Equity of publicly-funded hip and knee joint replacement surgery in New Zealand: results from a national observational study

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ABSTRACT

AIM: This study examines equity in the provision of publicly-funded hip and knee total joint replacement (TJR) surgery in New Zealand between 2006 and 2013 to: 1) investigate national rates by demographic characteristics; 2) describe changes in national rates over time; and 3) compare rates of provision between District Health Boards (DHBs).

METHODS: Hospital discharge data for people aged 20 years or over who had at least one hip or knee TJR between 2006 and 2013 was obtained from the Ministry of Health's National Minimum Dataset.

RESULTS: Higher TJR rates were observed among those aged 75–84 years, females, those of Māori ethnicity, those not living in rural or main urban areas and those in the most deprived socio-economic groups. TJRs increased from 7,053 in 2006 to 8,429 in 2013, however the rate was highest in 2007. In 2012–13, age-ethnicity-standardised rates varied between DHBs from 196 to 419/100,000 person years, with larger DHBs having lower rates than smaller DHBs.

CONCLUSION: There was evidence of geographic inequity in TJR provision across New Zealand. Despite increased numbers of procedures, rates of publicly-funded TJR surgery are barely keeping up with population increases. Reasons behind differences in provision should be examined.

Healthcare budgets are constrained and there are perennial concerns about the potential mismatch between health-care need and the provision of publicly-funded services. Ageing populations[1] and technological advances[2] are increasing pressures on healthcare budgets and the prioritisation of healthcare services can be required.[3] One area that is likely to be affected by these pressures is total joint replacement (TJR) surgery. The most common reason for TJR surgery in New Zealand is osteoarthritis (OA)[4] that is not responding adequately to conservative treatment. OA has a high prevalence among older adults[5,6] with 29% of New Zealanders aged over 65 years diagnosed with this condition.[7] This is important to consider as, currently in New Zealand, those aged over 65 years comprise 14% of the population but this is predicted to increase to 27% in 2063.[8] Therefore, demand for TJR will likely increase substantially. In New Zealand, hip TJR surgery (including privately-funded procedures) has already increased between 1999 and 2013 by 75%; there was a corresponding 158% increase for knee TJR surgery.[6] However, despite these increases, concerns have been raised that the provision of these procedures may not be expanding sufficiently to keep up with increases in clinical need or population changes.[9]

Publicly-funded healthcare in New Zealand is provided by 20 District Health Boards (DHBs) "…responsible for providing or funding the provision of health services in their district."[10] In New Zealand, prioritisation scoring tools are used to determine access to publicly-funded TJR surgery. This should ensure equitable access across the

country. However, Derrett et al (2009)[11] found a lack of equity between DHBs in the provision of elective hip and knee TJR (2000 to 2005), and an analysis of New Zealand newspaper articles and Parliamentary questions from 2000–2006 found that "… access inequities remained a persistent theme…" (p.57).[12] Although there has been an increase in funding for TJR surgery in New Zealand in recent years it is not clear whether that has translated into increased rates of surgical provision. Additionally, any increases in provision of TJR should be equitable with regard to geographic and demographic determinants such as place of residence, age, sex, ethnicity and socioeconomic deprivation.[13] This paper examines publicly-funded elective hip and knee TJR surgery provision among DHBs in New Zealand from 2006–2013. The aims of this study are to:

1. describe changes in rates of publicly-funded hip and knee TJR surgery nationally between 2006 and 2013,
2. investigate whether national rates vary according to age, sex, ethnicity, small-area deprivation and rurality, and
3. determine whether the provision of publicly-funded hip and knee TJR surgery is equitable across DHBs in New Zealand.

