



## ■ ARTHROPLASTY

# Patient-reported outcomes after hip and knee arthroplasty

## RESULTS FROM A LARGE NATIONAL REGISTRY

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### Aims

This study aims to describe the pre- and postoperative self-reported health and quality of life from a national cohort of patients undergoing elective total conventional hip arthroplasty (THA) and total knee arthroplasty (TKA) in Australia. For context, these data will be compared with patient-reported outcome measures (PROMs) data from other international nation-wide registries.

### Methods

Between 2018 to 2020, and nested within a nationwide arthroplasty registry, preoperative and six-month postoperative PROMs were electronically collected from patients before and after elective THA and TKA. There were 5,228 THA and 8,299 TKA preoperative procedures as well as 3,215 THA and 4,982 TKA postoperative procedures available for analysis. Validated PROMs included the EuroQol five-dimension five-level questionnaire (EQ-5D-5L; range 0 to 100; scored worst-best health), Oxford Hip/Knee Scores (OHS/OKS; range 0 to 48; scored worst-best hip/knee function) and the 12-item Hip/Knee disability and Osteoarthritis Outcome Score (HOOS-12/KOOS-12; range 0 to 100; scored best-worst hip/knee health). Additional items included preoperative expectations, patient-perceived improvement, and postoperative satisfaction. Descriptive analyses were undertaken.

### Results

For THA and TKA patients respectively, the patient profile was 2,850 (54.5%) and 4,684 (56.4%) female, mean age 66.8 years (SD 10.6) and 67.5 (SD 8.8), and mean BMI 29.9 kg/m<sup>2</sup> (SD 7.7) and 32.5 kg/m<sup>2</sup> (SD 7.0). The proportion of THA and TKA patients who reported their joint as 'much better' was 2,946 (92.6%) and 4,020 (81.6%) respectively, and the majority of patients were 'satisfied' or 'very satisfied' with their procedure (2,754 (86.5%) and 3,981 (80.8%)). There were 311 (9.7%) of THA patients and 516 (10.5%) of TKA patients who reported 'dissatisfied' or 'very dissatisfied' with their surgery.

### Conclusion

Large improvements in pain, function, and overall health were evident following primary THA and TKA. Approximately 10% of patients reported dissatisfaction with their surgery. Future analyses will focus on factors contributing to dissatisfaction after arthroplasty.

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### Introduction

Arthroplasty registries typically collect a defined minimum dataset with a primary outcome measure of revision surgery.<sup>1</sup> Recent health policy reforms have led to review processes within orthopaedic registries and the type of data being collected. There is a global emphasis on expanding

data collection beyond implant attributes and prosthesis survival, to include patient-reported outcome measures (PROMs) that provide an important patient perspective on surgical outcomes and inform clinical decision-making processes.<sup>2</sup>

PROMs are standardized, validated questionnaires completed by patients to ascertain

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perceptions of their health status, perceived level of impairment, disability, and health-related quality of life.<sup>3</sup> The data collected can be used at the patient level, facilitating discussions and appropriate intervention with their orthopaedic surgeon and other healthcare professionals. PROMs collection can enable clinicians to provide real-time feedback to patients, enabling comparison of their results with a broader cohort of patients, providing reassurance and identifying issues requiring intervention. At a broader level, PROMs collection can facilitate quality improvement processes including identifying healthcare delivery strengths and weaknesses within a region, hospital, or practice. Furthermore, PROMs can inform clinical decision-making by refining thresholds for surgery and they have the capacity to identify early warning signs in order to improve the overall quality of patient care.<sup>4</sup>

Orthopaedic registries are internationally recognized as a robust and powerful way to establish data collection processes and have demonstrated success in PROMs collection. To date, there are no reports of large-scale national PROMs collection programs involving patients undergoing arthroplasty in Australia. Nevertheless, Wilson et al<sup>2</sup> reported that, internationally, there are approximately 18 orthopaedic registries collecting PROMs including at least a sample of hip and knee arthroplasty patients. However, there is considerable variability with regard to the timing of PROMs collection and instrument selection, as well as differences in sampling and volume of missing data between registries. The International Society of Arthroplasty Registries have provided advice on selecting PROMs instruments, recommending that the instrument or specific PROMs questions should be appropriately developed with the relevant population group and measurement properties specific to arthroplasty patients.<sup>5</sup>

The purpose of this study is to describe the pre- and postoperative self-reported health and quality of life status of a large cohort of patients undergoing elective hip or knee arthroplasty surgery in Australia. A descriptive comparison with international nationwide registries will also be undertaken, to provide context for the Australian data.

## Methods

**Data collection.** The study was nested within the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR), a national registry that validates more than 97.8% of arthroplasty procedures for all Australian hospitals that perform arthroplasty (approximately 320), through a matching process with state and territory health department records.<sup>1,6</sup> Between July 2018 and April 2020, the AOANJRR conducted a PROMs pilot study that assessed the capacity to directly consent patients and collect preoperative and six-month

postoperative PROMs electronically. A total of 44 hospitals across Australia were involved in the pilot, including metropolitan and regional, and private and public hospitals from all states and one territory.

