

Knee Arthroplasties in Türkiye: A Study from a Health Management Perspective

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ABSTRACT

This study aimed to investigate the rate of increase in primary and revision knee arthroplasty procedures performed in Türkiye between 2013 and 2017, as well as the reasons for undergoing revision arthroplasty. The data include primary arthroplasty of knee and revision arthroplasty of knee procedures performed in public hospitals of Türkiye. This research is a retrospective study covering primary and revision knee arthroplasty procedures between 2013-2017. The data were obtained in Microsoft Excel format and made ready for analysis by making the necessary arrangements in Excel. $2 \times 2 \chi^2$ test and independent-sample t-test were used for the comparisons between the two groups. Binary logistic regression analysis was performed to determine the reasons for undergoing a revision procedure. Data analysis was performed using the IBM SPSS Statistics 23 software. A significance level of 0.05 and a confidence interval of 95% were employed in the analyses. A total of 219.607 knee arthroplasty procedures were conducted, comprising 210.519 primary knee arthroplasties and 8939 knee revision arthroplasties, spanning a five-year timeframe. It has been found that revision arthroplasty of the knee is performed nearly 1.5 times more often in males than in females, approximately 1000 times more frequently in patients with mechanical complications of the implant, about 500 times more often in patients with infection complications, roughly 1.3 times more frequently in patients without hypertension, and approximately 4.7 times more often in patients without hip implants. Anticipating the healthcare requirements in the forthcoming years and strategizing the provision of health services stand as crucial concerns within the scope of public health in Türkiye. The execution of projection studies is believed to be advantageous, enhancing the precision of healthcare planning efforts.

Keywords: Knee arthroplasty, revision ratio, causes of revision arthroplasty, Türkiye

ÖZET

Türkiye’de Diz Artroplastileri: Sağlık Yönetimi Açısından Bir Araştırma

Bu çalışmada 2013-2017 yılları arasında Türkiye’de yapılan primer ve revizyon diz artroplastisi işlemi artış oranını ve revizyon artroplastilerinin nedenlerinin araştırılması amaçlanmıştır. Veriler, Türkiye’deki kamu hastanelerinde gerçekleştirilen primer diz artroplastisi ve revizyon diz artroplastisi prosedürlerini içermektedir. Bu araştırma 2013-2017 yılları arasındaki primer ve revizyon diz artroplastisi işlemlerini kapsayan retrospektif bir çalışmadır. Veriler Microsoft Excel formatında elde edilmiş ve Excel üzerinde gerekli düzenlemeler yapılarak analize hazır hâle getirilmiştir. İki grubun karşılaştırılmasında $2 \times 2 \chi^2$ testi ve bağımsız örneklem t testi kullanılmıştır. Hastaların revizyon prosedürüne girme nedenlerini belirlemek için ikili lojistik regresyon analizi yapılmıştır. Verilerin analizi IBM SPSS Statistics 23 programı ile yapılmıştır. Analizlerde anlamlılık düzeyi 0,05 ve güven aralığı %95 olarak kullanılmıştır. Beş yıllık bir süre içinde 210.519 primer diz artroplastisi ve 8939 diz revizyon artroplastisi prosedürü dâhil olmak üzere toplam 219.607 diz artroplastisi prosedürü gerçekleştirilmiştir. Revizyon diz artroplastisi işleminin erkeklerde kadınlara göre yaklaşık 1,5, implantın mekanik komplikasyonu olanlarda yaklaşık 1000, implantın enfeksiyon komplikasyonu olanlarda yaklaşık 500, tansiyon hastalığı olmayanlarda yaklaşık 1,3 ve kalça implantı olmayan hastalarda yaklaşık 4,7 kat fazla yapıldığı bulunmuştur. Önümüzdeki yıllar için sağlık hizmeti ihtiyacının belirlenmesi ve sağlık hizmeti sunumunun planlanması, Türkiye’de halk sağlığı açısından önemli bir konudur. Projeksiyon çalışmalarının yapılmasının, sağlık hizmet planmasının daha doğru yapılabilmesi açısından faydalı olacağı düşünülmektedir.