Methods

This study examined New Zealand hospital discharge data for publicly-funded hip and knee TJR surgery from 2006–2013. Ethical approval for the study was received from the University of Otago Human Ethics Committee (Reference number D13/253). Relevant hospital discharge data was obtained from the Ministry of Health's National Minimum Dataset (NMDS).[14] The NMDS is a national collection containing publicly-funded hospital discharges and some privately-funded hospital discharges. Data was obtained for patients with at least one publicly-funded hip or knee TJR procedure who were discharged between 1 January 2006 and 31 December 2013. This time period was chosen as similar work on this topic[11] analysed data up until the end of 2005, and 2013 data was the latest available at the time this study commenced. The variables obtained from the NMDS included the International Classification of Diseases version 10 (ICD10) clinical code, age at discharge, sex, domicile code, ethnicity, type of admission, diagnosis type, event dates and the principal health service purchaser. As well as waiting list admissions, arranged admissions defined as "a planned admission where: the admission date is less than seven days after the date the decision was made by the specialist that the admission was necessary…"[14] were also included as these were likely to capture urgent sub-acute OA patients. Acute admissions and injury admissions (primary diagnosis code within ICD10 S00-T98)[15] were excluded as were those under 20 years of age at time of surgery and overseas residents. Hip and knee TJR surgeries were identified using the clinical codes in the 3rd edition of the Australian Modification of ICD10.[15] The specific procedures included were: total arthroplasty of hip, total arthroplasty of knee, total arthroplasty of knee with bone graft to femur or to tibia, total arthroplasty of knee with bone graft to femur and tibia and total replacement arthroplasty of patellofemoral joint of knee. Hemiarthroplasty of the knee was also included because indications for this are similar to TJR and their popularity may vary across the country. Revisions of hip and knee joint replacements were not included as the aim was to focus on primary procedures. Records with missing or historic domicile codes that could not be forward-mapped were excluded as these could not be analysed by DHB, area-level deprivation or rurality. Self-identified ethnicity data collected at the patient's health event was obtained from the NMDS. The recording of at least one ethnicity is mandatory, and two additional ethnic group codes may be recorded.[14] As the DHB-level denominator data was only available by 'prioritised ethnicity', this approach was used in our analyses with estimates obtained for Māori, Pacific, Asian and Other ethnicity groupings. Prioritisation follows a Statistics New Zealand (SNZ) algorithm with the end result being each person associated with only one ethnic group.[16] Māori ethnicity has the highest priority, meaning that people who identified as both Māori and any other ethnicities are classified as Māori. For example, those who identify as both Māori

and Pacific are classified as Māori. Pacific ethnicity is given the next highest priority with those who identify as Pacific and any other ethnicity (apart from Māori) being classified as Pacific.

The New Zealand Deprivation Index (NZDep2006) is a "…small-area index of relative socio-economic deprivation…"[17] (p.S7) derived from 2006 Census data. The NZDep scale runs from one (an area in the least deprived 10% of small areas) to 10 (in the 10% most deprived small areas). The 1:1 mapping between domicile codes available in the NMDS and Census area units used by SNZ enabled NZDep to be assigned to each TJR discharge record. Rurality was also derived from domicile codes by 1:1 mapping with SNZ's Census area units and SNZ's Urban/Rural Profile Classification.[18] The seven categories of the Urban/Rural profile were categorised for analysis as:

1. 'Main Urban' (described as being "… very large and centred on a city or main urban centre… minimum population of 30,000"),[18]
2. 'Other Urban' which consisted of 'Satellite Urban' ("defined as urban areas (other than main urban areas) where 20 percent or more of the usually resident employed population's workplace address is in a main urban area"[18] and 'Independent Urban' (defined as for Satellite Urban but <20 percent with a main urban area workplace), and
3. 'Rural' comprising the four rural profiles ('Rural Areas with a High Urban Influence,' 'Rural Areas with a Moderate Urban Influence,' 'Rural Areas with a Low Urban Influence' and 'Highly Remote Areas').

Denominator data were sourced from SNZ, and restricted to those aged 20 years and above. Annual resident population estimates by year, ethnicity, sex, age group and DHB region for 2006–2013 were calculated by SNZ. Usually resident population counts from the 2006 Census were used for calculations involving rurality and deprivation. In 2010 the Southern DHB was created from a merger of two DHBs (Otago and Southland); for this study we combined data from those DHBs and considered them as the Southern DHB throughout the period analysed. Crude rates per 100,000 person years (py) were calculated and presented alongside exact Poisson 95% Confidence Intervals (CIs). Age-standardised rates (ASRs) were calculated using direct standardisation and five-year age groups. Ten five-year age groups (<45, 45–49…80–84, 85+) were used for sex and ethnicity ASRs. Denominator data for deprivation and rurality ASRs was not available disaggregated by age for those over 65 years so these ASRs were calculated using age groups <45, 45–49, 50–54, 55–59, 60–64, 65+ years. Age- and ethnicity-standardised rates (AESRs) by DHBs were calculated in a similar way using four prioritised ethnic groups: Māori, Pacific, Asian and Other. Linear trends in rates were analysed using Poisson regression. Pitman's variance ratio test was used to compare the distribution of AESRs by DHB over time. Analyses were carried out using Stata/SE (version 13.1).[19]