Data collection involved initial (preoperative) direct electronic registration of patients at hospital preadmission clinics or private surgeon clinics, which occurred prior to the patient's arthroplasty procedure into an automated registry nested electronic data collection platform called RAPID (Real-time Automated Platform for Integrated Data capture, a platform designed and built within the South Australian Health and Medical Research Institute (SAHMRI) specifically for the AOANJRR). Patients could also register themselves into RAPID, which was communicated to patients at their pre-admission clinic. RAPID was available for use on multiple devices including smartphones, tablets or computers, using Android or iOS platforms. After electronic registration, patients were requested to provide consent and then commence the online PROMs survey questions. The survey questions could be completed at a time convenient to the patient, with resumable data collection available. Automated electronic reminders were sent to patients to complete their PROMs; RAPID allowed for a set number of reminders to be sent pre- and postoperatively by email (with an embedded link to the online survey) or text message, depending on the contact details provided by the patient during the registration process. Patients who had not completed their PROMs after three automated reminders were flagged for phone call follow-up.

Routinely collected registry data (including diagnosis, type of arthroplasty, patient age, sex, BMI, American Society of Anesthesiologists (ASA) score,<sup>7</sup> and surgical approach (hip only) were matched to all patients who provided PROMs data.

**Patient selection.** All patients undergoing a primary or revision hip or knee arthroplasty procedure from the 44 hospitals were invited to participate in the PROMs programme. Data on shoulder arthroplasties were also collected; however, given the relatively small sample ( $n = 845$ ) these data are not reported here. Hospitals were encouraged to register all patients regardless of their diagnosis. For the purposes of this analysis, we focused on primary procedures performed for osteoarthritis (OA), because it is the most common indication for total conventional hip arthroplasty and total knee arthroplasty. Patients could be registered and give consent for more than one procedure.

**Instrument and survey question selection.** PROMs instruments included the EuroQol five-dimension five-level questionnaire (EQ-5D-5L; all patients), Oxford Hip/Knee Scores (OHS/OKS; all patients),<sup>8-10</sup> and HOOS-12/KOOS-12 (optional completion given their recency and limited psychometric evidence); instrument selection was determined by an international expert panel, based on

**Table 1.** Survey questions for patient-reported outcome measures collected as decided by the international expert panel.

Question	Answers/Options
<b>Pain Questions</b>	
<p><b>Affected Joint Pain</b></p> <p>Patients were asked pre- and postoperatively: On a scale of 0 to 10. 0 being no pain at all. 10 being the worst pain imaginable. Please use the slider to indicate your average pain over the last 7 days in your [left/right] [hip/knee] which [will be/was] operated on.</p>	See Figure 1.
<p><b>Lower Back Pain</b></p> <p>Patients were asked pre- and postoperatively: On a scale of 0 to 10. 0 being no pain at all. 10 being the worst pain imaginable. Please use the slider to indicate the average pain over the last 7 days in your lower back.</p>	See Figure 1.
<b>Satisfaction Questions</b>	
<p>Patients were asked postoperatively: Please select ONE box which best describes how satisfied you are with the results of your [left/right] [hip/knee] arthroplasty?</p>	<p>Very dissatisfied Dissatisfied Neutral Satisfied Very satisfied</p>
<b>Joint Improvement Questions</b>	
<p>Patients were asked postoperatively: Please select ONE box which describes overall, how the problems are now with your [hip/knee] on which you had surgery, compared to before you had your operation?</p>	<p>Much better A little better About the same A little worse Much worse</p>
<b>Expectation Questions – All Joints</b>	
<b>Pain Expectation</b>	
<p>Patients were asked preoperatively: On a scale of 0 to 10. 0 being no pain at all. 10 being the worst pain imaginable. Please use the slider to indicate what you expect your average pain to be in 6 months' time in your [left/right] [hip/knee] which will be operated on.</p>	See Figure 1.
<b>Patients were asked postoperatively:</b>	
<p>On a scale of 0 to 10. 0 being no pain at all. 10 being the worst pain imaginable. Please use the slider to indicate your average pain over the last 7 days in your [left/right] [hip/knee] which was operated on.</p>	
<b>Mobility Expectation</b>	
<p>Patients were asked preoperatively: Please select ONE box that best describes how you think your mobility will be in 6 months' time. Patients were asked postoperatively: Please select ONE box that best describes your health TODAY.</p>	<p>Preoperative options: I will have no problems with walking around I will have slight problems with walking around I will have moderate problems with walking around I will have severe problems with walking around I will be unable to walk around Postoperative options: I have no problems with walking around I have slight problems with walking around I have moderate problems with walking around I am unable to walk around</p>
<b>Health expectation</b>	
<p>Patients were asked preoperatively: We would like to know how good or bad you expect your health to be in 6 months' time. This scale is numbered from 0 to 100. 100 means the best health you can imagine. 0 means the worst health you can imagine. Please use the slider to indicate how you think your health will be in 6 months' time. Patients were asked postoperatively (EQ-VAS): This scale is numbered from 0 to 100. 100 means the best health you can imagine. 0 means the worst health you can imagine. Please use the slider to indicate how your health is TODAY.</p>	See Figure 2.
EQ-VAS, EuroQol visual analogue scale.	