Anahtar kelimeler: Diz artroplastisi, revizyon oranı, revizyon artroplastisi nedenleri, Türkiye

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INTRODUCTION

Arthroplasty of the knee is one of the most common surgical procedures used in inpatient treatments in developed societies (1). This procedure is one of the most successful operations in orthopedic surgery (2), and patient satisfaction and clinical success are remarkably high in the treatment of end-stage knee joint diseases. However, revision surgeries might be required due to the life span of the prostheses and the failures experienced in the first procedure. The 10-year survival rate of primary arthroplasty of the knee can reach as high as 94-97% (2-4), whereas, in revision procedures, this rate decreases to 85-87% (4,5).

The ratio of revision arthroplasties to the total number of arthroplasties, including primary and revision arthroplasties, is referred to as the "revision burden" (6). This rate is increasing every year (7), and this trend is expected to continue (3). Due to its shorter lifespan and increased rate of complications (2-7), lower clinical success, lower patient satisfaction, and higher cost when compared to primary knee arthroplasty, revision arthroplasty of the knee is regarded as a public health issue (2-4). Additionally, there is a valid concern that these procedures may pose a risk to the financial stability of insurance funds in the coming years, as they are typically funded through health insurance mechanisms. Therefore, the identification of revision causes and their resolution can help mitigate issues stemming from revisions.

This study aimed to examine the rate of increase in the number of procedures for primary and revision knee arthroplasty, which was performed in Türkiye between 2013-2017, and to investigate the reasons behind these revision arthroplasties.

MATERIALS AND METHOD

Research Data

Research data has been obtained following the approval of the official authorities (Republic of Türkiye Ministry of Health Directorate General of Health Services and Directorate of Social Security Institutions permission letter, dated November 15, 2018, Decision No. 23642684-042). The data includes procedures for primary arthroplasty of the knee and revision arthroplasty of the knee conducted in public hospitals in Türkiye. This study retrospectively examines primary knee arthroplasty and revision knee arthroplasty procedures performed between 2013 and 2017.

Patients aged 18 and above, who underwent primary and revision arthroplasty of the knee and whose data were fully accessible and whose invoices were processed by the social security Institution were included in the study. The

exclusion criteria were defined as having malignancy, undergoing revision due to trauma, being under 18 years of age, and having unavailable data.

Patients who underwent primary knee arthroplasty and revision knee arthroplasty were assessed based on their age, gender, and year of the procedure. These individuals were analyzed for factors such as receiving intensive care treatment, experiencing mechanical complications (such as dislocation, non-infectious implant loosening, malposition, insert wear, implant breakage), undergoing revision due to infection, presence of hip arthrosis, polyarthrosis, diabetes, blood pressure, heart disease, osteoporosis, and the occurrence of hip arthroplasty. The study participants were categorized into two groups: those under 50 years old and those aged 50 and above.

Statistical Analysis

The data were obtained in Microsoft Excel format and made ready for analysis by making the necessary arrangements in Excel. 2x2 χ^2 test and independent-sample t-test were used for the comparisons between the two groups. Revision rates of the patients were compared in terms of demographic and medical variables. Independent variables were identified based on statistically significant differences determined through the 2x2 χ^2 test analysis. These variables included gender, age, mechanical complications, revision due to infection, diagnosis of blood pressure, osteoporosis diagnosis, and the presence of hip arthroplasty. Subsequently, a binary logistic regression analysis was conducted to ascertain the factors contributing to the requirement for a revision procedure. The statistical analysis of the data was performed using IBM SPSS Statistics software, version 23. The results were considered statistically significant at $p < 0.05$ with a confidence interval of 95%.