Results

Of the 74,784 procedures obtained from the NMDS for people with at least one publicly-funded hip or knee TJR and a date of discharge between 2006 and 2013, 62,907 (84.1%) met the inclusion criteria. Figure 1 details the exclusions. Of these 62,907 publicly-funded primary hip or knee TJR procedures, 2% were bilateral joint replacements giving a total of 64,222 primary hip or knee joints replaced (Table 1).

Figure 1:

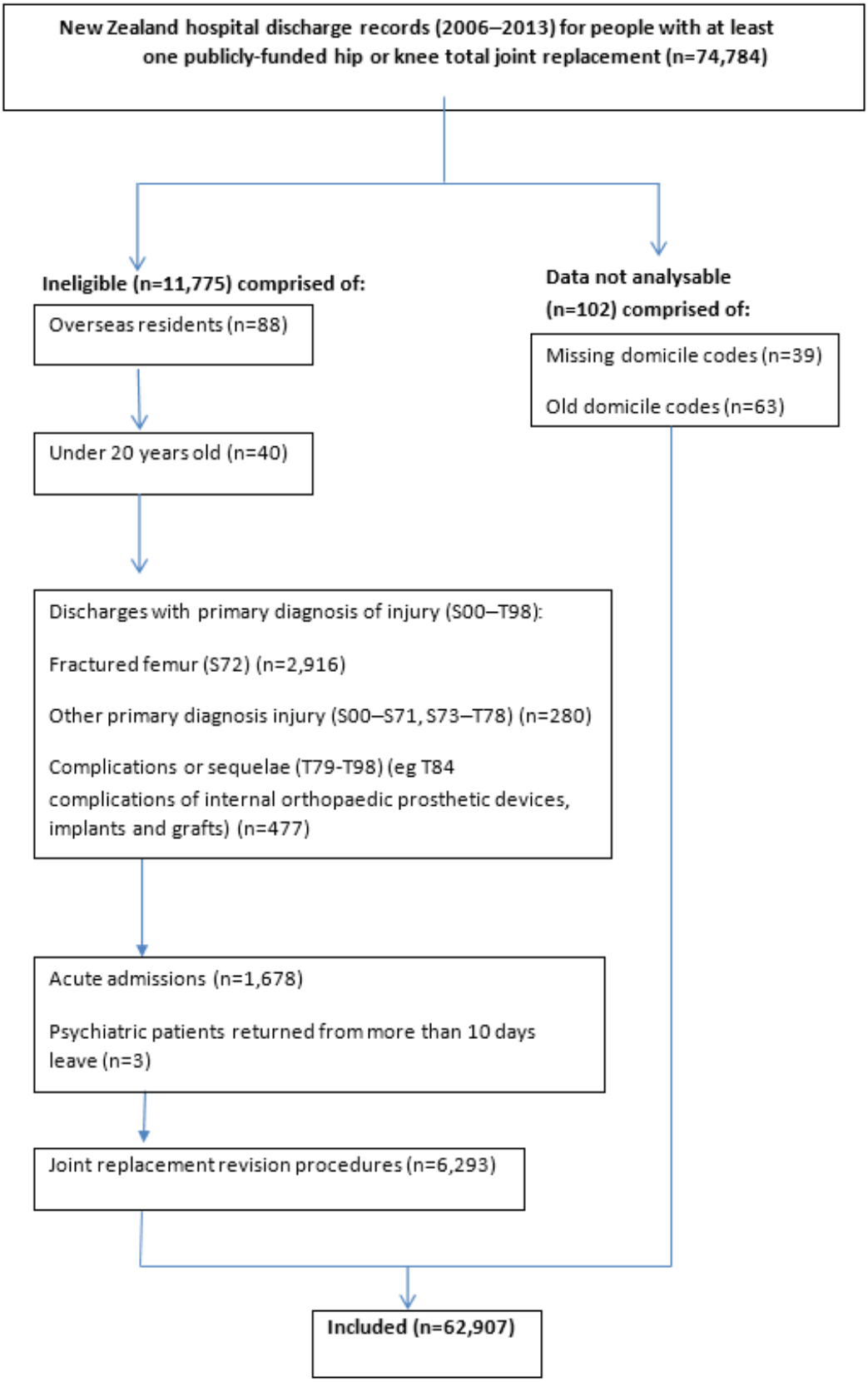
New Zealand hospital discharge records (2006–2013) for people with at least one publicly-funded hip or knee total joint replacement (n=74,784)
Ineligible (n=11,775) comprised of:
Overseas residents (n=88)
Under 20 years old (n=40)
Data not analysable (n=102) comprised of:
Missing domicile codes (n=39)
Old domicile codes (n=63)
Discharges with primary diagnosis of injury (S00–T98):
Fractured femur (S72) (n=2,916)
Other primary diagnosis injury (S00–S71, S73–T78) (n=280)
Complications or sequelae (T79-T98) (eg T84 complications of internal orthopaedic prosthetic devices, implants and grafts) (n=477)
Acute admissions (n=1,678)
Psychiatric patients returned from more than 10 days leave (n=3)
Joint replacement revision procedures (n=6,293)
Included (n=62,907)