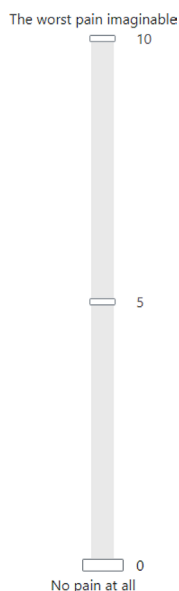


Fig. 1

A sliding scale available for patients to use with their mouse cursor within the Real-time Automated Platform for Integrated Data capture (RAPID) platform.

supporting psychometric evidence and contemporary clinical use.<sup>11–16</sup> Additional survey questions were also chosen by the expert panel and are listed in Table I.

**Statistical analysis.** Descriptive data analysis was performed using SAS software v. 9.4 (SAS Institute, USA). All numerical data are presented as mean and standard deviation (SD). Categorical data are presented as proportions. Differences between pre- and postoperative EQ-5D-5L scores were analyzed using chi-squared tests. Differences for all other outcomes were analyzed using a linear regression model with generalized estimating equations to account for the correlation between pre- and postoperative scores for the same patients. A p-value of < 0.05 was considered significant.

**Results**

Between July 2018 and April 2020, there were 16,770 procedures initially registered for PROMs collection in patients undergoing a primary hip or knee arthroplasty and with a diagnosis of OA. Of these procedures, 1,469 declined or opted out of the study and 14,058 consented for PROMs data collection. There were 13,527 procedures from 12,580 patients that provided preoperative responses; 5,228 total conventional hip arthroplasty procedures and 8,299 total knee arthroplasty procedures. For patients who commenced the pre- and postoperative PROMs survey, the response rate was 13,059 (96.5%) and 8,109 (98.9%) respectively, excluding completion of the optional HOOS-12/KOOS-12 with a pre- and postoperative response rate of 8,034 (59.4%) and 5,417 (66.1%), respectively. Patients completed preoperative PROMs at a mean of 0.93 months (SD 1.47) before surgery and postoperative PROMs at a mean (SD) of 6.10 (0.75) months

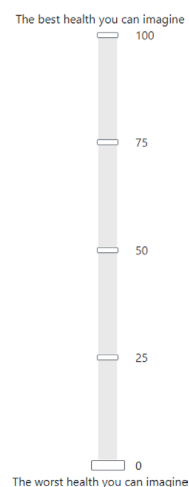


Fig. 2

A sliding scale available for patients to use with their mouse cursor within the Real-time Automated Platform for Integrated Data capture (RAPID) platform.

**Table II.** Patients characteristics by arthroplasty type (primary diagnosis of osteoarthritis).

Characteristic	THA	TKA
Total, n	5,228	8,299
Mean age, yrs (SD)	66.8 (10.6)	67.5 (8.8)
Female, n (%)	2,850 (54.5)	4,684 (56.4)
Mean BMI, kg/m <sup>2</sup> (SD)	29.9 (7.7)	32.5 (7.0)
<b>ASA grade, n (%)</b>		
1	402 (7.7)	383 (4.6)
2	2,927 (56.1)	4,443 (53.7)
3	1,834 (35.1)	3,379 (40.8)
4	58 (1.1)	76 (0.9)

ASA, American Society of Anesthesiologists; SD, standard deviation; THA, total hip arthroplasty; TKA, total knee arthroplasty.

after surgery. Demographic and clinical characteristics for the cohort are presented in Table II.

The pre- and postoperative PROMs data for hip and knee arthroplasty patients are outlined in Table III and Table IV. Patients’ mobility expectations were high preoperatively, with most patients expecting ‘no problems’ or ‘slight problems’ with mobility after their procedure; 4,713 (91.4%) for hips and 7,252 (88.6%) for knees. Mobility reported at six months (as measured by the ED-5D-5L mobility dimension) was similar to what patients expected; 2,707 (84.2%) of hip and 4,084 (82.0%) of knee arthroplasty patients reporting ‘no problems’ or ‘slight problems’. Hip arthroplasty patients expected higher pain levels preoperatively (mean of 1.6 (SD 2.5)), than what they experienced postoperatively (mean of 1.4 (SD 2.2); as measured by affected joint pain). Knee arthroplasty patients expected lower pain levels preoperatively (mean of 2.1 (SD 2.6)), than what they experienced postoperatively (mean of 2.3 (SD 2.4) as measured by affected joint pain). The mean expected health was 85.9 (SD 16.5) for hips and 84.5 (SD 16.0)

**Table III** Patient-reported outcome measures of patients undergoing primary total conventional hip arthroplasty (primary diagnosis of osteoarthritis).

