Current trends and projections in the utilisation rates of hip and knee replacement in New Zealand from 2001 to 2026

Gary Hooper, Alex J-J Lee, Alastair Rothwell, Chris Frampton

Abstract

Aim This study aimed to estimate the demand for total hip (THR) and knee replacements (TKR) by 2026 within New Zealand (NZ) and show how demographic factors are likely to influence this projection.

Method Yearly population data from the NZ Census was compared to the NZ Joint Register from 2001–2011 and ethnic and gender specific data was organised into 5 year age groups from 35 years to calculate the incidence for each age group. Poisson regression analysis was used to project the incidence for 2026 and to evaluate the independent associations between age, gender and ethnicity.

Results Between 2001 and 2011 the incidence of THR and TKR increased by 8.20% and 52.20% respectively with a peak incidence in the 70–74 age group. Men were less likely to undergo both THR and TKR (OR 0.91, 95% CI 0.89–0.94 and OR 0.88, 95% CI 0.89–0.90). By 2026 the absolute number of THR and TKR is estimated to increase by 84% (8950 procedures) and 183% (8613 procedures) respectively. Europeans were the most likely to undergo THR compared to Māori, Pacific people or Asians (OR 0.72, 95% CI 0.67–0.74). There was a large increase in the age standardised incidence of TKR for Pacific people and they were more likely to undergo TKR than Europeans (OR 1.00, 95% CI 0.97–1.04).

Conclusion Over the past decade, incidence of THR and TKR have increased, and by 2026, the number of THR and TKR is projected to increase by 84% and 183% respectively. This increase will create a significant socioeconomic burden which will necessitate prudent and focused healthcare strategies to ensure that there are adequate resources to meet this demand.

Osteoarthritis (OA) is the commonest form of arthritis and is present in a large number of adults in various populations, with the lifetime risk of developing symptomatic OA of the knee estimated to be up to 47%.

The incidence of OA increases rapidly in patients over 50 years of age. According to the World Health Organization Global Burden of Disease 2013 Study, osteoarthritis is ranked 18th amongst all diseases/road injury in the Western Pacific region, and is responsible for an increasing burden on the health expenditure.

Total hip (THR) and total knee replacement (TKR) are two common operations which reduce pain and improve function and quality of life in patients with hip and knee disorders.

In New Zealand, OA of the hip and knee is the commonest condition for which joint replacements are indicated. Total hip and knee replacements have been shown to be excellent surgical procedures with predictable results both in controlling the
debilitating pain secondary to arthritis, and in returning compromised patients to a satisfactory functioning lifestyle.\textsuperscript{7}

The improvements in implant design and surgical technique have resulted in a decreasing threshold for offering patients these procedures, which in turn, has resulted in younger, more active individuals accessing this surgery.

Osteoarthritis predominantly affects the older population and with the increased ageing population it is reasonable to predict that the incidence of THR and TKR will increase.\textsuperscript{6–8} This projection is supported by data from the USA, where the incidence for THR and TKR is estimated to increase by 174\% and 674\% respectively by 2030.\textsuperscript{10}

The population of NZ is ageing, with the 65+ age group likely to make up over one quarter of the population in the late 2030’s. This will result in an increase from 550,000 in 2009 to 1 million in the late 2020s, exceeding the number of children aged 0–14 years.\textsuperscript{11}

Not only is the population ageing, but this group of society is more likely to remain healthy and active for a longer period compared to previous generations, with an increased expectation of being productive and active during this time.

As a result of this, not only will all joint replacements be expected to perform at a higher level and to survive longer than has previously been reported, but patients are likely to demand an earlier replacement in order to live the remainder of their life without pain and with improved function.

Osteoarthritis is, and will remain, a major public health problem in the foreseeable future which will have major implications for health planning. Currently there is only limited epidemiological data on the utilisation of THR and TKR in New Zealand. Reliable projections of the demand for THR and TKR are necessary in order to implement appropriate healthcare strategies and for the training of the surgical workforce.

The primary objective of this study was to estimate the incidence rate of THR and TKR in New Zealand by 2026. We hypothesise that this will increase substantially in the next two decades. The secondary objective was to analyse the trends in the utilisation of THR and TKR over a 10-year period, and how it varies according to age, gender and ethnicity.