Table 1: Publicly-funded primary total hip and knee joint replacement procedures in those aged 20 years and over, 2006–2013 by District Health Board (DHB).

District Health Board	Overall N	Bilateral %	Population*	Overall Crude Rate** (95% CI)	Ranking/20***
Auckland	3,472	1.8	330,660	131.3 (126.9, 135.7)	20
Bay of Plenty	4,373	1.9	149,663	365.2 (354.5, 376.2)	5
Canterbury	6,781	2.5	367,993	230.3 (224.9, 235.9)	16
Capital and Coast	3,001	5.4	211,259	177.6 (171.3, 184.0)	19
Counties Manukau	5,636	2.8	318,674	221.1 (215.3, 226.9)	17
Hawke's Bay	2,703	0.2	109,900	307.4 (296.0, 319.3)	11
Hutt Valley	1,918	5.3	100,735	238.0 (227.5, 248.9)	15
Lakes	1,827	1.4	71,043	321.5 (306.9, 336.6)	9
Mid Central	2,719	1.2	118,968	285.7 (275.1, 296.6)	12
Nelson Marlborough	3,015	2.4	102,653	367.1 (354.2, 380.5)	4
Northland	2,987	1.8	112,131	333.0 (321.2, 345.1)	8
South Canterbury	1,460	0.3	41,890	435.7 (413.6, 458.6)	3
Southern	4,734	2.7	222,008	266.5 (259.0, 274,2)	14
Tairawhiti	889	0.1	31,134	356.9 (333.8, 381.2)	7
Taranaki	2,013	1.3	79,248	317.5 (303.8, 331.7)	10
Waikato	5,757	1.4	256,493	280.6 (273.4, 287.9)	13
Wairarapa	866	0.9	29,839	362.8 (339.0, 387.8)	6
Waitemata	6,274	2.0	378,591	207.1 (202.1, 212.3)	18
West Coast	871	0.6	24,241	449.1 (419.8, 480.0)	1
Whanganui	1,611	0.8	45,012	447.4 (425.8, 469.8)	2
Total	**62,907**	**2.1**	**3,102,133**	**253.5 (251.5, 255.5)**	

*Population = Average DHB population for 2006–2013 of those aged 20 years and over.
** Rate/100,000 person years.
***Ranking is from highest to lowest overall crude rate for the 20 DHBs.

Table 2: Publicly-funded hip and knee total joint replacement procedures in New Zealand for those aged 20 years and over from 2006–2013 by year.

Discharge Year	Denominator	Number	Rate*	95% CI
2006	2982345	7,053	236.5	(231.0, 242.1)
2007	3015800	7,943	263.4	(257.6, 269.2)
2008	3046505	7,535	247.3	(241.8, 253.0)
2009	3083845	7,934	257.3	(251.7, 263.0)
2010	3124770	7,745	247.9	(242.4, 253.4)
2011	3158140	7,950	251.7	(246.2, 257.3)
2012	3185125	8,318	261.2	(255.6, 266.8)
2013	3220535	8,429	261.7	(256.2, 267.4)

*Rate/100,000 person years of those aged 20 years and over.