Question	Preoperative (n = 5,228)	Postoperative (n = 3,215)	Mean difference (95% CI)	p-value
<b>EQ-5D-5L mobility, n (%)</b>				
No problems	255 (4.9)	1,980 (61.6)		< 0.001*
Slight problems	873 (16.7)	727 (22.6)		
Moderate problems	2,153 (41.2)	355 (11.0)		
Severe problems	1,846 (35.4)	139 (4.3)		
Unable to do	94 (1.8)	14 (0.4)		
<b>EQ-5D-5L personal care, n (%)</b>				
No problems	1,828 (35.0)	2,550 (79.4)		< 0.001*
Slight problems	1,622 (31.1)	502 (15.6)		
Moderate problems	1,367 (26.2)	138 (4.3)		
Severe problems	371 (7.1)	18 (0.6)		
Unable to do	31 (0.6)	3 (0.1)		
<b>EQ-5D-5L usual activities, n (%)</b>				
No problems	374 (7.2)	1,917 (59.7)		< 0.001*
Slight problems	1,249 (23.9)	863 (26.9)		
Moderate problems	2,032 (39.0)	306 (9.5)		
Severe problems	1,257 (24.1)	79 (2.5)		
Unable to do	304 (5.8)	46 (1.4)		
<b>EQ-5D-5L pain/discomfort, n (%)</b>				
No pain	73 (1.4)	1,550 (48.3)		< 0.001*
Slight pain	725 (13.9)	1,133 (35.3)		
Moderate pain	2,320 (44.6)	401 (12.5)		
Severe pain	1,733 (33.3)	110 (3.4)		
Extreme pain	355 (6.8)	15 (0.5)		
<b>EQ-5D-5L anxiety/depression, n (%)</b>				
Not anxious or depressed	2,511 (48.2)	2,469 (76.9)		< 0.001*
Slightly anxious or depressed	1471 (28.3)	486 (15.1)		
Moderately anxious or depressed	956 (18.4)	199 (6.2)		
Severely anxious or depressed	200 (3.8)	42 (1.3)		
Extremely anxious or depressed	68 (1.3)	13 (0.4)		
Mean EQ VAS (SD)	67.0 (20.1)	81.3 (15.6)	14.3 (13.7 to 15.0)	< 0.001†
Mean Lower Back Pain (SD)	4.1 (3.0)	2.7 (3.0)	-1.4 (-1.5 to -1.3)	< 0.001†
Mean Affected Joint Pain (SD)	6.9 (2.1)	1.4 (2.2)	-5.5 (-5.5 to -5.4)	< 0.001†
Mean Oxford Hip Score (SD)	20.5 (8.8)	41.5 (7.4)	21.0 (20.7 to 21.4)	< 0.001†
Mean HOOS-12 Pain Score (SD)	37.7 (18.3)	87.6 (16.7)	49.8 (48.9 to 50.7)	< 0.001†
Mean HOOS-12 Function Score (SD)	44.6 (20.1)	88.6 (14.4)	44.0 (43.1 to 44.8)	< 0.001†
Mean HOOS-12 Quality of Life Score (SD)	30.5 (19.1)	81.0 (19.2)	50.4 (49.5 to 51.4)	< 0.001†
Mean HOOS-12 Summary Score (SD)	37.6 (17.5)	85.7 (15.4)	48.1 (47.3 to 48.9)	< 0.001†
<b>Expected mobility, n (%)</b>				
No problems	3,523 (68.3)			
Slight problems	1,190 (23.1)			
Moderate problems	305 (5.9)			
Severe problems	109 (2.1)			
Unable to do	28 (0.5)			
Mean Expected Joint Pain (SD)	1.6 (2.5)			
Mean Expected Health (SD)	85.9 (16.5)			
<b>Procedure satisfaction, n (%)</b>				
Very satisfied		2,276 (71.5)		
Satisfied		478 (15.0)		
Neutral		119 (3.7)		
Dissatisfied		68 (2.1)		
Very dissatisfied		243 (7.6)		
<b>Joint change, n (%)</b>				
Much better		2,946 (92.6)		
A little better		130 (4.1)		
About the same		55 (1.7)		

Continued



**Table III** Continued

Question	Preoperative (n = 5,228)	Postoperative (n = 3,215)	Mean difference (95% CI)	p-value
A little worse		27 (0.8)		
Much worse		25 (0.8)		

\*Chi-squared test.

†Regression analysis.

CI, confidence interval; EQ-5D-5L, EuroQol five-dimension five-level questionnaire; HOOS, Hip disability and Osteoarthritis Outcome Score; SD, standard deviation; VAS, visual analogue scale.

for knees. Mean actual health as reported by the EQ-VAS at six months postoperatively was similar to expectations for both joints; 81.3 (SD 15.6) for hips and 79.7 (SD 15.8) for knees.

