



# Projections for primary hip and knee replacement surgery up to the year 2060: an analysis based on data from The National Joint Registry for England, Wales, Northern Ireland and the Isle of Man

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## ABSTRACT

**Introduction** We estimated the number of primary total hip and knee replacements (THR and TKR) that will need to be performed up to the year 2060.

**Methods** We used data from The National Joint Registry for England, Wales, Northern Ireland and the Isle of Man on the volume of primary THRs ( $n=94,936$ ) and TKRs ( $n=100,547$ ) performed in 2018. We projected future numbers of THR and TKR using a static estimated rate from 2018 applied to population growth forecast data from the UK Office for National Statistics up to 2060.

**Results** By 2060, THR and TKR volume would increase from 2018 levels by an estimated 37.7% ( $n=130,766$ ) and 36.6% ( $n=137,341$ ), respectively. For both males and females demand for surgery was also higher for patients aged 70 and over, with older patients having the biggest relative increase in volume over time: 70–79 years (44.6% males, 41.2% females); 80–89 years (112.4% males, 85.6% females); 90 years and older (348.0% males, 198.2% females).

**Conclusion** By 2060 demand for hip and knee joint replacement is estimated to increase by almost 40%. Demand will be greatest in older patients (70+ years), which will have significant implications for the health service requiring forward planning given that morbidity and resource use is higher in this population. These issues, coupled with two waves of COVID-19, will impact the ability of health services to deliver timely joint replacement to many patients for a number of years, requiring urgent planning.

## KEYWORDS

Total hip replacement – Total knee replacement – Future numbers – Demand

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## Introduction

Primary total hip and knee replacement (THR and TKR) are both common clinically, and are cost-effective interventions for treating arthritis.<sup>1–5</sup> These operations cost the National Health Service (NHS) approximately £2 billion annually, which represents 1.5% of the entire NHS budget.<sup>4</sup>

Given the high procedural volume and associated costs, it is important to estimate future demand for THR and TKR so that policymakers and relevant stakeholders can plan in advance regarding what resources are needed to safely deliver care. This planning is complex and multifactorial because in addition to appropriate finances, considerations must be made for delivering primary and secondary care, implant costs and workforce planning, including training surgeons. Although previous attempts have been made to forecast future UK demand for joint replacement,<sup>5</sup> these have limitations. These

limitations include using data from over a decade ago, which does not reflect current practice, and changes in funding and health policy, especially given changes promoting enhanced recovery after surgery. In addition, these predictions are no longer likely to reflect future demand, given current data suggest the forecasts for 2035 will soon be surpassed.<sup>5</sup>

In the UK, substantial issues already exist for delivering timely joint replacement surgery, with orthopaedic surgery having the largest waiting list of any individual specialty.<sup>6</sup> Over half of the clinical commissioning groups now ration access to joint replacement to reduce local expenditure,<sup>7</sup> leading to more patients seeking surgery in the private sector.<sup>8</sup> Lengthy waiting times, sometimes over 1 year, exist for many patients needing THR or TKR.<sup>9</sup> Furthermore, planned operations are commonly cancelled, with 60% of cancellations on the day of surgery, usually due to lack of beds, staff and/or operating capacity, which can be compounded during the

winter months.<sup>10</sup> These substantial delays for patients needing joint replacement can result in more severe pain and mobility problems, which can lead to more complex surgery being required that has less-predictive outcomes.<sup>9</sup>

In the winter of 2017 hospitals had to cancel elective surgery due to seasonal flu and winter bed pressures, with orthopaedics experiencing an 8.4% fall in surgery compared with the previous winter.<sup>11</sup> More recently, the advent of the COVID-19 worldwide pandemic has had drastic and unprecedented implications for healthcare services. In the UK, all elective orthopaedic surgery was cancelled during March 2020 for at least 3 months.<sup>12</sup> Elective surgery has subsequently been restarted, but at much lower volumes, with elective theatres unlikely to reach full capacity for a number of months.<sup>13</sup> This has been impacted further by a second wave of COVID-19 with associated national lockdowns.<sup>14</sup> All these factors are likely to impact on the ability to deliver timely joint replacement to many patients. Estimating the future need for joint replacement at this juncture would be useful for planning healthcare delivery.