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Nationally, the number of publicly-funded hip and knee TJR procedures increased by 19.5% from 7,053 in 2006 to 8,429 in 2013 (Table 2) while the rate increased by only 10.7%. The rate peaked in 2007 at 263/100,000 py before decreasing (2008–2011) and returning to 261 and 262/100,000 py in 2012 and 2013 respectively. Although there was a statistically significant increase in the rates from 2006 onwards (p-value <0.001), there is no evidence to suggest a linear change in the rates from 2007 onwards (p-value=0.2).

From 2006 to 2013 inclusive, the highest rate of publicly-funded hip and knee TJR procedures was for those aged 75–84 years at the time of surgery (1,063/100,000 py) followed by those aged 65–74 (907/100,000 py), with the lowest rate among those aged less than 55 years (45/100,000 py) (Table 3). ASRs were significantly higher for females (260/100,000 py) than for males (246/100,000 py).

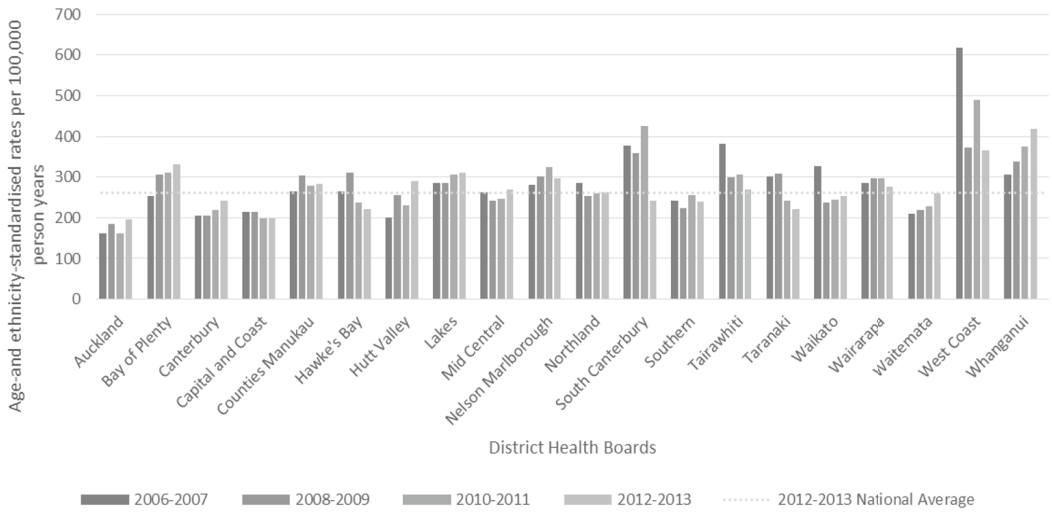
The crude TJR rate of 300/100,000 py was highest among those categorised as 'Other' ethnicity (ie those not identifying

Table 3: Publicly-funded primary hip and knee total joint replacement procedures for those aged 20 years and over for 2006–2013 by socio-demographic characteristics.

	Denominator*	N	Annual crude rate	(95% CI)**	ASR***	(95% CI)
Overall	**3,102,133**	**62,907**	**253.5**	**(251.5, 255.5)**	--	-- --
Age group (years)						
<55	2,066,311	7,405	44.8	(43.8, 45.8)	--	-- --
55–64	474,338	14,939	393.7	(387.4, 400.0)	--	-- --
65–74	311,123	22,581	907.2	(895.4, 919.2)	--	-- --
75–84	183,611	15,611	1062.8	(1046.2, 1080.0)	--	-- --
85+	66,751	2,371	444.0	(426.3, 462.2)	--	-- --
Sex						
Female	1,612,114	34,075	264.2	(261.4, 267.0)	259.7	(257.0, 262.5)
Male	1,490,019	28,832	241.9	(239.1, 244.7)	246.2	(243.4, 249.1)
Prioritised Ethnicity						
Māori	366,255	5,793	197.7	(192.7, 202.9)	303.1	(294.8, 311.5)
Pacific	158,319	1,809	142.8	(136.3, 149.6)	224.2	(213.4, 235.0)
Asian	327,923	1,259	48.0	(45.4, 50.7)	93.8	(88.2, 99.3)
Other****	2,249,636	54,046	300.3	(297.8, 302.9)	258.3	(256.1, 260.4)
Rurality						
Main Urban Area	2,037,012	40,003	245.5	(243.1, 247.9)	258.6	(256.1, 261.1)
Other Urban Area	399,417	14,672	459.2	(451.8, 466.7)	361.6	(355.7, 367.5)
Rural	362,802	8,230	283.6	(277.5, 289.8)	295.9	(289.4, 302.3)
NZDep						
1–3 (least deprived)	785,292	13,314	211.9	(208.3, 215.6)	219.6	(215.9, 223.4)
4–7	1,136,757	26,780	294.5	(291.0, 298.0)	279.9	(276.6, 283.3)
8–10 (most deprived)	877,113	22,806	325.0	(320.8, 329.3)	342.0	(337.6, 346.5)