Method

Yearly population data between 2001–2011 were extracted from the New Zealand Census.\textsuperscript{11} Age and gender specific data on European, Māori, Pacific (mostly of Samoan, Tonga, Niuean, or Cook Islands origin), and Asian ethnic groups were collected and organised into 5 year age brackets from 35 years. Ethnic data from the New Zealand Census were available either by ‘Total Response’ (a person who identifies with multiple ethnicities is counted in each of the identified ethnic group), or ‘Prioritised Ethnicity Data’ (assigning the ethnicity of a person who has identified with multiple ethnicities to just one ethnicity). This study uses ‘Total Response’. The rationale for this choice is expanded in the discussion.

Procedures for patients under the age of 35 were excluded, as these numbers were low and it was considered that they were unlikely to have a significant influence on the future trend and projections.

The total number of elective THR and TKR performed between 2001–2011 was extracted from the New Zealand Joint Registry (NZJR) to provide a yearly rate. The NZJR was established in 1999 by the New Zealand Orthopaedic Association, and collects data on all patients undergoing THR and TKR
within New Zealand in both the public and private sectors. The NZJR undergoes constant audit and has been shown to have >95% compliance rate.\textsuperscript{12}

The data was categorised for age, gender, and ethnic group in accordance with the data obtained from the New Zealand Census.

The THR and TKR incidence rates were calculated by dividing the total number of THR and TKR in each age gender group over the total population in that group. The trends in rates were compared between the two time periods 2001–2006 [period 1] and 2006–2011 [period 2].

Age and gender-standardised arthroplasty incidences were calculated to adjust for different gender and age distributions to allow rate comparisons between ethnicities during period 2. The female European population model was used for standardisation. Rate ratios calculated with the use of Poisson regression model were used to evaluate the independent associations between demographic characteristics (age, gender, ethnicity) and arthroplasty rates of THR and TKR.

The estimates generated from the Poisson regression model were combined with projected population data from Statistics New Zealand to provide gender, age, and ethnicity arthroplasty incidences up to 2026.

**Results**

From 2006 to 2011, there were 31260 THR and 31,958 TKR performed. The average age was 66.9 (range 15.3–101.0) years and 68.5 (range 8.2–100.5) years for THR and TKR respectively.

The highest incidence of THR was observed in the 75–79 age group whereas the highest incidence of TKR was in the 75–79 age group for men, and 70–74 age group for women (Figures 1a, 1b).

**Figure 1a. The mean annual incidence of total hip replacement per 100,000 from 2006–2011, separated by gender and age**
Figure 1b. The mean annual incidence of total knee replacement per 100,000 from 2006–2011 separated by gender and age

Incidence of THR and TKR—The incidence of TKR increased by 31% from 2001 to 2006 with a 16% increase from 2006 to 2011. This pattern was not observed in THR, with 1.9% decrease from 2001 to 2006 and 10.3% increase from 2006 to 2011. (Figures 2a, 2b).

Overall increases from 2001 to 2011 in the THR and TKR incidences were 8.2% and 52.2% respectively. Men had a lower incidence of THR. Compared with women, the age standardised rate ratio (RR) for THR in men was 0.91 (95% confidence interval [CI] 0.89–0.94) (Table 1).

Figure 2a. The incidence of total hip replacement per 100,000 of population
Figure 2b. The incidence of total knee replacement per 100,000 of population

Table 1. Poisson regression model representing associations of demographic factors with rates of THR and TKR

<table>
<thead>
<tr>
<th>Variables</th>
<th>THR Rate Ratio*</th>
<th>95% Confidence Interval</th>
<th>TKR Rate Ratio*</th>
<th>95% Confidence Interval</th>
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<td>0.12–0.14</td>
<td>0.54</td>
<td>0.52–0.56</td>
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</tbody>
</table>

* Poisson regression model included all factors in the table.

**Ethnic differences in incidence**—A small increase in the incidence of THR was observed from 2006 to 2011 in all ethnic groups. Comparisons of ethnicities were performed after standardising for the different age and gender makeup for each ethnicity. Europeans were most likely to undergo THR compared to Māori, Pacific...
people, and Asian (RR 0.72, 95% CI 0.70–0.74, RR 0.15, 95% CI 0.14–0.16, RR 0.13, 95% CI 0.12–0.14, respectively) (Table 1, Figure 3a).

There was a large increase in the age standardised incidence of TKR for Pacific people, and they were slightly more likely to undergo TKR than Europeans (RR 1.001, 95% CI 0.97–1.04) (Table 1). An overall decrease over the five years was seen in the incidence of TKR for Māori and Asian groups (Figure 3b).

