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Use of total knee arthroplasty by type of public insurance scheme: a cross-sectional study based on claims data in Thailand

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ABSTRACT

Objectives Life expectancy is increasing in many middle-income countries (MIC). Total knee arthroplasty (TKA) can promote independent living among older people with osteoarthritis. In Thailand, healthcare costs for employed and retired civil servants and their parents are covered by the Civil Servant Medical Benefit Scheme (CSMBS), and the Universal Coverage Scheme (UCS) protects older people not covered by other public schemes. We investigated the extent to which use of TKA varied by insurance scheme.

Design A retrospective cross-sectional study.

Setting We used national-level inpatient claims data from CSMBS and UCS between 1 Jan 2018 and 31 Dec 2020.

Participants We included patients aged >50 with primary osteoarthritis who underwent TKA.

Primary and secondary outcome measures A Poisson regression model was used to estimate procedure rates per 100 000 insured people per year by an insurance scheme. In patients who underwent TKA, we used a generalised linear model to estimate absolute differences (AD) by the insurance scheme in the use of mobile-bearing implants and simultaneous BTKA. We report estimated average TKA rates, adjusted for age, sex, calendar year and health region, if all patients would have been insured either by CSMBS or UCS.

Results Of the 39 198 patients undergoing TKA, 13 814 were insured by CSMBS (35.2%) and 25 384 by UCS (64.8%). The adjusted estimated TKA rate per 100 000 insured people per year for CSMBS was 149.3 (95% CI 146.8–151.8) and for UCS 59.3 (58.5–60.0), resulting in a rate ratio of 2.52 (2.47–2.57, p<0.0001). Among patients undergoing TKA, 8.7% of CSMBS-insured patients and 8.6% of UCS-insured patients received mobile-bearing implants while 6.0% and 3.6%, respectively, received simultaneous BTKA (adjusted ADs for mobile-bearing implants 0.7% (-2.4, 3.9), p=0.6445 and for simultaneous BTKA 2.7% (-0.3, 5.8), p=0.0811).

Conclusions The substantial difference between TKA rates of the two insurance schemes clearly demands policy attention. Further investigations should clarify whether the different rates reflect appropriate use. We recommend other countries experiencing rapid population ageing to explore how well healthcare systems are responding to the changing needs of their older populations.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The use of national-level claims data ensures representativeness of the two schemes' membership and statistical power of the analysis.
⇒ Public insurance claims data may have missed self-paying or privately insured patients, although these are likely few due to the intervention's high cost.
⇒ Claims data lacked key details, especially patient preferences, clinical severity, prior treatments and physicians or hospital characteristics which likely influenced TKA decisions and surgical techniques.

INTRODUCTION

Middle-income countries (MIC), especially in Asia and Latin America, are starting to experience rapid population ageing.[1] Older persons often face functional impairment and long-term illnesses and are less able to engage in income-generating activities.[1] In many countries, increasing total knee arthroplasty (TKA) use reflects the growing numbers of older people.[2] TKA is a safe and effective treatment to eliminate pain and restore knee functions for advanced knee arthritis, a common problem affecting the quality of life of elderly people. The procedure is costly and should ideally be performed after non-operative treatment (such as physical therapy, medications) fails.[3 4] Previous literature reported that around one-third of patients requiring TKA need it for both knees.[5] The use of simultaneous bilateral TKA (BTKA) under a single anaesthesia, as opposed to a two-staged BTKA, has been suggested as a more cost-effective option among those requiring BTKA.[2 4] However, concerns over safety persist and treatment strategy depends largely on patient and surgeon preferences.[4 5]