RESULTS

A total of 219.607 arthroplasty of the knee procedures, including 210.519 primary arthroplasty of the knee and 8939 revision arthroplasty of the knee procedures, were performed over a five-year period. Around 98.6% of arthroplasty patients were aged 50 years and older. The rate of revision arthroplasty of the knee was approximately 11% in patients under 50 years old, whereas it was approximately 4% in patients aged 50 years and older. The number of female patients who underwent knee arthroplasty was approximately five times higher than that of male patients. While the revision rate was approximately 6% in male patients, it was determined as approximately 4% in female patients. Nearly 10% of patients received intensive care treatment, and nearly 10% of the patients who underwent

primary arthroplasty of the knee and approximately 13% of the patients who underwent revision arthroplasty of the knee received intensive care treatment (Table 1).

As expected, mechanical complications, which are considered to have a significant impact among the causes of revision arthroplasty, and revision due to infection, were found to be more common in patients who underwent revision arthroplasty. The occurrence of hip arthrosis was approximately 0.032% in patients who underwent revision arthroplasty, while this rate was observed to be 0.025% in patients who underwent primary arthroplasty. Among the entire group of arthroplasty patients, only 92 individuals were diagnosed with polyarthrosis (Table 1).

Upon evaluating the infection rate among patients following arthroplasty, it was identified in 0.74% of the

overall patient population. Among those who underwent revision procedures, the post-procedure infection rate was approximately 16.29%, whereas this rate was 0.08% for primary procedures (Table 1).

Fourteen percent of the patients had diabetes, 18% had hypertension, 1.7% had heart disease, and 0.2% had osteoporosis. The prevalence rate of diabetes was approximately 14% for both primary and revision arthroplasty patient groups. While the rate of blood pressure diagnosis in primary arthroplasty patients was around 18%, this rate was 16% in patients who underwent revision arthroplasty. The incidence of heart disease was approximately 1.73% in primary arthroplasty patients and 1.78% in revision arthroplasty patients. A total of 178 patients also underwent hip arthroplasty (Table 1).

Table 1. Distribution of patients' demographic and medical data by primary and revision knee arthroplasty procedures

		Primary knee arthroplasty		Revision knee arthroplasty		Total	
		n	%	n	%	n	%
Gender	Male	33.785	15.4	1981	0.9	35.766	16.3
	Female	176.883	80.5	6958	3.2	183.841	83.7
Age	<50	2772	1.3	336	0.2	3108	1.4
	≥50	207.896	94.7	8603	3.9	216.499	98.6
Intensive care treatment	No	189.604	86.3	7811	3.6	197.415	89.9
	Yes	21.064	9.6	1128	0.5	22.192	10.1
Mechanical complications	No	210.378	95.8	4170	1.9	214.548	97.7
	Yes	290	0.1	4769	2.2	5059	2.3
Revision due to infection	No	210.494	95.9	7483	3.4	217.977	99.3
	Yes	174	0.1	1456	0.7	1630	0.7
Hip arthrosis	No	210.126	95.7	8910	4.1	219.036	99.7
	Yes	542	0.2	29	0.0	571	0.3
Polyarthrosis	No	210.580	95.9	8935	4.1	219.515	100.0
	Yes	88	0.0	4	0.0	92	0.0
Diabetes	No	180.943	82.4	7671	3.5	188.614	85.9
	Yes	29.725	13.5	1268	0.6	30.993	14.1
Hypertensive diseases	No	172.459	78.5	7525	3.4	179.984	82.0
	Yes	38.209	17.4	1414	0.6	39.623	18.0
Heart diseases	No	207.013	94.3	8780	4.0	215.793	98.3
	Yes	3655	1.7	159	0.1	3814	1.7
Osteoporosis	No	210.291	95.8	8913	4.1	219.204	99.8
	Yes	377	0.2	26	0.0	403	0.2
Presence of hip arthroplasty	No	210.519	95.9	8910	4.1	219.429	99.9
	Yes	149	0.1	29	0.0	178	0.1
Total		210.668	95.9	8939	4.1	219.607	100.0

