BMJ Open

Are we getting better over time? Clinical and patient-reported outcomes for reverse shoulder arthroplasty: a National Joint Registry cohort study

Olivia O'Malley ,[1] Andrew Davies ,[1] Mansour Taghavi Azar Sharabiani ,[2] Amar Rangan ,[3] Sanjeeve Sabharwal,[4] Peter Reilly[1,5]

To cite: O'Malley O, Davies A, Taghavi Azar Sharabiani M, *et al*. Are we getting better over time? Clinical and patient-reported outcomes for reverse shoulder arthroplasty: a National Joint Registry cohort study. *BMJ Open* 2025;**15**:e096084. doi:10.1136/bmjopen-2024-096084

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-096084).

Received 06 November 2024
Accepted 27 August 2025

For numbered affiliations see end of article.

Correspondence to
Olivia O'Malley;
o.omalley23@imperial.ac.uk

ABSTRACT

Objectives This study aims to review whether both clinical and Patient Reported Outcome Measures (PROMs) of Reverse Shoulder Arthroplasty have improved over time using the National Joint Registry (NJR).

Design This study is a population-based cohort study using the NJR and Hospital Episode Statistics for England.

Setting Publicly funded hospitals and procedures in England from 1 January 2013 to 31 December 2021.

Participants All patients that received a reverse shoulder arthroplasty (RSA) in the specified time period. Patients were excluded if they had less than 1 year of follow-up.

Main outcome measures Primary outcome was revision at one year. Secondary outcomes were non-revision re-operation and mortality at one year, length of stay (LOS) and mean change in Oxford Shoulder Score (OSS) from pre-operatively to 6 months post-operatively.

Results There were 24 411 RSA cases available for analysis. There was no significant improvement in revision rates over time; however, there was a significant reduction in non-revision re-operations (OR 0.93 (0.86–0.99) p=0.03) and mortality (0.96 (0.92–1.00) p=0.04). LOS over time improved with an average reduction of 0.24 days per year, ranging from a mean of 3.94 days in 2013 to 2.44 days in 2021 (p<0.001). There was also a significant improvement in OSS preoperatively to 6 months as time progressed (p<0.001) with an average improvement of 0.51 points per year with a mean improvement in 2013 of 15.84 improving to 20.29 in 2021.

Conclusion Over the 9-year period recorded in the NJR, revision rates were low and remained similar. There has, however, been an improvement in other clinical outcomes such as non-revision reoperation and mortality as well as functional outcomes and reduced LOS, which demonstrates progress in the quality of care provided to shoulder replacement patients and is suggestive of advancements in surgical techniques, perioperative management and rehabilitation strategies.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study is the largest study to date looking at outcomes over time of reverse shoulder arthroplasty.
⇒ The study is reflective of the population given the mandatory reporting to the National Joint Registry.
⇒ Due to a merging of the NJR and Hospital Episode Statistics database, there was a reduction in the sample size; however, this study still includes the outcomes of over 24 000 patients.
⇒ The Patient Reported Outcome meas Measures data set had a large proportion of missing data and therefore the results should be interpreted with caution. The low completion rates were, however, consistent across years.

INTRODUCTION

Reverse shoulder arthroplasty (RSA) is the most commonly used shoulder replacement in the UK and despite being originally designed for cuff tear arthropathy, the range of indications as well as patient demographics has expanded substantially.[1] Since the commencement of the National Joint Registry (NJR) in 2012, the percentage of shoulder arthroplasties that are RSAs has increased from 25.7% to 63.4% in 2023.[2] Case numbers of RSA increased up until the pandemic with a peak of 4621 cases per year in 2019 and case numbers in 2023 have exceeded pre-pandemic levels with 5212 cases performed.[2] Case numbers both in the UK and worldwide are expected to continue to increase with an associated significant financial burden to healthcare systems.[3 4]

The current RSA design was conceptualised in the 1970s and this design reversed the anatomy so the socket was placed on the proximal humerus and the humeral head on the glenoid.[5] In order to reduce complications of the original design, several modifications in the implants design have taken place, such as lateralisation at the glenoid component to reduce scapular notching, shortening of the humeral component as well as stemless designs to preserve bone stock and reduce metaphyseal stress and changes in the neck shaft angle to improve stability.[6] As well as implant design, advances in technology such as navigation systems and patient specific implants have changed the way an RSA may be implanted.[7 8]

With this development in implant design as well as increasing surgical experience and case numbers, there is limited evidence on whether both clinical and patient-reported outcomes are improving over time. A systematic review looking at Patient Reported Outcome Measures (PROMs) and re-operation rates from 1990 to 2015 found there was no improvement in reported outcomes in more recent RSA studies.[9] However, a single centre study in the USA reported an increased American Shoulder and Elbow score (ASES) at 5 years by each subsequent year of surgery between 2008 and 2018.[10]

This study aims to assess at population level if the outcomes of RSA both clinically and in terms of PROMs are improving over time using data from the NJR of England, Wales, Northern Ireland, Isle of Man and the States of Guernsey.

METHODS

Data source: the NJR has been routinely collecting data in England, Wales, Northern Ireland, Isle of Man and the States of Guernsey since 2012. The dataset contains pseudo-anonymised patient details, patient demographics, procedure type and the outcome of the patient in terms of 'unrevised', 'revision' or 'death'. The NJR dataset can be linked to the Hospital Episode Statistics (HES) database using the primary NJR index number. The HES database contains medical comorbidities in the form of ICD-10 (International Statistical Classification Of Diseases 10th Revision) codes and operation details in the form of OPCS-4 (Office of Population, Census & Surveys Classification of Surgical Operations & Interventions 4th Revision) codes. Mortality data are obtained from the Office for National Statistics mortality register which is regularly updated and linked to HES data.