Thailand is a middle-income country, with 20% of its population aged 60 and above in 2023.[6] Its growth of the age-standardised

incidence rate of diagnosed osteoarthritis —from 383.46 to 459.26 per 100 000 between 1990 and 2019[7]—was the second highest among 204 countries and territories, exceeded only by Spain.[8] Over 6 million people in Thailand suffered from osteoarthritis in 2018 and most were elderly.[9] All Thai citizens are insured automatically through different public health insurance schemes. Two schemes that cover older people are the Civil Servant Medical Benefit Scheme (CSMBS), which insures employed and retired civil servants and their parents and the Universal Coverage Scheme (UCS), which insures anyone not entitled to other public schemes. Other schemes mainly insure formal sector employees — those with registered employment and social security contributions — and therefore include only a small proportion of older members.[10] TKA for knee arthritis is reimbursable by diagnosis-related group (DRG) for both schemes but UCS has more restrictions and requirements.[11] Notably, until 2022, UCS limited the number of procedures per year, and it requires preauthorisation for patients aged 55 years or younger with primary or unspecified arthritis.[12] Both schemes pay additionally for knee implants. CSMBS sets a maximum price of fixed-bearing implants at 50 000 Baht (1540 USD), and mobile-bearing implants at 75 000 Baht (2310 USD) and restricts the latter for patients aged less than 60 years.[13] UCS sets the same maximum price for both types, ranging between 48 000 and 50,000 Baht (1479–1540 USD), but does not specify any age restrictions.[14 15] Mobile-bearing design is intended to prolong use and enhance the range of motion, especially for younger patients; however, evidence on its clinical benefits over fixed-bearing design is inconclusive.[16 17]

In this study, we explore whether TKA rates were similar between UCS and CSMBS. Additionally, we explore differences between schemes in the use of mobile-bearing implants and simultaneous BTKA.

METHODS

Data sources

Two national-level data sources were used. The national-level insurance claims for inpatient care for both CSMBS and UCS contained encrypted patient identification number, encrypted admission number, insurance scheme, sex, age, hospital code, admission date, discharge date, diagnosis codes (as International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)),[18] procedure codes (as International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM))[19] and implant codes. Population statistics were derived from the national database of all public insurance scheme enrolment administered by the National Health Security Office. It contained the number of population disaggregated by sex, age, region, year and health insurance schemes. During the study period, CSMBS or UCS covered approximately 86% of individuals aged over 50 years.[20]

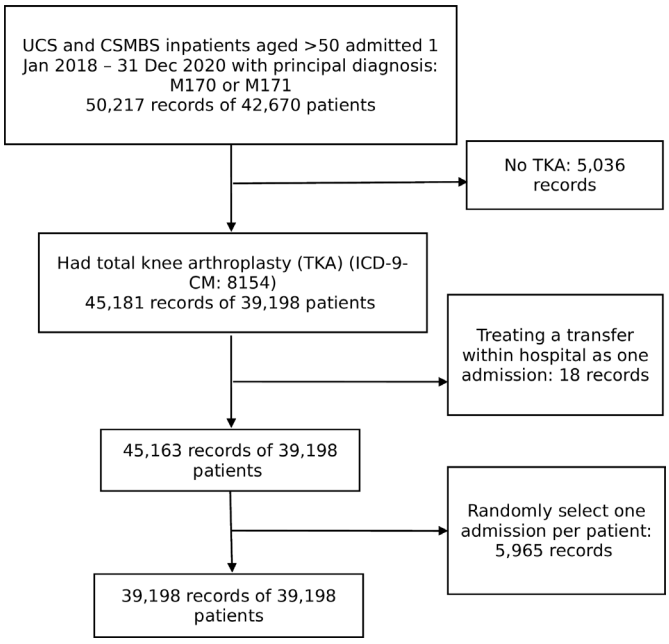

Figure 1 Patient selection flow. CSMBS, Civil Servant Medical Benefit Scheme; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; TKA,Total knee arthroplasty; UCS,Universal Coverage Scheme.