Figure 3a. The ethnic variations of the age and gender standardised incidence for total hip replacement per 100,000 from 2006–2011

Figure 3b. The ethnic variations in the age and gender standardised incidence of total knee replacement per 100,000 from 2006–2011
**Projections for 2026**—Based on the poison regression model, the absolute number of THR was estimated to increase by 84% from 4875 in 2001 to 8950 by 2026. The absolute number of TKR was estimated to increase by 183%, from 3049 in 2001 to 8613 by 2026. Using these estimates, the incidence of THR and TKR in 2026 will be 306.3 and 294.8 per 100,000 respectively (Figure 4).

**Figure 4. The projections for the number of total hip and knee replacements expected to be performed in 2026 (2001–2011 shows actual numbers, 2011–2026 shows the projected number of operations based on our projection model)**

Health planning relies on reliable data to provide estimates and projections for the allocation of funds for the rational provision of care to the community. The NZJR has been audited regularly and has continued to demonstrate at least a 95% compliance rate, making it the most reliable and robust source of demographic data for THR and TKR in this country.

The epidemiological data gathered in this study has provided both crude incidence rates and age and sex adjusted incidence rates to give a more reliable representation of the change in rate for each population, particularly when considering different ethnic groups.

This study has shown that the incidence of THR and TKR is progressing at a concerning rate and although the estimated projections in 12 years is not as high as in the USA, a relative increase in the incidence of THR (84%) and TKR (183%) over 26 years (2001–2026) equates to a incidence of 306.3 and 294.8 per 100,000 respectively (in 2026). This means that approximately 6000 further joint replacements will need to be performed.
It is important to note, that this is only a projection, and the relative contributions of biological, lifestyle, and socioeconomic factors may influence the observed trend in this study. However, since there does not seem to be any other treatment for osteoarthritis that will surpass joint replacement surgery in the immediate horizon, it would be safe to assume that the incidence of THR and TKR will continue to rise in the future.

Currently the NZJR (2013 data) shows that an orthopaedic surgeon in New Zealand performs approximately 36 hip and 32 knee replacements per year on average. To service the predicted increase in replacement surgery means that approximately 80 extra surgeons will need to be trained if current practise standards continue, and this does not take into consideration the other demands that this ageing population will place on orthopaedic services. There are significant implications on both education and training as well as funding increased positions within public hospitals.

The incidence rates per 100,000 for THR and TKR in New Zealand is high when compared to other countries. Kim et al. reported the 2005 South Korean incidence of TKR as 157/100,000 for women and 20/100,000 for men compared to the New Zealand 2006 incidence of 208/100,000 and 207/100,000 respectively. Knee replacement is far more common in South Korea compared to THR but even so this result shows a wide variance which is unlikely to be explained by socioeconomic factors alone.

Other, so called, first world countries also show a significantly lower incidence rates compared to New Zealand with Denmark (Pedersen et al.) having a 2002 incidence of 131/100,000 and the USA (Kurtz et al.) of 69/100,000 for THR compared to 254/100,000 in this country. The reason for this large variance is not obvious.

Some may suggest that the figures reflect an over-servicing within New Zealand, but it is unlikely that joint replacements are being performed on patients with minimal symptoms as over 50% of the replacements are performed within public hospitals who comply with national health scoring criteria, identifying patients with significant discomfort and functional need.

It is more likely that the high incidence reflect a health system which has identified an area of need and responded to this, with strategies such as the Ministry of Health Joint Replacement Initiative, which has achieved reasonable success in treating this patient demand.

The fact that the USA predictions for the number of TKR are almost three times the predictions in New Zealand over the next 18 years suggests that we have been more proactive in dealing with this problem over the preceding years and therefore have a smaller predicted increase.

The largest relative increase in the number of replacement surgery has been seen in TKR. These results are similar to other studies which have shown both an increase in the absolute number and incidence rates of TKR, and also an increasing incidence in younger patients (<60 years).

Several factors are likely to be responsible for this differential increase in TKR.
Firstly, not only is the New Zealand population ageing but the prevalence of obesity is
also increasing and it has been shown that there is a direct link between obesity and OA of the knee,\textsuperscript{17,18} which is not seen in THR.

Secondly, knee replacement is more common in women who have a longer life expectancy when compared to men, and therefore a larger population base in the 70-79 age band with the highest utilisation rate.

The main age bands responsible for this increased incidence rates were the 75-79 year group for THR and the 70–79 year groups for TKR which was likely to be associated with the improved life expectancy and subsequent increased functional demands from this older patient group.