We estimated the number of primary THRs and TKRs that will need to be performed up to the year 2060. Estimates were made based on the current volume of primary THR and TKR as recorded in The National Joint Registry (NJR) for England, Wales, Northern Ireland and the Isle of Man, and assuming that the population would grow in line with current national projections.

## Methods

### Data sources

Current procedural volumes for primary THR and TKR were obtained from publicly available data recorded in the NJR for England, Wales, Northern Ireland and the Isle of Man.<sup>15</sup> The registry started collecting data in 2003 and is the world's largest mandatory joint replacement registry, with excellent levels of data completion and accuracy.<sup>16,17</sup> Currently, 94% of patients consent for their personal data to be included in the NJR.<sup>15</sup> The NJR collects data on procedures performed in both the NHS and the independent/private sector.

### Participants

Counts of the number of patients receiving primary THR and TKR operations, by age and gender in 2018, were obtained from publicly available NJR data.

### Population counts

Every 2 years, the UK Office for National Statistics (ONS) calculates national population projections by age and sex for the UK and publishes them on its website. The projections are created by taking the latest mid-year population estimates and combining them with assumptions about likely levels of migration, mortality and fertility in future years. These projections are widely used by government centrally in the UK and also within the devolved nations to make future estimates about

education, pensions, taxation and other important policy areas.

We obtained age- and gender-specific population projections for England, Wales and Northern Ireland from the ONS covering the period 2018 to 2060,<sup>18</sup> upon which to project the estimated THR and TKR rates.

## Analysis

Age was grouped as follows: 18–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80–89 and 90 years and above. Rates for hips and knees were estimated separately. The projection method used counts of primary THR and TKR held at 2018 levels from the NJR, applied to the population forecast data sets which contain population growth estimates by age and gender over time, as forecast by the ONS.

## Results

### Primary THR

In 2018, the NJR recorded 94,936 primary THRs. The projected overall numbers of primary THRs were 98,114 in 2020, 111,724 in 2030, 121,855 in 2040, 127,383 in 2050 and 130,766 in 2060 (Table 1). By 2060, there would be an estimated 37.7% increase in the number of primary THRs compared with 2018. In males, the increase in the number of primary THRs was 39.3% compared with 36.7% in females.

In both males and females, the number of primary THRs in 2060 remains fairly constant in patients under 60 years of age. For patients aged between 60 and 69 there was a modest increase in the number of primary THRs by 2060 compared with 2018 (Table 1). For both males and females demand for surgery was higher for patients aged 70 and over, with older patients having the biggest relative increase in volume over time (Figures 1 and 2): 48,242 THRs by 2060 in 70–79 year olds (44.6% males, 41.2% females); 28,093 THRs in 80–89 year olds (112.4% males, 85.6% females); and 2,997 THRs in patients 90 years and older (348.0% males, 198.2% females).

### Primary TKR

In 2018, the NJR recorded 100,547 primary TKRs. The projected overall numbers of primary TKRs were 104,059 in 2020, 118,503 in 2030, 128,849 in 2040, 133,789 in 2050 and 137,341 in 2060 (Table 2). By 2060, there would be an estimated 36.6% increase in the number of primary TKRs compared with 2018. In males, the increase in the number of primary TKRs was 40.4% compared with 33.6% in females.

In both males and females, the number of primary TKRs in 2060 remains fairly constant in patients under 60 years of age. For patients aged between 60 and 69 there was a modest increase in the number of primary TKRs by 2060 compared with 2018 (Table 2). For both males and females, demand for surgery was higher for patients aged 70 and over, with older patients having the biggest relative increase in volume over time (Figures 3 and 4): 53,996 TKRs by 2060 in 70–79 year olds (44.6%

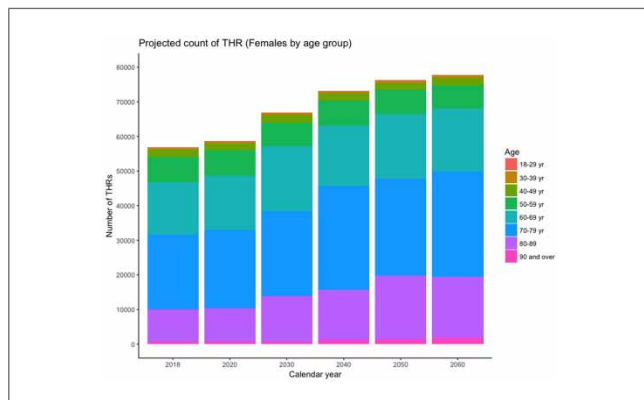
**Table 1** Projections for primary total hip replacement (THR) up until 2060

