by cancer stage or the timing and severity of myocardial infarction, which could offer deeper insights into the relationship between these comorbidities and postoperative mortality.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Artificial Intelligence Usage Statement: The authors declared that no Artificial Intelligence tool was used in the preparation of the manuscript.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of İstanbul Medipol University (Approval no: E-10840098-202.3.02-5201, Date: 14.08.2025).

Informed Consent: N/A.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – İ.B., Ş.B., İ.T.; Design – M.A., C.Y.; Supervision – N.A., M.M.Ü., İ.A.; Resources – İ.A.; Materials – M.B., Ö.S.H.; Data Collection and/or Processing – M.B., İ.B.; Analysis and/or Interpretation – Ö.S.H., N.A.; Literature Search – M.A.; Writing – M.A.; Critical Review – C.Y., İ.T.

Declaration of Interests: İbrahim Azboy is a member of the Editorial Board of Acta Orthopaedica et Traumatologica Turcica. However, their involvement in the peer review process was as solely as an author. Other authors have no conflict of interest to declare.

Funding: The authors declared that this study has received no financial support.

References

1. Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. *Lancet*. 2007;370(9597):1508-1519. [CrossRef]
2. Sloan M, Premkumar A, Sheth NP. Projected volume of primary total joint arthroplasty in the U.S., 2014 to 2030. *J Bone Joint Surg Am*. 2018;100(17):1455-1460. [CrossRef]
3. Parvizi J, Holiday AD, Ereth MH, et al. The Frank Stinchfield Award. Sudden death during primary hip arthroplasty. *Clin Orthop Relat Res*. 1999;(369):39-48. [CrossRef]
4. Patterson BM, Healey JH, Cornell CN, et al. Cardiac arrest during hip arthroplasty with a cemented long-stem component. A report of seven cases. *J Bone Joint Surg Am*. 1991;73(2):271-277. [CrossRef]
5. Schöning B, Schulitz KP, Pfluger T. Statistical analysis of perioperative and postoperative mortality of patients with prosthetic replacement of the hip joint. *Arch Orthop Trauma Surg (1978)*. 1980;97(1):21-26. [CrossRef]
6. Inacio MCS, Dillon MT, Miric A, et al. Mortality after total knee and total hip arthroplasty in a large integrated health care system. *Perm J*. 2017;21(21):16-171. [CrossRef]
7. Gregory JJ, Starks I, Aulakh T, et al. Five-year survival of nonagenerian patients undergoing total hip replacement in the United Kingdom. *J Bone Joint Surg Br*. 2010;92(9):1227-1230. [CrossRef]
8. Moran CG, Wenn RT, Sikand M, et al. Early mortality after hip fracture: is delay before surgery important? *J Bone Joint Surg Am*. 2005;87(3):483-489. [CrossRef]
9. Migliorini F, Giorgino R, Hildebrand F, et al. Fragility fractures: risk factors and management in the elderly. *Medicina (Kaunas)*. 2021;57(10):1119. [CrossRef]
10. Mirghaderi SP, Sheikhbahaei E, Salimi M, et al. COVID-19 infection rate after urgent versus elective total hip replacement among unvaccinated individuals: a multicenter prospective cohort amid the COVID-19 pandemic. *Ann Med Surg (Lond)*. 2022;80:104307. [CrossRef]
11. Birinci Ş. A digital opportunity for patients to manage their health: Turkey National Personal Health Record System (The e-Nabız). *Balk Med J*. 2023;40(3):215-221. [CrossRef]
12. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191-2194. [CrossRef]
13. World Health Organization. *ICD-10: International Statistical Classification of Diseases and Related Health Problems*. 10th revision. 2nd ed. Geneva: World Health Organization; 2004.
14. Charlson M, Szatrowski TP, Peterson J, et al. Validation of a combined comorbidity index. *J Clin Epidemiol*. 1994;47(11):1245-1251. [CrossRef]
15. Karam JA, Huang RC, Abraham JA, et al. Total joint arthroplasty in cancer patients. *J Arthroplasty*. 2015;30(5):758-761. [CrossRef]
16. Beksaç B, González Della Valle A, Salvati EA. Thromboembolic disease after total hip arthroplasty: who is at risk? *Clin Orthop Relat Res*. 2006;453:211-224. [CrossRef]