Patient cohort

We included patients aged over 50 years insured through CSMBS and UCS who were hospitalised between 1 January 2018 and 31 December 2020 with principal diagnosis of primary osteoarthritis (ICD-10: M170, M171) and who underwent TKA (ICD-9-CM: 8154). Revision TKA cases (ICD-9-CM: 8155, 0080, 0081, 0082, 0083 or 0084) were excluded. We combined information from multiple consecutive records due to transfer within the same hospital and treated them as one admission. Finally, we randomly selected one admission per patient to avoid having to analyse correlated observations. There were no missing data on sex, age, hospital code, admission date or discharge date. See figure 1.

Main exposure and outcome

The main exposure was insurance scheme. We measured three outcomes. The primary outcome was TKA rate in 100 000 population per year. Two secondary outcomes were use of mobile-bearing implant and simultaneous BTKA among those undergoing TKA. We captured outcomes using ICD-9-CM with extension code indicating the number of sites operated on in one surgery and implant codes. TKA was identified by the first four digits of procedure codes “8154”. BTKA was identified by the first six digits of procedure codes “8154+2”. Mobile-bearing implant was identified by implant code “7004”.

Statistical analysis

Two analytical methods were used. The first method was to estimate the procedure rate ratio of TKA in 100 000 insured people using Poisson regression models. We

compared rates between insurance schemes and adjusted for sex, age (51–60 years, 61–65 years, 66–70 years, 71–75 years, and 76 years and older), year and health region. Then, we estimated average TKA rates, adjusted for age, sex, calendar year and health region, and number of patients who would have been insured either by CSMBS or UCS were calculated.[21] The second method was to estimate absolute differences (AD) to compare utilisation of mobile-bearing implants and simultaneous BTKA among patients undergoing TKA between insurance schemes. We used a generalised linear model (GLM) with a Gaussian distribution and identity link function. We also accounted for intrahospital clustering by using a robust sandwich estimator of variance. Models were adjusted for sex, age, year of admission and health region. We also analysed whether the association between insurance scheme and utilisation was modified by hospital type by including an interaction term. We categorised hospitals into three types: Ministry of Public Health (MOPH)-owned hospital, other public hospitals (eg, university hospital and military hospital) and private hospital.

Patient and public involvement

Patients and/or the public were not involved in this retrospective study.

RESULTS

Patient characteristics

Of the included 39 198 patients, 13 814 (35.2%) were insured by CSMBS and 25 384 (64.8%) by UCS. See table 1. Most were female (84.0%). The overall mean age was 67.2 years (UCS 66.0, CSMBS 69.4). The distribution across six age groups showed that patients insured through UCS were typically younger than those insured by CSMBS. Numbers of patients undergoing TKA were similar across three calendar years. Most UCS-insured patients were treated at MOPH hospitals (82.7%), followed by other public hospitals (14.2%) and private hospitals (3.1%). In contrast, more CSMBS-insured patients were treated at other public hospitals (59.0%), followed by MOPH hospitals (37.7%) and private hospitals (3.3%). The distribution over 13 health regions was similar in both schemes except for Region 13 (Bangkok), where only 15.1% UCS-insured patients but 33.9% CSMBS-insured patients were treated.

TKA procedure rate by insurance scheme

The overall TKA rate was 72.2 per 100 000 insured people per year. The unadjusted rates were different by insurance scheme, 55.7 for those insured by UCS and 158.3 for those insured by CSMBS. Figure 2 compares unadjusted rates between UCS and CSMBS by sex, age group and year. CSMBS had higher TKA rates in all subgroups with the overall rate ratio being 2.84 (158.3/55.7). However, the CSMBS/UCS rate ratios were smaller in younger age groups [51–60 years: 1.86 (50.6/27.2) and 61–65 years: 1.97 (163.6/82.9)] and were very large in those aged 76 and over [6.00 (203.1/33.8)]. We did not compare TKA rates across 13 health regions because CSMBS-insured patients were not restricted to obtaining care within their region of residence.