Significant differences between pre- and postoperative responses in all EQ-5D-5L dimensions were observed for hips (Table III) and knees (Table IV). Significant postoperative improvements were also evident for all other outcome measures, for hips (Table III) and knees (Table IV).

AOANJRR PROMs data were compared with other international registries that selected comparable PROMs instruments and items (Table V).

**Discussion**

Large improvements in pain, function, and overall health were evident following primary hip and knee arthroplasty. Notably, there was close alignment between preoperative patient expectations for pain, mobility, and health outcomes, and those same outcomes reported at six months following arthroplasty. This positive finding may indicate that, for many patients, realistic expectations are being set by their treatment surgeon and facilitated through effective preoperative education. Patient-perceived improvement and satisfaction data further highlight the successful surgical outcomes for most patients. There were approximately 10% of patients dissatisfied with their procedure and future analyses will focus on factors contributing to optimal functional and quality of life outcomes after hip and knee arthroplasty.

**International registry comparison.** We can draw comparisons between AOANJRR PROMs data and data reported by other international registries. Comparison between registries provides context to the current findings and enables benchmarking, although differences between countries (including differences in healthcare systems as well as access to and delivery of healthcare) should be acknowledged.<sup>17</sup> However, different PROMs instruments and questions are used by national registries, thus valid comparisons can be challenging and should be made with caution. For example, we were unable to make comparisons with some national registries (American Joint Replacement Registry, Norwegian Arthroplasty Register, Canadian Joint Replacement Registry) due to different PROMs instrument selection as well as availability of

published data. Nevertheless, comparisons with some large national registries can be made.

**UK National Joint Registry.** AOANJRR PROMs data can be compared with some of the NHS England’s national PROMs programme data (through the National Joint Registry), where the NJR similarly collect preoperative and six month postoperative PROMs data for hip and knee arthroplasty patients.<sup>18</sup> For hip arthroplasty patients, the preoperative and postoperative EQ-VAS mean was lower in the NJR compared with the AOANJRR (preoperative 63.5 vs 67.0 and postoperative 77.5 vs 81.3, respectively). UK NJR knee arthroplasty patients also had a lower average pre- and postoperative EQ-VAS compared with AOANJRR data (preoperative 67.9 vs 69.2 and postoperative 75.4 vs 79.7, respectively). Both registries assessed improvement at six months following arthroplasty, using a similarly worded question and five possible response options (from ‘much better’ to ‘much worse’). Following the same trajectory, 86.6% of NJR hip arthroplasty patients reported ‘much better’ compared to 92.6% from the AOANJRR. The NJR also had a lower percentage of patients reporting ‘much better’ for knee arthroplasty patients (75.0% vs 81.6%). There are numerous factors which may account for the differences seen between the two registries. The available NJR summary data included revision procedures,<sup>18</sup> which are known to have poorer patient outcomes, and may negatively skew their findings compared with AOANJRR data, which was restricted to primary joint arthroplasty procedures. Furthermore, the UK NJR data included all procedure types, whereas AOANJRR data was restricted to total knee and total conventional hip arthroplasty patients.<sup>18</sup> Lastly, the two registries are from distinct geographical locations; Grassie et al<sup>19</sup> suggest that geographical factors including ethnicity and culture may affect PROMs responses. Research studies within and between countries and registries have reported differences in patient characteristics, health system structure, healthcare delivery, as well as with PROMs responses themselves, where the advice is to take caution with cross cultural comparisons, particularly with generalizing outcomes.<sup>17,20–22</sup>

**New Zealand Orthopaedic Association Joint Registry.** Comparisons can be drawn between Oxford Hip/Knee scores from the AOANJRR and the closer geographical area of New Zealand (data collected by the

**Table IV.** Patient-reported outcome measures for patients who underwent primary total knee arthroplasty (primary diagnosis of osteoarthritis).