17. Ambrus JL, Ambrus CM, Mink IB, et al. Causes of death in cancer patients. *J Med*. 1975;6(1):61-64.
18. Boniello AJ, Simon MS, Emenari CC, et al. Complications and mortality following total hip arthroplasty in the octogenarians: an analysis of a national database. *J Arthroplasty*. 2018;33(7S):S167-S171. [CrossRef]
19. Bozic KJ, Lau E, Kurtz S, et al. Patient-related risk factors for postoperative mortality and periprosthetic joint infection in Medicare patients undergoing TKA. *Clin Orthop Relat Res*. 2012;470(1):130-137. [CrossRef]
20. Hunt LP, Ben-Shlomo Y, Clark EM, et al. 90-day mortality after 409,096 total hip replacements for osteoarthritis, from the National Joint Registry for England and Wales: a retrospective analysis. *Lancet*. 2013;382(9898):1097-1104. [CrossRef]
21. Warth LC, Pugely AJ, Martin CT, et al. Total joint arthroplasty in patients with chronic renal disease: is it worth the risk? *J Arthroplasty*. 2015;30(9)(suppl):51-54. [CrossRef]
22. Jämsä P, Jämsen E, Huhtala H, et al. Moderate to severe renal insufficiency is associated with high mortality after hip and knee replacement. *Clin Orthop Relat Res*. 2018;476(6):1284-1292. [CrossRef]
23. Deegan BF, Richard RD, Bowen TR, et al. Impact of chronic kidney disease stage on lower-extremity arthroplasty. *Orthopedics*. 2014;37(7):e613-e618. [CrossRef]
24. Nüesch E, Dieppe P, Reichenbach S, et al. All cause and disease specific mortality in patients with knee or hip osteoarthritis: population based cohort study. *BMJ*. 2011;342(342):d1165. [CrossRef]
25. Michet CJ 3rd, Schleck CD, Larson DR, et al. Cause-specific mortality trends following total hip and knee arthroplasty. *J Arthroplasty*. 2017;32(4):1292-1297. [CrossRef]
26. Onochie E, Kayani B, Dawson-Bowling S, et al. Total hip arthroplasty in patients with chronic liver disease: a systematic review. *SICOT J*. 2019;5:40. [CrossRef]
27. Seol YJ, Yoon TR, Lee DH, et al. Outcome analysis of hip or knee arthroplasty in patients with cirrhotic liver disease. *J Orthop*. 2017;14(1):171-175. [CrossRef]
28. Rhee C, Lethbridge L, Richardson G, et al. Risk factors for infection, revision, death, blood transfusion and longer hospital stay 3 months and 1 year after primary total hip or knee arthroplasty. *Can J Surg*. 2018;61(3):165-176. [CrossRef]
29. Memtsoudis SG, Della Valle AG, Besculides MC, et al. Risk factors for perioperative mortality after lower extremity arthroplasty: a population-based study of 6,901,324 patient discharges. *J Arthroplasty*. 2010;25(1):19-26. [CrossRef]
30. Lerman BJ, Popat RA, Assimes TL, et al. Association between heart failure and postoperative mortality among patients undergoing ambulatory noncardiac surgery. *JAMA Surg*. 2019;154(10):907-914. [CrossRef]
31. Ledford CK, Wolverton MR, Spencer-Gardner LS, et al. What are the outcomes after primary total hip and knee arthroplasty in patients with prior cerebrovascular accidents? *J Arthroplasty*. 2022;37(12):2347-2352. [CrossRef]
32. Trela-Larsen L, Kroken G, Bartz-Johannessen C, et al. Personalized estimation of one-year mortality risk after elective hip or knee arthroplasty for osteoarthritis. *Bone Joint Res*. 2020;9(11):808-820. [CrossRef]
33. Zhan C, Kaczmarek R, Loyo-Berrios N, et al. Incidence and short-term outcomes of primary and revision hip replacement in the United States. *J Bone Joint Surg Am*. 2007;89(3):526-533. [CrossRef]
34. Parvizi J, Johnson BG, Rowland C, et al. Thirty-day mortality after elective total hip arthroplasty. *J Bone Joint Surg Am*. 2001;83(10):1524-1528. [CrossRef]
35. Berstock JR, Beswick AD, Lenguerrand E, et al. Mortality after total hip replacement surgery: a systematic review. *Bone Joint Res*. 2014;3(6):175-182. [CrossRef]
36. Viña J, Borrás C, Gambini J, et al. Why females live longer than males: control of longevity by sex hormones. *Sci Aging Knowl Environ*. 2005;2005(23):pe17. [CrossRef]
37. Choi BG, McLaughlin MA. Why men's hearts break: cardiovascular effects of sex steroids. *Endocrinol Metab Clin North Am*. 2007;36(2):365-377. [CrossRef]