	Recorded number of THR	Projected number of THR					Percentage change 2060 vs 2018
	2018	2020	2030	2040	2050	2060	
Total	94,936	98,114	111,724	121,855	127,383	130,766	37.7
Sex							
Males	38,095	39,393	44,862	48,692	51,173	53,053	39.3
Females	56,841	58,721	66,862	73,164	76,210	77,713	36.7
Males by age (years)							
<30	168	166	169	176	166	172	2.7
30–39	502	509	515	506	542	507	1.0
40–49	2,205	2,186	2,321	2,344	2,310	2,474	12.2
50–59	6,416	6,535	6,023	6,401	6,482	6,408	-0.1
60–69	11,258	11,502	13,884	12,895	13,799	14,046	24.8
70–79	12,379	13,059	14,210	17,422	16,451	17,894	44.6
80–89	4,922	5,170	7,358	8,331	10,643	10,454	112.4
≥90	245	266	382	614	780	1,098	348.0
Females by age (years)							
<30	203	199	202	210	198	206	1.4
30–39	527	532	514	501	536	502	-4.8
40–49	2,064	2,043	2,173	2,100	2,050	2,192	6.2
50–59	7,212	7,364	6,763	7,194	6,966	6,817	-5.5
60–69	15,206	15,532	18,890	17,439	18,627	18,109	19.1
70–79	21,488	22,633	24,521	30,097	28,101	30,348	41.2
80–89	9,504	9,759	13,034	14,493	18,349	17,639	85.6
≥90	637	657	766	1,129	1,382	1,899	198.2

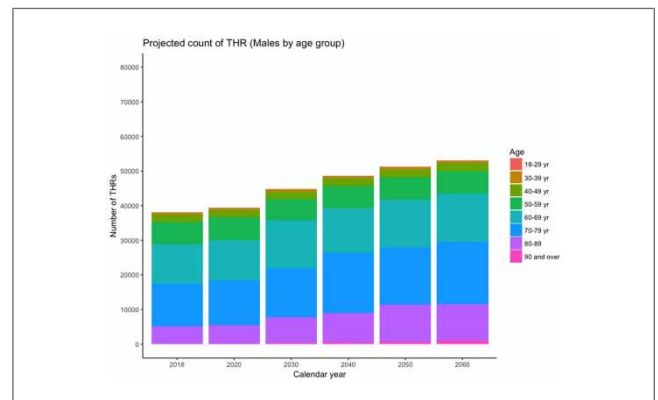
males, 41.2% females); 25,657 TKRs in 80–89 year olds (112.4% males, 85.6% females); and 1,904 TKRs in patients 90 years and older (348.0% males, 198.2% females).

**Discussion**

We estimate that by 2060 the UK demand for hip and knee joint replacement will increase by almost 40%. Previous



**Figure 1** Projections for primary total hip replacement (THR) in females to 2060



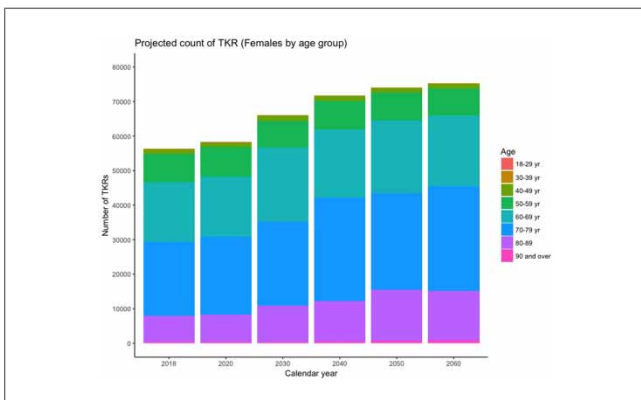
**Figure 2** Projections for primary total hip replacement (THR) in males to 2060