Question	Preoperative (n = 8,299)	Postoperative (n = 4,982)	Mean difference (95% CI)	p-value
<b>EQ-5D-5L mobility, n (%)</b>				
No problems	499 (6.0)	2,599 (52.2)		< 0.001*
Slight problems	1,507 (18.2)	1,485 (29.8)		
Moderate problems	3,844 (46.4)	692 (13.9)		
Severe problems	2,374 (28.6)	198 (4.0)		
Unable to do	68 (0.8)	8 (0.2)		
<b>EQ-5D-5L personal care, n (%)</b>				
No problems	4,849 (58.5)	4,008 (80.6)		< 0.001*
Slight problems	1,928 (23.3)	744 (15.0)		
Moderate problems	1,260 (15.2)	173 (3.5)		
Severe problems	224 (2.7)	38 (0.8)		
Unable to do	27 (0.3)	12 (0.2)		
<b>EQ-5D-5L usual activities, n (%)</b>				
No problems	1,062 (12.8)	2,528 (50.9)		< 0.001*
Slight problems	2,233 (27.0)	1,658 (33.4)		
Moderate problems	3,347 (40.4)	603 (12.1)		
Severe problems	1,396 (16.9)	132 (2.7)		
Unable to do	245 (3.0)	50 (1.0)		
<b>EQ-5D-5L pain/discomfort, n (%)</b>				
No pain	182 (2.2)	1,505 (30.3)		< 0.001*
Slight pain	1,382 (16.7)	2,363 (47.6)		
Moderate pain	4,010 (48.4)	882 (17.8)		
Severe pain	2,331 (28.1)	190 (3.8)		
Extreme pain	376 (4.5)	27 (0.5)		
<b>EQ-5D-5L anxiety/depression, n (%)</b>				
Not anxious or depressed	4,307 (52.0)	3,696 (74.4)		< 0.001*
Slightly anxious or depressed	2,209 (26.7)	836 (16.8)		
Moderately anxious or depressed	1,371 (16.6)	328 (6.6)		
Severely anxious or depressed	297 (3.6)	82 (1.7)		
Extremely anxious or depressed	93 (1.1)	23 (0.5)		
Mean EQ VAS (SD)	69.2 (18.6)	79.7 (15.8)	10.5 (10.0 to 11.0)	< 0.001†
Mean Lower Back Pain (SD)	3.4 (3.0)	2.7 (3.0)	-0.6 (-0.7 to -0.5)	< 0.001†
Mean Affected Joint Pain (SD)	6.7 (2.1)	2.3 (2.4)	-4.4 (-4.5 to -4.4)	< 0.001†
Mean Oxford Knee Score (SD)	22.0 (8.3)	37.6 (8.0)	15.6 (15.3 to 15.8)	< 0.001†
Mean KOOS-12 Pain Score (SD)	39.3 (17.1)	76.9 (19.2)	37.7 (36.9 to 38.4)	< 0.001†
Mean KOOS-12 Function Score (SD)	44.7 (19.4)	80.8 (16.7)	36.1 (35.3 to 36.8)	< 0.001†
Mean KOOS-12 Quality of Life Score (SD)	30.5 (17.8)	70.8 (20.5)	40.3 (39.5 to 41.1)	< 0.001†
Mean KOOS-12 Summary Score (SD)	38.2 (16.3)	76.2 (17.3)	38.0 (37.3 to 38.7)	< 0.001†
<b>Expected mobility, n (%)</b>				
No problems	4,734 (57.8)			
Slight problems	2,518 (30.8)			
Moderate problems	689 (8.4)			
Severe problems	210 (2.6)			
Unable to do	35 (0.4)			
Mean Expected Joint Pain (SD)	2.1 (2.6)			
Mean Expected Health (SD)	84.5 (16.0)			
<b>Procedure satisfaction, n (%)</b>				
Very satisfied		2,828 (57.4)		
Satisfied		1,153 (23.4)		
Neutral		430 (8.7)		
Dissatisfied		212 (4.3)		
Very dissatisfied		304 (6.2)		
<b>Joint change, n (%)</b>				
Much better		4,020 (81.6)		
A little better		523 (10.6)		
About the same		185 (3.8)		

Continued

**Table IV.** Continued

Question	Preoperative (n = 8,299)	Postoperative (n = 4,982)	Mean difference (95% CI)	p-value
A little worse		121 (2.5)		
Much worse		77 (1.6)		

\*Chi-squared test.

†Logistic regression analysis.

CI, confidence interval; EQ-5D-5L, EuroQol five-dimension five-level questionnaire; KOOS, Knee disability and Osteoarthritis Outcome Score; SD, standard deviation; VAS, visual analogue scale.