With adjustment for age, sex, year and health region, the estimated average TKA rate per 100 000 people per year assuming that all patients were insured by UCS was 59.3 (95% CI 58.5 to 60.0) and the corresponding figure for CSMBS was 149.3 (95% CI 146.8 to 151.8), with an adjusted rate ratio of 2.52 (95% CI 2.47 to 2.57; p<0.0001). See table 2.

Association between insurance scheme and the use of mobile-bearing implant

Among 39 198 patients undergoing TKA, 8.6% received mobile-bearing implants (table 3). The use of mobile-bearing implants was similar for both schemes, 2188 of the 25 384 UCS-insured patients (8.6%) and 1201 of the 13 814 CSMBS-insured patients (8.7%). With adjustment for age, sex, year and health region, the difference in the use of mobile-bearing implants between patients insured by UCS and CSMBS was not statistically significant [AD 0.7% (95% CI −2.4, 3.9), p=0.6445]. There was no evidence that the association between insurance scheme and the use of mobile-bearing implants was modified by hospital type (p-value for interaction=0.5572) (online supplemental file).

Association between insurance scheme and the use of simultaneous BTKA

Only 4.4% of patients undergoing TKA had a simultaneous BTKA (table 3). Only 908 of the 25 384 UCS-insured patients (3.6%) had a simultaneous BTKA, compared with 831 of the 13 814 CSMBS-insured patients (6.0%). The difference in the use of simultaneous BTKA between patient insured by UCS and CSMBS was not statistically significant with adjustment for age, sex, year and health region [AD 2.7% (95% CI −0.3 to 5.8), p=0.0811]. The adjusted model including an interaction term did not show that the association between insurance scheme and the use of simultaneous BTKA was modified by hospital type (p=0.7112) (online supplemental file).

DISCUSSION

Our results showed that the estimated TKA rate of the CSMBS population was 2.5 times higher than that of the UCS population with adjustment for age, sex, year and health region. Among patients undergoing TKA, there was no difference between the two schemes in the use of mobile-bearing implants or in carrying out simultaneous BTKA. There was also no evidence that hospital type modified any of these associations.

This study has several strengths. To the best of our knowledge, this is the first study to investigate TKA use by insurance schemes in low- and middle-income countries. We selected TKA in primary osteoarthritis to represent access to a non-emergency service, typically used by older

Table 1 Characteristics of 39 198 patients

Characteristics	Total		UCS		CSMBS	
	N	%	N	%	N	%
All patients	39 198	100.0	25 384	64.8	13 814	35.2
Sex						
Male	6284	16.0	3764	14.8	2520	18.2
Female	32 914	84.0	21 620	85.2	11 294	81.8
Age						
mean age (SD)	67.2 (7.1)		66.0 (6.6)		69.4 (7.6)	
51–60 years	7273	18.6	5507	21.7	1766	12.8
61–65 years	9481	24.2	6812	26.8	2669	19.3
66–70 years	10 149	25.9	6854	27.0	3295	23.9
71–75 years	6920	17.7	3968	15.6	2952	21.4
76 years and over	5375	13.7	2243	8.8	3132	22.7
Calendar year						
2018	13 096	33.4	8535	33.6	4561	33.0
2019	13 656	34.8	8895	35.0	4761	34.5
2020	12 446	31.8	7954	31.3	4492	32.5
Hospital type						
MOPH hospitals	26 186	66.8	20 980	82.7	5206	37.7
other public hospitals	11 764	30.0	3608	14.2	8156	59.0
private hospitals	1248	3.2	796	3.1	452	3.3
Health region						
1	5987	15.3	4416	17.4	1571	11.4
2	2940	7.5	1902	7.5	1038	7.5
3	2749	7.0	2270	8.9	479	3.5
4	5042	12.9	3275	12.9	1767	12.8
5	5222	13.3	3838	15.1	1384	10.0
6	2395	6.1	1840	7.2	555	4.0
7	669	1.7	334	1.3	335	2.4
8	1021	2.6	731	2.9	290	2.1
9	1515	3.9	1034	4.1	481	3.5
10	352	0.9	245	1.0	107	0.8
11	1152	2.9	777	3.1	375	2.7
12	1638	4.2	884	3.5	754	5.5
13	8516	21.7	3838	15.1	4678	33.9