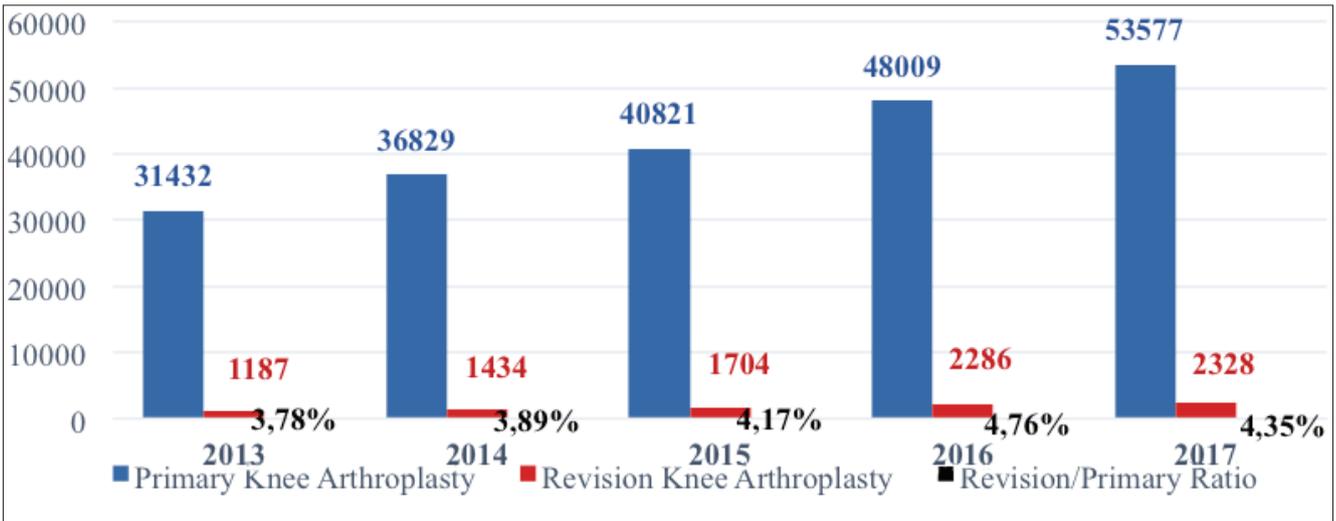


Figure 1. Distribution of primary and revision knee arthroplasty procedures by years.

It is evident that both primary arthroplasty procedures and revision arthroplasty procedures exhibit an upward trend over the years (Figure 1).

Based on the χ^2 test results of the variables that may be the reasons for revision knee arthroplasty, the difference between the revision rates between the patient groups was found to be significant in terms of sex, age, mechanical complication of the implant, infection complication of the implant, tension, osteoporosis, presence of hip implant and post-procedure infection (Table 2).

According to the outcomes of the binary logistic regression as displayed in Table 3, revision arthroplasty of the knee was performed nearly 1.5 times more frequently in males than females, approximately 1000 times more frequently in patients with mechanical complications of the implant, approximately 500 times more frequently in patients with infection complications, approximately 1.3 times more frequently in patients hypertension, and approximately 4.7 times more frequently in patients without hip implants (Table 3).

DISCUSSION

Total knee arthroplasty is one of the most successful orthopedics surgeries, significantly reducing mortality (2). Studies show that total knee arthroplasties (8) and their revision rates (3,5,9) are increasing day by day and will continue to increase in the future. Bhandari et al. reported that the increase in the number of revision knee total knee arthroplasty is due to the increase in the number of primary procedures, prolongation of life expectancy, increase in obesity rate, and decrease in the average age of patients who underwent primary procedures (3). Hamilton et al. also found

that performing the primary procedures at a young age and performing the revision before the age of 75 increases the probability of revision (2). This study revealed that knee arthroplasty is conducted approximately five times more frequently in women compared to men. Moreover, one of the significant findings of this research was that the predominant reasons for the revision total knee arthroplasty in public hospitals across Türkiye over five years were mechanical complications of implants and implant-related infections. In our study, the average revision rate was found to be approximately 4%. In another study conducted in Türkiye, the revision rate was reported as approximately 3.4% (10).