**Table V.** International registry patient-reported outcome measure comparison.

Question	AOANJRR	NJR	NZJR	Swedish Hip Register	Swedish Knee Register	LROI
<b>Mean EQ-VAS for hips</b>						
Preoperative	67.0	63.5	N/A	N/A	N/A	N/A
Postoperative	81.3	77.5	N/A	N/A	N/A	N/A
<b>Mean EQ-VAS for knees</b>						
Preoperative	69.2	67.9	N/A	N/A	65.0	N/A
Postoperative	79.7	75.4	N/A	N/A	77.0	N/A
Mean joint change for hips, %	92.6	86.6	N/A	N/A	N/A	N/A
Mean joint change for knees, %	81.6	75.0	N/A	N/A	N/A	N/A
<b>Mean Oxford Hip Score (SD)</b>						
Preoperative	20.5 (8.8)	N/A	N/A	N/A	N/A	22.8 (11.5)
Postoperative	41.5 (7.5)	N/A	40.4 (7.6)	N/A	N/A	42.0 (8.3)
<b>Mean Oxford Knee Score (SD)</b>						
Preoperative	22.0 (8.3)	N/A	N/A	N/A	N/A	22.9 (19.2)
Postoperative	37.6 (8.0)	N/A	37.7 (8.0)	N/A	N/A	36.7 (15.14)
<b>Mean EQ-5D-5L Mobility*</b>						
Preoperative	38.4	N/A	N/A	51.2	N/A	N/A
Postoperative	95.1	N/A	N/A	95.0	N/A	N/A
<b>Mean EQ-5D-5L Personal Care</b>						
Preoperative	20.6	N/A	N/A	26.9	N/A	N/A
Postoperative	65.0	N/A	N/A	70.0	N/A	N/A
<b>Mean EQ-5D-5L Usual Activities: Some Problems*</b>						
Preoperative	40.3	N/A	N/A	52.2	N/A	N/A
Postoperative	92.4	N/A	N/A	94.4	N/A	N/A
<b>EQ-5D-5L Pain/Discomfort: Some Pain*</b>						
Preoperative	40.3	N/A	N/A	64.1	N/A	N/A
Postoperative	98.6	N/A	N/A	99.7	N/A	N/A
<b>EQ-5D-5L Anxiety/Depression: Some Anxiety*</b>						
Preoperative	23.1	N/A	N/A	29.8	N/A	N/A
Postoperative	51.8	N/A	N/A	61.4	N/A	N/A
<b>Postoperative satisfaction: Very Satisfied/Satisfied*</b>						
Hips	86.5	N/A	N/A	85.5	N/A	N/A
Knees	80.8	N/A	N/A	N/A	87.0	N/A

\*Categories were dichotomized into ‘some problems’ and ‘no problems’ for mobility, personal care, and usual activities for the EQ-5D. The pain dimension was dichotomized into ‘some pain’ or ‘no pain’ and the anxiety/depression dimension into ‘some anxiety’ or ‘no anxiety’ for the EQ-5D dimensions. AOANJRR, Australian Orthopaedic Association National Joint Replacement Registry; LROI, Dutch Arthroplasty Register; N/A, not available; NJR, National Joint Registry; NZJR, New Zealand Orthopaedic Association Joint Registry.

New Zealand Joint Registry (NZJR)).<sup>23</sup> Notably, the NZJR does not collect preoperative PROMs data, thus drawing conclusions from the similarities observed at the six month timepoint is difficult as potential preoperative differences are unknown.<sup>24</sup> Through the NZJR, Oxford Hip Score was collected from a random sample of patients over a 20-year period (until mid-2019) and at the six-month post-surgery mark, the mean Oxford Hip Score for

primary hip procedures was 40.4 (SD 7.6), compared to 41.5 (SD 7.5) in the current study. This similarity can also be seen with primary knee procedures reported by the NZJR, where the mean Oxford Knee Score was 37.7 (SD 8.0), compared with 37.6 (SD 8.0) from the AOANJRR.

**The Swedish Hip Arthroplasty Register and Swedish Knee Arthroplasty Register.** Some comparison between the AOANJRR and Swedish Hip and Knee Registers can be made,



although this is limited by differing postoperative data collection timepoints (Swedish Register is reporting one-year postoperative PROMs). Due to the ceiling and floor effects seen for numerous PROMs instruments following surgery,<sup>25</sup> and the minimal improvement seen between the six and 12 month recovery period,<sup>26</sup> we have compared the two registries. The Swedish Hip Register transitioned from the three-level EQ-5D to the five-level EQ-5D in 2017 and for ease of comparison between registries, categories were dichotomized into 'some problems' and 'no problems' for mobility, personal care, and usual activities dimensions.<sup>27</sup> The pain dimension was dichotomized into 'some pain' or 'no pain' and the anxiety/depression dimension into 'some anxiety' or 'no anxiety'. For preoperative primary hip arthroplasty procedures in Sweden 'some problems/pain/anxiety', was reported for mobility (95.0%), personal care (70.0%), usual activities (94.4%), pain/discomfort (99.7%), and anxiety/depression (61.4%). The corresponding preoperative values in Australian hip arthroplasty patients were similar; 95.1%, 65.0%, 92.4%, 98.6, and 51.8%, respectively. For all postoperative primary hip arthroplasty EQ-5D-5L dimensions, Sweden reported more problems/pain/anxiety compared with Australia; mobility (51.2% vs 38.4%), personal care (26.9% vs 20.6%), usual activities (52.2% vs 40.3%), pain/discomfort (64.1% vs 40.3%), and anxiety/depression (29.8% vs 23.1%). Browne et al<sup>26</sup> determined in a systematic review that there may be a difference between the benefits of surgery expected at six and 12 months. We hypothesize that the difference of EQ-5D-5L dimensions between registries may be due to the timepoint differences. Nevertheless, overall procedure satisfaction is similar for Sweden and Australia: 85.5% compared with 86.5% respectively, despite the timepoint differences. However, the Swedish Hip Register reports satisfaction on a 0 to 100 scale and supplies a transpose scale to dichotomize the variables allowing a match to the AOANJRR, therefore this cross-nation comparison warrants caution with interpretation.