*Uses 2006–2013 resident population estimates for all except Rurality and NZDep comparisons which use 2006 usually resident Census counts.
**Rate/100,000 person years (≥20 year- olds).
***Age-standardised rate.
****The numerator of those classified as 'other' ethnicity includes those with ethnicity recorded as 'Don't Know,' 'Refused to answer,' 'Response unidentifiable' or 'Not Stated' to align with denominator.

Figure 2: Age- and ethnicity-standardised rates of publicly-funded hip and knee total joint replacements per 100,000 person-years by District Health Board from 2006–2013.



as Māori, Pacific or Asian). Māori had the second highest crude rate (198/100,000 py). However, Māori had the highest ASR of procedures (303/100,000 py) followed by those of 'Other' and Pacific ethnicities (258 and 224/100,000 py respectively). Those of Asian ethnicity had a substantially lower ASR (94/100,000 py). Differences in crude and ASRs between prioritised ethnic groups were all statistically significant.

Rates were highest for people living in 'Other Urban Areas' (ie urban areas other than those classified as centred on a city or main urban centre) with a crude rate of 459/100,000 py and an ASR of 362/100,000 py). This ASR was significantly higher than the ASR for those in 'Rural' (296/100,000 py) and 'Main Urban Areas' (259/100,000 py).

There was a clear linear relationship between TJR procedure rates and socio-economic deprivation, with people that lived in the most deprived three deciles (deciles 8–10) having a significantly higher ASR (342/100,000 py) than those in deciles 4–7 (280/100,000 py) and similarly those who lived in the least deprived deciles (deciles 1–3) had a substantially lower ASR again (220/100,000 py).

Of the 20 DHBs, 10 had increases in their age- and ethnicity-standardised rate (AESR) of TJR procedures between the periods 2006–07 to 2012–13, one was unchanged and nine had a reduced rate (Figure 2). Of the eight largest DHBs by population, five had an increase in AESR: Bay of Plenty (31%), Auckland (22%), Waitemata (25%), Canterbury (19%) and Counties Manukau (7%). Southern's AESR remained unchanged and Capital Coast's and Waikato's fell by 7% and 22% respectively. In contrast, AESRs fell between the periods 2006–07 to 2012–13 in seven of the 12 smaller DHBs: West Coast, Wairarapa, Tairawhiti, South Canterbury, Taranaki, Hawke's Bay and Northland. However, in 2012–13, the six smallest DHBs by population (with the exception of South Canterbury) had AESRs higher than five of the six DHBs with the largest populations. Five of the eight largest DHBs (Auckland, Canterbury, Capital and Coast, Southern and Waikato) were below the New Zealand average of 261/100,000 py in 2012–13 as were three of the smallest DHBs (Hawkes Bay, Taranaki and South Canterbury). To assess whether the variation in AESRs by DHB had changed over time, the standard deviation of DHB's AESRs for 2006–07 was compared with that from the rates for 2012–13. Excluding one outlier (West Coast), there was no statistically significant difference over time (ratio of standard deviations 1.13, (95% CI 0.70, 1.82), p=0.6).

There were also variations by DHB for those in the most deprived deciles. For those in the most deprived three deciles, considering the eight years of the study combined, the ASRs varied from 236/100,000 py (Auckland) to 514/100,000 py (South Canterbury) (results not shown). Again, the smaller DHBs had greater provision within this group of the population, with the five smallest DHBs by population having ASRs of at least 400/100,000 pys, a rate which was not reached for the most deprived deciles in any of the other larger DHBs.