One of the most significant outcomes of our study, as well as of previous studies, is the notable increase in the count of primary and revision total knee arthroplasty procedures. Kurtz et al., in their study, predicted that by 2030, the number of primary knee arthroplasty procedures will increase by 174% and the number of revision knee arthroplasty will increase by 137-601% (9). In a study conducted in Germany, it was predicted that from 2020 to 2050, the number of total knee arthroplasty primers will increase by 43% and the number of revisions by 90% (11). It has also been reported that with the increase in the elderly population, the rate of knee or hip prosthesis presence in the Swedish population increased from 2.5% in 2010 to 3.2% in 2021, and in 89 years old the population knee prosthesis rate reaching 2021 increased to 9.4%. Moreover, knee prostheses were found to be more common in the female population (12). In a study conducted in England, it is predicted that the number of total knee arthroplasty will increase by 117% from 2012 to 2030 (13). In our study, it was found that the number of primary total knee arthroplasty increased by 70.1% and the

		Primary knee arthroplasty (n)	Revision knee arthroplasty (n)	Total (n)	p
Gender	Male	33.785	1981	35.766	<0.001*
	Female	176.883	6958	183.841	
Age	<50	2772	336	3108	<0.001*
	≥50	207.896	8603	216.499	
Mechanical complications	No	210.378	4170	214.548	<0.001*
	Yes	290	4769	5059	
Revision due to infection	No	210.494	7483	217.977	<0.001*
	Yes	174	1456	1630	
Hip arthrosis	No	210.126	8910	219.036	0.222
	Yes	542	29	571	
Polyarthrosis	No	210.580	8935	219.515	0.893
	Yes	88	4	92	
Diabetes	No	180.943	7671	188.614	0.842
	Yes	29.725	1268	30.993	
Hypertensive diseases	No	172.459	7525	179.984	<0.001*
	Yes	38.209	1414	39.623	
Heart diseases	No	207.013	8780	215.793	0.756
	Yes	3655	159	3814	
Osteoporosis	No	210.291	8913	219.204	0.015*
	Yes	377	26	403	
Presence of hip arthroplasty	No	210.519	8910	219.429	<0.001*
	Yes	149	29	178	
Total		210.668	8939	219.607	

*p< 0.05.

	Wald	P	Exp (B)	95% CI for Exp (B)	
				Lower	Upper
Constant	879.433	<0.001*	33.880.225		
Gender (1)	89.645	<0.001*	1.506	1.384	1.639
Mechanical complications (1)	12.537.086	<0.001*	0.001	0.001	0.001
Revision due to infection (1)	5.954.993	<0.001*	0.002	0.001	0.002
Hypertensive diseases (1)	30.182	<0.001*	1.315	1.192	1.450
Presence of hip arthroplasty (1)	21.320	<0.001*	0.214	0.111	0.412

Dependent variables: Revision knee arthroplasty
 Model Chi-square value= 41969.356; p< 0.05.
 Cox-Snell R2= 0.174; Nagelkerke R2= 0.603.
 *p< 0.05

number of revisions by 96.1% from 2013 to 2017 in Türkiye. The rise in the quantity of both primary and revision total knee arthroplasties in Türkiye highlights the necessity for conducting projection studies. These studies are essential

for strategic health service provisioning and precise resource planning in the forthcoming years. This matter is widely acknowledged as one of the paramount concerns within health policies.

Table 4. Logistic regression model classification table

	Predicted		
	Primary knee arthroplasty	Revision knee arthroplasty	Percentage correct
Primary knee arthroplasty	210.209	459	99.8
Revision knee arthroplasty	2770	6169	69.0
Overall percentage			98.5

The cut value is 0.500.