The Swedish Knee Register can be compared to the AOANJRR for mean EQ-VAS and surgery satisfaction.<sup>28</sup> Preoperative mean EQ-VAS for Sweden was 65.0 (SD 22.0) and postoperatively 77.0 (SD 20.0). For Australia, the corresponding values followed a similar trajectory of 69.2 (SD 18.6) preoperatively and 79.7 (SD 15.8) postoperatively. Procedure satisfaction levels are also comparable with Sweden reporting 87.0% and the AOANJRR, 80.8% for 'satisfied' and 'very satisfied' categories; noting caution due to Sweden's transpose scale to obtain these categories for comparison. The EQ-5D-5L and KOOS-12 could not be compared for knee patients as the Swedish Knee Register collected responses for the 3-level EQ-5D and the full KOOS questionnaire.

**Dutch Arthroplasty Register.** The Dutch Arthroplasty Register (LROI) collects PROMs pre- and postoperatively for hip and knee arthroplasty patients with a primary diagnosis of osteoarthritis.<sup>29</sup> However, their postoperative hip procedure collections were reported at three and 12 months, and

their knee procedure postoperative collections at six and 12 months. The mean Oxford Hip Scores from the LROI and the AOANJRR can be compared, where the respective preoperative mean scores were similar, 22.8 (SD 11.5) for LROI and 20.5 (SD 8.8) for the AOANJRR. Postoperatively the mean scores were again similar between registries (42.0 (SD 8.3) and 41.5 (SD 7.4)), noting a 12-month follow-up timepoint for LROI. The LROI preoperative Oxford Knee Score was 22.9 (SD 19.2) and six-month postoperative mean score of 36.7 (15.14). This is similar to the AOANJRR Oxford Knee Scores of 22.0 (SD 8.3) preoperatively, and 37.6 (SD 8.0) postoperatively. No further PROMs comparisons were made between the AOANJRR and LROI, due to differences in PROMs instrument and question selection.

Overall, when summarizing these registry comparisons, it is apparent that the Australian PROMs following arthroplasty surgery are broadly comparable with those reported for other countries. Further analysis of PROMs data will enable the identification of factors contributing to optimal and suboptimal patient outcomes after arthroplasty surgery in Australia.

This study has several strengths. PROMs data collection was nested within a large nationwide registry which facilitated the collection of comprehensive PROMs data in a relatively short period of time. Additionally, PROMs data collection by the AOANJRR provides new information from a region where systematic PROMs data collection on a large scale had not previously occurred within the orthopaedic field. These data have the capacity to influence practice and improve overall quality of patient care within the region,<sup>4</sup> while enabling international benchmarking. Moreover, another strength of this study is the collection of PROMs data via the purpose-built electronic platform, RAPID. Electronic PROMs collection has proven to be a successful means of outcome data collection, as evidenced by the Function and Outcomes Research for Comparative Effectiveness in Total Joint Replacement (FORCE-TJR) registry that has reported high levels of enrolment and data completion via electronic collection.<sup>30</sup> Additionally, the versatility of electronic collection via RAPID allows for further timepoints to be added for PROMs collection, enabling longer-term assessment of functional and quality of life outcomes.

The intention of this study was to document, for the first time, the pre- and postoperative status of a large national sample of Australians undergoing arthroplasty. It was not intended to examine relationships between demographic factors and outcomes. Nevertheless, we acknowledge the presence of study limitations. Firstly, selection bias may have been introduced with the hospitals participating in the pilot study. Hospitals were selected based on volunteering and by invitation to those hospitals/orthopaedic surgeons who were previously involved with the AOANJRR via existing collaborations. Additionally, HOOS-12 and KOOS-12 instruments were available for optional completion to decrease patient burden; positively, most patients completed the

optional questions (59.40% preoperatively and 66.10% postoperatively), increasing the volume of data collected. A national rollout of PROMs data collection is planned for the Registry which will increase our sample size and capacity to undertake future large-scale analyses. The AOANJRR is also investigating adding further timepoints for PROMs collection beyond six months, which may provide additional data for benchmarking and comparison against international registries. Nevertheless, Canfield et al<sup>31</sup> determined that most of the improvement in PROMs after primary joint arthroplasty surgery occur within the first six months following surgery.<sup>31</sup> Lastly, we acknowledge that a meta-analysis would be the preferred option to compare AOANJRR data against international registries. Presently, this is not feasible given the different timepoints for PROMs collection and instrument selection differences between arthroplasty registries and thus the reason why we have provided a descriptive comparison of international PROMs data compared with AOANJRR data.

This study represents the first systematic collection of PROMs data before and after arthroplasty in Australia by a nationwide registry. Large improvements in pain, function, and overall health scores were evident for primary hip and knee arthroplasty patients. Preoperative patient expectations aligned closely with postoperative outcomes, indicating that realistic expectations are set within the orthopaedic community. There were approximately 10% of patients dissatisfied with their surgery which informs the direction of future analyses and will enable factors contributing to optimal patient outcomes to be identified.

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