CSMBS, Civil Servant Medical Benefit Scheme; MOPH, Ministry of Public Health; UCS, Universal Coverage Scheme.

populations who are not part of the workforce. We used national-level claims data ensuring representativeness of the two schemes' membership and statistical power of the analysis. Together, the two schemes cover around 86% of Thailand's population aged over 50.

Despite the strengths, our study faced some limitations. First, the insurance claims data lacked some details influencing the TKA decision, such as severity of cartilage destruction, pain level, previous treatment, body weight and physical activity, which prevented better risk adjustment. Second, we did not know patient preferences. Some patients with osteoarthritis of the knee may have been offered TKA but then preferred less-invasive treatment. Also, patients undergoing TKA themselves may have preferred a specific implant type or surgical technique. Third, our procedure rates were estimated based on patient counts although some patients had TKA two times. Similarly, the utilisation of mobile-bearing implants was based on a single randomly selected surgery if patients had TKA more than once. This might have resulted in lower rates overall, but it is unlikely that this could have changed systematically the differences between

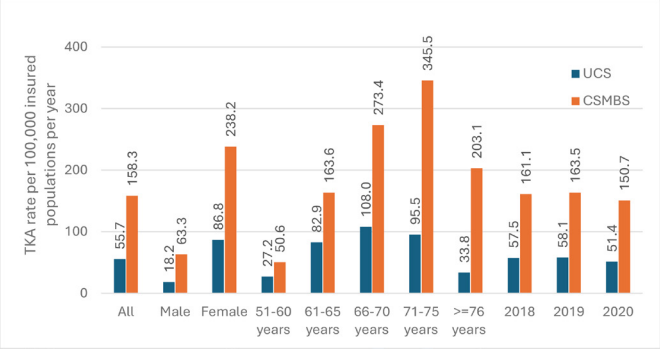

Figure 2 Unadjusted TKA rate per 100 000 insured populations per year. TKA, Total knee arthroplasty.

the schemes. Alternative modelling strategies may also be used to explore the results if repeated outcomes are included.[22] Fourth, we identified our patient cohort from public insurance claims, thus missing those who paid out-of-pocket for TKA or used private insurance. We expect the number of self-paying patients to be minimal because TKA is a high-cost intervention, ranging between 150 000 and 350 000 Baht for one knee (~4100–9600 USD) in private hospitals,[23 24] roughly 50–100% of Thailand's GDP per capita.[25] Lastly, more detailed information on the supply side such as physician characteristics (eg, number, experience, remuneration scheme) or hospital facilities (eg, availability of operating rooms and medical equipment) was not available. These factors are also likely to affect the provision of care.

As with other practice variation studies comparing preference-sensitive care, we would need information on patient needs and preferences to conclude which scheme has a more appropriate level of TKA utilisation as many care alternatives are clinically acceptable. However, our results show more than a twofold difference in TKA rates after adjustment, which suggests that there might be more structural underlying reasons linked to the type of insurance scheme that covered the patients' healthcare cost.

An alternative explanation could be that the differences in socioeconomic status may have contributed to the patients' decisions to seek care and their expectations about treatment.[26] For example, CSMBS-insured patients who are entitled to a pension are more able than UCS-insured patients to cover the cost of travelling to hospitals offering TKA and other indirect costs related to the surgery.