In this study, the revision rate among the total number of knee arthroplasties was found to be lower in women (approximately 3.9%) than in men (5.9%). The rate of revision total knee arthroplasty in patients over 50 years of age (approximately 12%) was found to be approximately three times higher than in patients aged 50 years and younger (approximately 4.1%). In addition, the revision rate was found to be higher in patients with osteoporosis, hypertension, mechanical complications of prostheses, hip prostheses, and infection compared to the opposite groups. In their study, Dy et al. reported that the revision rate was higher in patients younger than 50 years of age compared to older patients (14). However, an alternate study did not establish a significant variance in revision rates across age groups (15). While diabetes is recognized to amplify complications (16), this current study did not reveal a noteworthy correlation between the presence of diabetes and the need for revision knee arthroplasty. Revision rates are of great importance for health service delivery cost, quality, and future health service planning. Koh et al. found the revision rate to be 6.1% in their study covering 15 years of follow-up. Within the same study, the researchers identified periprosthetic joint infection and aseptic loosening as the primary reasons for revisions (17). Similarly, another study noted that infection and loosening stood out as the predominant causes for revising total knee arthroplasties (18). In our study, aseptic loosening and periprosthetic joint infection emerged as the foremost factors driving the need for revisions.

This study has some limitations. Firstly, it has a retrospective design. Secondly, costs could not be evaluated in the study.

CONCLUSION

In this study, changes in the rates of primary and revision total knee arthroplasty procedures performed in Türkiye between 2013 and 2017 were examined based on the demographic and medical characteristics of the patients over the years. Additionally, the reasons for revision knee arthroplasty were investigated. The research results are expected to provide insights into healthcare delivery costs,

revision rates, healthcare quality, and healthcare planning pertaining to primary and revision knee arthroplasty in the coming years.

As in other countries, the number of primary and revision total knee arthroplasty is increasing rapidly in Türkiye. Inadequate healthcare quality and patient characteristics can cause an increase in revision rates.

Identifying healthcare service requirements for the upcoming years and strategizing healthcare service delivery is an important issue for public health in Türkiye. Projection studies may offer benefits by enhancing the accuracy of healthcare service planning.

Ethics Committee Approval: This is a retrospective study and an ethics committee decision was not required.

Informed Consent: Patient consent was obtained.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept- HA; Design- HA; Supervision- HA; Data Collection and/or Processing- HA; Analysis and/or Interpretation- HA; Literature Search - HA; Writing- HA; Critical Review- HA.

Conflict of Interest: Author declare that they have no conflicts of interest or funding to disclose.

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REFERENCES

1. Healthcare Cost and Utilization Project (HCUP). Retrieved December 1, 2020. Available from: <https://www.hcupus.ahrq.gov/faststats/NationalProceduresServlet?year1=2015&characteristic1=0&included1=0&year2=&characteristic2=0&included2=1&expansionInfoState=hide&dataTablesState=hide&definitionsState=hide&exportState=hide>
2. Hamilton DF, Howie CR, Burnett R, Simpson AH, Patton JT. Dealing with the predicted increase in demand for revision total knee arthroplasty: Challenges, risks and opportunities. *Bone Joint J* 2015;97(6):723-8. <https://doi.org/10.1302/0301-620X.97B6.35185>
3. Bhandari M, Smith J, Miller LE, Block JE. Clinical and economic burden of revision knee arthroplasty. *Clin Med Insights Arthritis Musculoskelet Disord* 2012;5:89-94. <https://doi.org/10.4137/CMAMD.S10859>