Census data demonstrates a wide difference in life expectancy when comparing the Māori and Non-Māori populations with the current life expectancy for Māori men 70.4 years compared to Non-Māori men of 79 years\textsuperscript{11}. These results may partially explain why the incidence of joint replacement has not increased within the Māori population, where the increased rate of obesity might suggest otherwise.

Furthermore, it has been well established that the Māori population are lower users of primary health care services.\textsuperscript{19,20} Since elective THR and TKR are dependent on referrals from primary care, poorer access to primary care may explain the lower incidence rates of both THR and TKR in Māori compared to European population.

This observation is similar to that found by Singleton et al.\textsuperscript{21} Similar patterns have been observed for the Māori population in other health intervention rates, such as coronary artery revascularisation procedures and cancer treatment.\textsuperscript{22–24}

Further research in the prevalence of osteoarthritis in Māori and non-Māori populations may assist in addressing the potential ethnic disparities of THR and TKR in New Zealand.

The Asian population demonstrated a low incidence rate for replacement, especially TKR, where it would be anticipated that the rate would mirror other data from Asian countries. The incidence rate of 120/100,000 for TKR was markedly lower than the 2005 Korean data\textsuperscript{13} (157/100,000) suggesting that changing countries and environmental factors may affect the incidence for joint replacement. This may reflect specific cultural behaviour that leads to adult immigrants returning to their country of origin to receive major operations, such as THR and TKR.

The population of Pacific people within New Zealand is increasing and the incidence rate for joint replacement, particularly TKR, has increased at a rate higher than the European population. The reason for this is not clear.

Due to the lack of surgeon expertise and surgical instrumentation, non-residents who do not contribute to the denominator (population number) used in this study, may be immigrating to New Zealand to receive replacement surgeries, resulting in the apparent observation. This effect may be amplified given that the Pacific people have the smallest population number in New Zealand, as a small change in the number of surgeries will affect the incidence significantly. Further analysis was not possible as data regarding citizenship status was not collected by the NZJR.

According to the New Zealand Health Survey 2013\textsuperscript{25}, obesity rates were highest in Pacific adults (68% of the population), followed by Māori adults where 48% were
obese. However, the obesity rate has increased significantly for Māori adults since 2011, whereas a similar increase was not observed in Pacific adults. This may partly explain why the incidence of TKR is highest in the Pacific population in 2011, and one may speculate that the prevalence for Māori may increase in the future.

There are several limitations of this study. First, Poisson regression analysis to predict utilisation rates has limitations in that it assumes the population demand for replacement surgery will continue unabated until everyone will have had a replacement. Obviously that is not the case and we can assume that there will be a point when saturation will occur. This is difficult to predict and the current data would suggest that with the population ageing, being healthier and having higher functional expectations that we are still some way form this saturation point.

Second, there are inherent assumptions when estimating population projections into the future. This study incorporates New Zealand Census data, which reflect the best available projections, taking into account the current fertility, mortality and net migration rates.

Third, we have assumed that the prevalence of hip and knee osteoarthritis will remain constant until 2026. With the ageing population and increase in the prevalence of obesity in our population, it would be reasonable to assume that the prevalence of osteoarthritis will increase, and in fact, projections presented in this study will underestimate the future incidence for THR and TKR.

Furthermore, improving non-operative treatment for osteoarthritis may decrease the need for joint replacement surgery in the future, and the effect of this has not been taken into account in our predictions.

Fourth, by using the ‘Total Response’ ethnicity data, we have inevitably overestimated the population number, which may affect the accuracy of the presented results. This difference was 3.7% for the age bracket used in this study. However, a similar error (under-estimation) would be made if prioritised ethnicity data was used, and in doing so, conceals diversity within ethnic groups, and is avoided across official statistics.96

Of note, the difference in population estimates if all ages were included is 9.6%, which further supports our study design.

Lastly, although the incidence rates amongst various ethnicities have been discussed in this study, details of socioeconomic status of patients receiving THR and TKR was not available for analysis. This would provide further indication of the potential discrepancies that exist in the incidence of THR and TKR.

In conclusion, the demand for THR and TKR is projected to increase significantly by 2026, and as far as the continued care for the community is concerned, the trends and projections presented in this study will need to be factored into the continuing service and training requirements for the delivery of an efficient and effective National Orthopaedic Service.
Competing interests: Nil (and no external funds were received for this study).

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