**Table 2** Projections for primary total knee replacement (TKR) to 2060

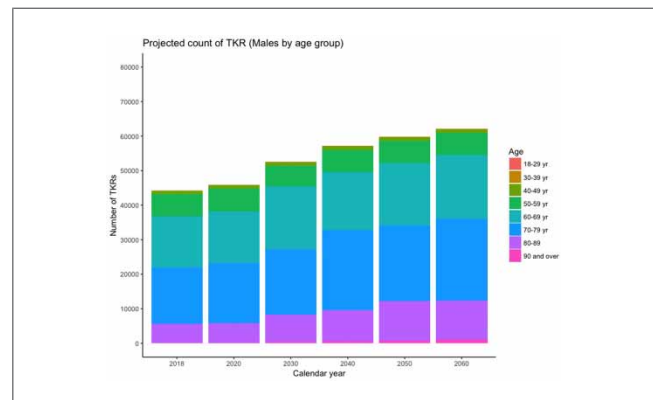
	Recorded number of TKR		Projected number of TKR				Percentage change 2060 vs 2018
	2018	2020	2030	2040	2050	2060	
Total	100,547	104,059	118,503	128,849	133,789	137,341	36.6
Sex							
Males	44,195	45,819	52,491	57,118	59,744	62,051	40.4
Females	56,352	58,240	66,012	71,730	74,045	75,290	33.6
Males by age (years)							
<30	7	7	7	7	7	7	2.7
30–39	74	75	76	75	80	75	1.0
40–49	909	901	957	966	952	1,020	12.2
50–59	6,447	6,567	6,052	6,432	6,513	6,439	-0.1
60–69	14,743	15,063	18,182	16,887	18,071	18,394	24.8
70–79	16,445	17,348	18,877	23,145	21,854	23,772	44.6
80–89	5,352	5,621	8,001	9,059	11,573	11,368	112.4
≥90	218	236	340	547	694	977	348.0
Females by age (years)							
<30	13	13	13	13	13	13	1.4
30–39	102	103	100	97	104	97	-4.8
40–49	1,352	1,339	1,423	1,375	1,343	1,436	6.2
50–59	8,284	8,459	7,768	8,264	8,001	7,831	-5.5
60–69	17,191	17,560	21,356	19,716	21,059	20,473	19.1
70–79	21,400	22,541	24,420	29,973	27,986	30,224	41.2
80–89	7,699	7,905	10,558	11,740	14,864	14,289	85.6
≥90	311	321	374	551	675	927	198.2

studies also show joint replacement demand continues to grow worldwide.<sup>5,19</sup> The important new study finding is the increased demand in older male patients, particularly

the very elderly, with numbers doubling by 2060 in patients aged 80–89 years and increasing almost fourfold in those aged 90 years and above. The risk of medical



**Figure 3** Projections for primary total knee replacement (TKR) in females to 2060



**Figure 4** Projections for primary total knee replacement (TKR) in males to 2060

and surgical complications after joint replacement, including mortality, is significantly higher in older patients, with patients 40% more likely to have any complication for each subsequent 10 years of age.<sup>20–23</sup> This increased patient risk should be accounted for when planning future healthcare.

The NHS already struggles to meet joint replacement demand.<sup>9</sup> Substantial delays for surgery can exacerbate pain and mobility problems for patients, who may need stronger analgesia, which can raise issues such as opiate dependence, side-effects and worse outcomes postoperatively.<sup>24,25</sup> The impact of surgical delay can be substantial on a patient's physical and mental health,<sup>9</sup> with recent evidence observing that over one-third of patients waiting for surgery have a health state worse than death.<sup>26</sup> Ultimately, these delays may lead to patients needing more complex surgery with less-predictive outcomes.

The onset of the COVID-19 pandemic has massively disrupted the delivery of elective surgical care worldwide. In the UK, two waves of COVID-19 with national lockdowns have led to prolonged periods of no, followed by reduced, elective surgery, which is still far from reaching pre-pandemic volumes. It is estimated that 75,000 joint replacement cases were lost in 2020 (37.5% of annual volume).<sup>27</sup> Therefore, in 2021, the volume of joint replacement will need to increase by 37.5% to treat all patients needing surgery. This is a substantial increase in surgical volume and healthcare costs over a short timeframe, especially given that our projections for primary THR and TKR volume would not increase to these levels for 40 years in 2060.