Discussion

This study demonstrates that national rates of publicly-funded elective hip and knee TJR procedures have not increased beyond their 2007 peak. Higher rates were observed in older adults, females, those not living in 'Rural' or 'Main Urban Areas' and those living in areas of greater social deprivation. Rates varied between DHBs, even when age- and ethnicity-standardised. In general, there were higher rates of the provision of publicly-funded hip and knee TJR procedures among the smallest DHBs in New Zealand compared with the largest population DHBs in 2012–13.

A strength of this study was the use of consistently collected data for the entire New Zealand population. A limitation is that domicile was obtained from the National Health Index database which is updated when patients present at their DHB and therefore may no longer reflect the domicile as it was at the time of surgery for all participants. This study is restricted to publicly-funded procedures, therefore it does not consider the overall provision of TJR surgery, some of which are privately-funded. Comparing NMDS discharge data of publicly-funded hip and knee TJR with National Joint Registry data which includes both privately- and publicly-funded procedures,[4] it appears that approximately 65% of TJR were publicly-funded in New Zealand between 2006–2012. The provision of privately-funded procedures may vary by DHB and may influence the provision of publicly-funded procedures. Derrett et al[11] previously reported that DHBs with low rates of publicly-funded hip and knee TJR procedures had high rates of privately-funded procedures. A further limitation of our analyses is that we have reported on the provision of TJR; provision does not necessarily reflect demand for procedures or the severity of disease. Previous research has suggested that there is unmet need for these procedures in New Zealand.[9,13] Demand may vary across the country[9] and in some DHBs, 33–41% of patients listed for TJR are being returned to their General Practitioner without surgery due to waiting time targets.[20] There was an increase in the number of publicly-funded hip and knee TJR procedures carried out nationally between 2006 and 2013 in those aged 20 years and over. However, the bulk of the increase in both numbers and rate occurred between 2006 and 2007 as the Orthopaedic Joint Initiative ("…a programme of increased funding specifically targeting major joint replacement…") (p.15)[21] finished. During the period of this study, 2006–2013, the rate was highest in 2007. Between 2007 and 2013 the number of publicly-funded TJR procedures increased by 486 (6%) but the rate decreased by 0.6% suggesting that the increased number of publicly-funded TJR procedures is barely keeping up with population increases. Hooper et al[22] have predicted that numbers of hip and knee replacements will increase significantly by 2026. Such a predicted increase has clear implications for public funding of TJRs. The highest rate of hip and knee TJR procedures was for those people aged 75–84 years followed by 65–74 year olds. This is not surprising and aligns with the higher prevalence of OA among older age groups.[5] As life expectancy increases, it is likely that demand in the over 85 year-olds will increase.

Although the rate of procedures was higher among females, the difference between males and females was relatively small and probably reflects the higher prevalence of OA among women.[5]

Nationally, people in the least deprived deciles had the lowest rate of publicly-funded TJR procedures while those in the most deprived deciles had the highest rate. This is open to a number of different interpretations. Poorer access to medical care in the lower deciles might be expected to lead to a decreased rate of TJR rather than the increased rate seen. It is likely that there is greater use of private surgery by those of higher socio-economic status either through insurance or self-funding. However the findings may also reflect greater need for TJR among people of lower socio-economic status (for example, if need is related to type of occupation). However, no direct link between socio-economic deprivation and joint replacement has yet been identified other than possibly obesity; people in the most deprived areas of New Zealand having higher rates of obesity compared with those in the least deprived areas.[23]

Nationally, by prioritised ethnicity, Māori had the highest ASR of publicly-funded TJR