Apart from patient-side factors, it is likely that the different benefit package conditions, reimbursement prices and access rules between UCS and CSMBS are reasons for practice variation. During the observed period, UCS restricted the number of TKA procedures to approximately 12 000 procedures a year, allocated to 13 health regions.[27] A preauthorisation process was introduced for UCS-insured patients under 55 years old and when the regional quotas were reached. This administrative process can take a week, making surgical arrangements more difficult, especially for patients for whom the journey to a hospital is more inconvenient. As a result, orthopaedic surgeons may have delayed the surgery in some patients whose reimbursement was doubtful and focused on CSMBS-insured patients who offered easier reimbursement.

In regional hospitals or university hospitals, the higher reimbursement rates for CSMBS-insured patients might make them more financially attractive because the CSMBS's DRG base rates depend on hospital capacity while those of UCS are fixed.[11] Hospitals could also charge additionally to CSMBS-insured patients to co-pay out-of-pocket, while UCS prohibits additional charges to the patients.[28 29] It is unlikely that hospitals compensated for UCS's lower reimbursement rate by increasing the volume of procedures, given the annual restriction on the number of TKA procedures. The free access rules of CSMBS could result in an earlier discussion with orthopaedic surgeons compared with UCS-insured patients who first need a referral from a general physician. Professional opinions have been found to strongly influence treatment choices for preference-sensitive care due to information asymmetry.[30]

Due to more administrative burden and lower reimbursement, it is possible that patients insured through the UCS experienced discriminatory behaviour, such as feelings of disrespect, poorer communication or compromised quantity and quality of care, patterns that have also been observed in other countries.[31] Healthcare professionals may unconsciously hold implicit biases that affect the delivery of care.[32] Hospitals may implement

Table 2 Unadjusted and adjusted TKA rates per 100 000 insured populations per year

Schemes	People aged >50 years*	Patients undergoing TKA	Unadjusted procedure rate	Adjusted estimates†		
				Estimated procedure rate (95% CI)	Rate ratio (95% CI)	P value
Total	54 324 088	39 198	72.2			
UCS	45 599 901	25 384	55.7	59.3 (58.5 to 60.0)	Reference	<0.0001
CSMBS	8 724 187	13 814	158.3	149.3 (146.8 to 151.8)	2.52 (2.47 to 2.57)	

*Aggregated populations in 3 years (2018–2020).
†Results from Poisson regression model and were adjusted for age, sex, year and health region.
CI, confidence interval; CSMBS, Civil Servant Medical Benefit Scheme; TKA, Total Knee Arthroplasty; UCS, Universal Coverage Scheme.

Table 3 Differences in the use of mobile-bearing implants and simultaneous BTKA in 39 198 patients

	All Patients	Patients with outcome of interest		Unadjusted estimates*			Adjusted estimates*†		
Schemes	N	N	%	AD (%pt)	95% CI	P value	AD (%pt)	95% CI	P value
Mobile-bearing implant									
All	39 198	3389	8.6						
UCS	25 384	2188	8.6	Reference		0.9654	Reference		0.6445
CSMBS	13 814	1201	8.7	0.1	(–3.3 to 3.4)		0.7	(–2.4 to 3.9)	
Simultaneous BTKA									
All	39 198	1739	4.4						
UCS	25 384	908	3.6	Reference		0.1506	Reference		0.0811
CSMBS	13 814	831	6.0	2.4	(–0.9 to 5.8)		2.7	(–0.3 to 5.8)	

*Results from the generalised linear model accounted for intra-cluster correlation within the same hospital.
†Adjusted for age, sex, year and health region.
AD, absolute difference; CI, confidence interval; CSMBS, Civil Servant Medical Benefit Scheme; %pt, percentage point; UCS, Universal Coverage Scheme.

organisational policies, or even unintentional practices, that provide differential access to care among patients.[33] This type of insurance-based discrimination can have serious consequences at multiple levels: it can reduce patients' trust, satisfaction and willingness to seek care, potentially leading to delayed diagnoses and treatment. At the system level, it can exacerbate health disparities and undermine equity in healthcare access and outcomes.