Previous population studies have described how future rates of THR and TKR may change. Dixon *et al*<sup>28</sup> used data from English Hospital Episode Statistics, and assumed a continual linear trend, looking at the past linear increase in THR and TKR numbers to predict future numbers increasing at the same linear rate. Kurtz *et al*<sup>19</sup> used Poisson regression combined with US census data making assumptions about observed prior trends in the prevalence of surgery observed from 1990 to 2003 to determine whether this would continue to increase or remain constant. In our previous work, as a secondary analysis, we also incorporated an exponential extrapolation directly from a log-linear model based on previous estimated rates for THR and TKR.<sup>5</sup> The main limitation of all these data-driven estimates based on historical increases in THR and TKR numbers is that they do not incorporate or consider constraints in relation to capacity and planning (availability of hospital theatres, beds, surgeons, etc).

It is important to understand the policy context when making such projections. Between 2002–2003 and 2007–2008 the NHS saw a large and sustained increase in investment and funding (average annual increase in real terms of 7.4%). This increased capacity to deliver elective surgery, which included using the independent sector to improve productivity. However, the current climate involves increasingly strained NHS funding, with growth now slower than historical trends.<sup>29</sup> There are fewer

hospital beds available for joint replacement today than previously, and wards have been closed. Therefore, with a current lack of investment, ever-increasing waiting times, cancellations of elective surgery, further delays from two waves of COVID-19 and limited ability for further efficiency savings than has already been achieved in the past with enhanced recovery protocols, it is unrealistic to base our modelled projections on historical increases in the numbers of THRs and TKRs performed. Furthermore, NJR annual reports show the numbers being stable over recent years.<sup>15</sup> Therefore, the projections we produce here are simply based on the current numbers of operations being performed and expected future changes in the age-gender population demographics due to an ageing population.

It is highly unlikely that COVID-19 will be eradicated in the medium term and thus strategies need to be developed to deliver routine care effectively in the presence of COVID-19. Patients undergoing joint replacement commonly suffer from obesity (40% for THR and 56% for TKR)<sup>15</sup> and have comorbidities. Taking this together with our projections, we can conclude that the NHS will need to make provision to undertake a large number of joint replacements on old, obese comorbid patients within the context and risks of COVID-19. Our estimates represent an urgent call for engagement of the health service, government, policymakers and relevant stakeholders (such as The British Orthopaedic Association, The Royal College of Surgeons of England and The National Institute for Health and Care Excellence) to now plan what resources are needed to safely deliver primary THR and TKR to patients. This will be complex and must involve consideration of hospital capacity, healthcare resources, staffing, workforce planning and implant procurement. Although some investment has been made with regards to workforce planning (increases in medical and nursing student places and an increase in non-UK trained healthcare professionals working in the NHS),<sup>30–32</sup> this alone is unlikely to be enough to deliver the future demand for joint replacement in the UK. Therefore, the only solution we can see is to greatly upscale capacity without delay. The costs of this will be considerable and although THR and TKR are cost-effective treatments,<sup>1,33</sup> society needs to decide if it is willing to pay. Failure to act will result in a backlog that is so severe that many patients may die before treatment.

## Conclusions

We estimate that by 2060 the UK demand for hip and knee joint replacement will increase by almost 40% from current levels. Demand will be greatest in older male patients (70 years and above) and will have significant implications for the health service that requires forward planning given that morbidity and resource use is higher in this population. The existing backlog of patients awaiting elective joint replacement has been substantially impacted further by two waves of COVID-19. The health service, government, policymakers



and relevant stakeholders must therefore use this information to urgently plan what resources are needed to safely deliver primary THR and TKR.

## Competing interests

GSM has received personal fees for undertaking medicolegal work for Leigh Day. AWB received a grant funded by Stryker investigating the outcome of a total knee replacement manufactured by Stryker. AJ has received consultancy fees from Freshfields Bruckhaus Deringer and has held advisory board positions (which involved receipt of fees) from Anthera Pharmaceuticals, INC. DJC has no conflicts of interest.

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## Author contributions

GSM, DJC and AJ conceived the study and all authors were involved in its design. DJC performed the data analysis. All authors interpreted data and wrote, edited and approved the final report. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. AJ is the guarantor for this study and had final responsibility for manuscript submission.

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