4. Ong KL, Mowat FS, Chan N, Lau E, Halpern MT, Kurtz SM. Economic burden of revision hip and knee arthroplasty in medicare enrollees. *Clin Orthop Relat Res* 2006;446:22-8. <https://doi.org/10.1097/01.blo.0000214439.95268.59>
5. Hardeman F, Londers J, Favril A, Witvrouw E, Bellemans J, Victor J. Predisposing factors which are relevant for the clinical outcome after revision total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2012;20(6):1049-56. <https://doi.org/10.1007/s00167-011-1624-8>
6. Kurtz S, Mowat F, Ong K, Chan N, Lau E, Halpern M. (2005). Prevalence of primary and revision total hip and knee arthroplasty in the United States from 1990 through 2002. *J Bone Joint Surg* 2005;87:1487-97. <https://doi.org/10.2106/00004623-200507000-00010>
7. Rosso F, Cottino U, Dettoni F, Bruzzone M, Bonasia DE, Rossi R. Revision total knee arthroplasty (TKA): Mid-term outcomes and bone loss/quality evaluation and treatment. *J Orthop Surg Res* 2019;14(1):1-9. <https://doi.org/10.1186/s13018-019-1328-1>
8. Sloan M, Premkumar A, Sheth NP. Projected volume of primary total joint arthroplasty in the u.s., 2014 to 2030. *J Bone Joint Surg* 2018;100(17):1455-60. <https://doi.org/10.2106/JBJS.17.01617>
9. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg* 2007;89(4):780-5. <https://doi.org/10.2106/00004623-200704000-00012>
10. Ceyhan E, GURSOY S, Akkaya M, Ugurlu M, Koksall I, Bozkurt M. Toward the Turkish national registry system: A prevalence study of total knee arthroplasty in Turkey. *J Arthroplasty* 2016;31(9):1878-84. <https://doi.org/10.1016/j.arth.2016.02.033>
11. Klug A, Gramlich Y, Rudert M, Drees P, Hoffmann R, Weißenberger M, et al. The projected volume of primary and revision total knee arthroplasty will place an immense burden on future health care systems over the next 30 years. *Knee Surg Sports Traumatol Arthrosc* 2021;29:3287-98. <https://doi.org/10.1007/s00167-020-06154-7>
12. Rolfson O, Nåtman J, Rogmark C, Sundberg M, Mohaddes M, Kärrholm J, W-Dahl A. The prevalence of joint replacement in Sweden. *Orthop Proc* 2023;105(12):87. <https://doi.org/10.1302/1358-992X.2023.12.087>
13. Patel A, Pavlou G, Mújica-Mota RE, Toms AD. The epidemiology of revision total knee and hip arthroplasty in England and Wales: A comparative analysis with projections for the United States. A study using the national joint registry dataset. *Bone Joint J* 2015;97(8):1076-81. <https://doi.org/10.1302/0301-620X.97B8.35170>
14. Dy CJ, Marx RG, Bozic KJ, Pan TJ, Padgett DE, Lyman S. Risk factors for revision within 10 years of total knee arthroplasty. *Clin Orthop Relat Res* 2014;472(4):1198-207. <https://doi.org/10.1007/s11999-013-3416-6>
15. Lizaur-Utrilla A, Martinez-Mendez D, Miralles-Muñoz FA, Marco-Gómez L, Lopez-Prats FA. Comparable outcomes after total knee arthroplasty in patients under 55 years than in older patients: A matched prospective study with minimum follow-up of 10 years. *Knee Surg Sports Traumatol Arthrosc* 2017;25(11):3396-402. <https://doi.org/10.1007/s00167-016-4406-5>
16. Gu A, Wei C, Robinson HN, Sobrio SA, Liu J, Sculco TP, Sculco PK. Postoperative complications and impact of diabetes mellitus severity on revision total knee arthroplasty. *J Knee Surg Sports Traumatol Arthrosc* 2020;33(3):228-34. <https://doi.org/10.1055/s-0038-1677542>
17. Koh CK, Zeng I, Ravi S, Zhu M, Vince KG, Young SW. Periprosthetic joint infection is the main cause of failure for modern knee arthroplasty: An analysis of 11,134 knees. *Clin Orthop Relat Res* 2017;475(9):2194-201. <https://doi.org/10.1007/s11999-017-5396-4>
18. Lewis PL, Robertsson O, Graves SE, Paxton EW, Prentice HA, W-Dahl A. Variation and trends in reasons for knee replacement revision: A multi-registry study of revision burden. *Acta Orthop* 2021;92(2):182-8. <https://doi.org/10.1080/17453674.2020.1853340>