The reason we did not find any difference in the use of mobile-bearing implants may be that it is unclear whether the clinical benefits are superior[17] and cost-effectiveness over fixed-bearing implants and balanced insurance policies from both schemes. Although CSMBS pays a higher price for mobile-bearing implants, it clearly reserves them for patients younger than 60 years. UCS's single reimbursement rate for knee implants might provide a disincentive for the use of more costly mobile-bearing designs. As for the use of simultaneous BTKA, without any differences in scheme policies, its use might largely depend on surgeon skill and perceptions of safety rather than the patient's insurance type.

Some existing studies support our suggestions on the influence of socioeconomic factors.[34] Studies in high-income countries confirm that patient income influences TKA use in both insurance-based and single-payer systems.[35] We are not aware of any similar previous studies in Thailand. Most Thai studies addressed clinical issues of TKA in a single hospital site. Internationally, US studies reported that privately insured patients were more likely to undergo TKA and that they were also more likely to receive simultaneous BTKA than publicly insured (ie, Medicare/Medicaid) patients,[4 34] confirming that insurance policies could influence TKA practice.

Our findings offer four important contributions for policy and future research. First, it provides novel evidence of potential inequities in utilisation of non-emergency high-cost care, specifically TKA, among older adults in Thailand, highlighting lower utilisation among those insured through UCS. This suggests a potential unmet need that may not be driven by clinical appropriateness but rather by administrative restrictions. Second, the findings point to the importance of re-evaluating policy approaches, advocating for monitoring of appropriateness rather than blanket procedural quotas under UCS. Thailand should also integrate value-based monitoring frameworks, such as Patient-Reported Outcome Measures (PROMs), to collect data on functional recovery, pain relief, adverse events, quality of life and overall satisfaction.[36] Third, our study calls for further studies exploring in more detail the appropriateness of TKA procedures overall[37] as well as differences in appropriateness between public insurance schemes, which are urgently needed. Qualitative research would also be important to further investigate explanations for the observed differences, ensuring that both the perspectives of patients and that of healthcare providers and clinicians are represented. Further studies comparing TKA waiting time and treatment outcomes by insurance type could address different aspects of access as well as quality of care. Finally, this study contributes to the broader literature on health system equity in MIC undergoing demographic transitions.

TKA is only one of many elective services that benefit older people. Studies exploring other elective procedures (eg, cataract surgery and cancer treatment) as well as access to assistive devices (eg, eyeglasses, dentures and dental implants, and hearing aids) are needed to build further evidence. These insights not only inform Thai health policy but also provide relevant implications for other MIC where healthcare supply is limited and rapid population ageing is occurring. Countries should use national or large databases to explore healthcare utilisation and aim to establish sufficient service provision to enable older people to access necessary care while managing rising costs.

CONCLUSION

Our study identified a substantial difference in TKA procedure rates among older populations between two public health insurance schemes in Thailand. It was unclear if there was unmet need among patients insured by UCS due to rationed supply. Further research should explore whether the different rates reflect appropriate use of services. Access to TKA improves the quality of life and reduces risks of dependency in older people. Therefore, we urge other MIC experiencing rapid population ageing to use national healthcare utilisation data to explore how well healthcare systems are responding to the changing needs of their older populations.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Institute for Development of Human Research Protection, Thailand (Certificate No. IHRP2021179 dated December 27, 2021) and London School of Hygiene & Tropical Medicine (Ethics Ref 27820 dated July 19, 2022). Patient consent was not obtained because we used an anonymised secondary dataset. The dataset has been stripped of all identifying information and there is no way it could be linked back to the subjects from whom it was originally collected whether during or after data collection.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. We are not allowed to distribute the patient dataset outside of the research team or use it for other purposes beyond the original agreed objectives. Researchers who are interested in using UCS and/or CSMBS patient dataset can request access directly from National Health Security Office and/or the Comptroller General's Department of the Ministry of Finance respectively.

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