procedures. In a series of patients from a regional registry, Singleton et al[24] found that Māori were younger, had poorer pre-operative function than non-Māori patients and comprised 13.7% of their TJR procedures but only 11.2% of their population. Hooper et al[22] reported a relative rate in Māori of 0.72 for hip and 0.76 for knee TJR compared with those of 'European' ethnicity using data from the New Zealand Joint Registry. The main differences between that study and the current study are that privately-funded and acute procedures are included in the Joint Registry figures and that their analysis was based on joints not procedures. Their use of total response rather than prioritised ethnicity will not affect the rate for Māori as Māori are given top priority in our analysis by prioritised ethnicity. It is possible that lower rates of private utilisation among Māori may explain the difference in findings. It is not clear whether the higher rate of TJR in the current study is a reflection of an additional need among Māori or whether it is due to greater demand in the public sector due to lower private provision. It has been recognised previously that ethnicity data collected in the NMDS may undercount people of Māori ethnicity[25] which may have influenced the findings of this study. However, if Māori undergoing TJR surgery were less likely to be classified as Māori in the NMDS, the rate reported for Māori would be an under-estimate. It is unclear why rates were substantially lower among those of Asian ethnicity compared with those of Māori, Pacific or 'Other' ethnicities. It is possible that this may relate to more privately-funded procedures among this ethnic group. However Hooper et al[22] found similar results while including privately-funded procedures and suggested that older Asians living in New Zealand may return to their home country for joint surgery.[22] The ASR of TJR for people of Pacific ethnicity was over twice the rate for those of Asian ethnicity but was still significantly lower than the rate for those of Māori and 'Other' ethnicities. It is unclear why this is the case given Pacific people are highly represented in the most deprived areas of New Zealand and have higher rates of obesity compared with other ethnicities.[23] As the DHB-level denominator data was only available by 'prioritised ethnicity,' estimates for Pacific people do not include those who identified with both Māori and Pacific ethnic groups. Similarly, those who responded as being of both Pacific and Asian ethnicity are only included as Pacific.

There were differences in procedure rates by rurality with the highest rate for those living in 'Other Urban Areas' and the lowest rate for those in 'Main Urban Areas.' The lower rate for those living in 'Main Urban Areas' may have been influenced by a greater availability of private procedures in these areas but we cannot determine that in this study. While there may be some relationship between rurality and DHB-specific rates, the denominator data available for this analysis precluded examining this.

In the current study, AESRs varied by DHB with a 3.8 fold rate variation between lowest and highest in 2006–07 and a two-fold rate variation in 2012–13. However, if one outlier was excluded, there was no statistically significant change in the variation between DHBs from 2006–07 to 2012–13. In other words, there has been no apparent improvement in the equity of provision of publicly-funded TJR across DHBs over the eight years of the study period. Derrett et al,[11] although not standardising for ethnicity and also including revision procedures, reported nearly a five-fold variation of ASRs for publicly-funded TJR between DHBs in 2001–2002. They also reported geographic inequity for those in the poorest three deciles and found that rates of publicly-funded procedures were lowest for this group of people in DHBs that had the highest rates of privately-funded procedures.[11] Examining the ASR of publicly-funded TJR procedures by DHB for those in the most deprived deciles in the current study also found that rates varied considerably.

The larger DHBs typically had lower rates of publicly-funded TJR compared with the smaller DHBs and five of the eight largest DHBs had rates that were below the New Zealand average in 2012–13. These findings indicate that those living within the largest DHBs (by population) may be disadvantaged in terms of access to publicly-funded hip and knee TJR surgery. We cannot determine the reasons behind these findings. There may be greater access to private surgery in the larger DHB regions which may reduce

the demand for public surgery. It has also been suggested that higher rates of private surgery could lead to lower rates of publicly-funded surgery due to surgeons not being available for public work.[11] Other factors such as high acute loads and complex tertiary referrals, which are likely to be more common in larger DHBs, may also influence access to publicly-funded procedures.

Conclusion

Despite an increase in the number of publicly-funded hip and knee TJR procedures between 2006 and 2013, the national increase in rate has been negligible since 2007 suggesting that the increased number of procedures may be only just keeping up with increases in the population. While the data demonstrated higher rates in older adults, females, people of Māori ethnicity, and those living in areas of greater social deprivation and 'other urban areas,' there was no systematic evidence of inequities disadvantaging vulnerable, higher needs or isolated groups, although this study did not include privately-funded procedures. In general, there were higher rates of the provision of publicly-funded hip and knee TJR procedures among the smallest DHBs in New Zealand, by population, compared with the largest population DHBs. The finding that rates vary between DHBs, even when age- and ethnicity- standardised, suggest equity among DHBs is not being achieved nationally. This indicates that further work is required to meet one of the key objectives in the New Zealand Ministry of Health's programme for elective surgery which is to "Work towards everyone having equal access to elective surgery no matter where they live".[26] Further research, using validated scoring tools, is needed to compare access to TJR according to need and to examine reasons behind differences in provision.

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