Patient and public involvement

Shoulder arthroplasty has been deemed a high research priority by the James Lind Alliance. Research priorities and results are regularly discussed at quarterly PPI (Patient & Public Involvement) meetings at Imperial College London.

Inclusion

Data were requested from the three databases for patients of all ages receiving a reverse shoulder arthroplasty procedure from 1 April 2012 to 31 March 2022. Following the collection of these databases, the files were routinely cleaned and linked. In order to complete an analysis of an annual caseload, patients who had a procedure between 1 January 2013 and 31 December 2021 were included. Patients were excluded if they had less than 1-year follow-up.

Outcomes

Primary outcome was revision at 1 year. Revision was defined as any operation where one or more components are added to, removed from or modified in a joint replacement or if a debridement and implant retention with or without modular exchange is performed.[11] Secondary outcomes include non-revision re-operation at 1 year, mortality at 1 year and length of stay (LOS). Patient reported outcomes from pre-operatively to 6 months postoperatively using Oxford Shoulder Score (OSS) will also be compared between years. To identify re-operation procedures, OPCS-4.9 codes were used (appendix 1); re-operations on the same shoulder not as part of a revision procedure were included. Re-operations included subacromial decompression, rotator cuff repair, stabilisation, relocation, manipulation under anaesthesia +/- capsular release, synovectomy and fracture fixation. LOS was calculated from the primary procedure date in the NJR to the discharge date provided by HES. Collecting OSS is coordinated by the NJR. Shoulder PROMS were collected as a pilot study prior to 2016 and PROMS collection was made routine in 2017.[11 12] OSS is a patient focused, shoulder-specific questionnaire. It consists of 12 domains which are scored 0–4 with a maximum score of 48.[13 14] The score has been extensively tested and validated and is deemed a reliable test for assessing patients' shoulder symptoms.[15] As defined by Dawson *et al* within the questionnaire, if there are up to two items missing, the average of the remaining items can be substituted for the missing values. If more than two items are missing, the results will be disregarded.[14] Due to recall bias in concordance with NJR, preoperative score must be within 90 days prior to the primary surgery until the day of the primary operation. There is no specified method for collecting pre-operative PROMS in trauma patients, for example, if this is prefracture function or function at time of injury. The 6-month data collection must be within 5–8 months postoperatively.[16] A month was calculated as an average month (30.42 days) to calculate cut-offs when validating the questionnaires, for the OSS minimally clinically important difference (MCID) for RSA at 6 months postoperatively has been calculated at 4.7 and this value will be used in this study.[17]

Statistical analysis

The Kaplan-Meier method was used to analyse time to revision at 1 year, combined revision/non-revision re-operation at 1 year and mortality at 1 year and a log-rank test was completed to assess overall trend over the consecutive years. The incidence of revision, re-operation and mortality within 1 year of primary RSA date was compared between years using logistic regression. The regression model was adjusted for confounders described in the literature to affect the outcomes of RSA. These included age, gender, American Society of Anaesthesiologist Score (ASA), Charlson Comorbidity Index (CCI), indication in terms of trauma or elective, deprivation rank, operating consultant surgeon volume and the funding source (NHS

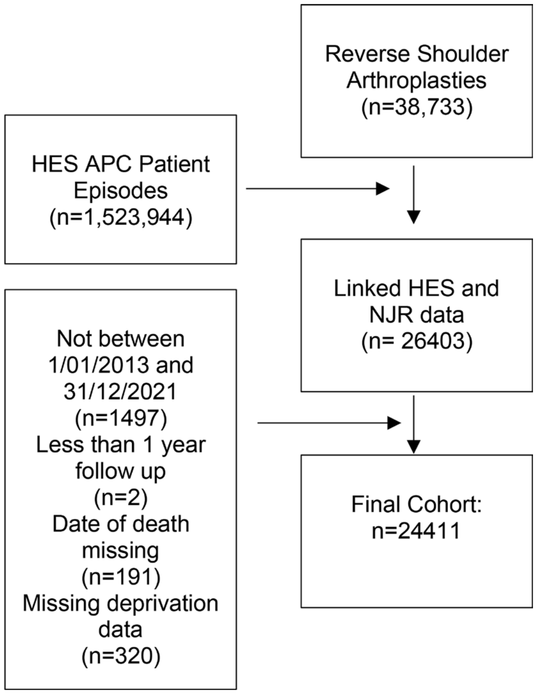


Figure 1 Flow diagram of study cohort. HES Hospital Episode Statistics; NJR National Joint Registry; APC, Admitted Patient Care.

or independent) also included.[18–22] CCI was calculated using ICD-10 codes from the HES database (appendix 2). Comorbidities were identified from episodes prior to or at the same time as the index arthroplasty.[16 23 24] The cut-off used for operating consultant volume was 10.4 cases per annum.[22] Multicollinearity was assessed using variance inflation factors (VIF). All predictors had VIFs below three, except ASA score categories 2 and 3, which had VIFs of approximately six. Pairwise correlation between ASA score and CCI was low (r=0.3), suggesting only mild shared variance. Given clinical relevance and acceptable VIF thresholds, all variables were retained in the model. Results of the logistic regression model are presented as OR with 95% CIs. LOS and mean OSS score between preoperative and 6 months was compared between years using linear regression with the model being adjusted for the covariates described. Linear regression results are presented with regression coefficients (RCs) and 95% CIs. Significance will be deemed if p value <0.05. The STrengthening the Reporting of OBservational studies in Epidemiology guidelines were adhered to in this study.[25] The statistical analysis was performed using StataSE V.16 (StataCorp, Texas, USA).

RESULTS

There were 38 733 RSAs in the database between April 2012 and March 2022. Following merging with the HES database and excluding those patients who did not meet the inclusion criteria, 24 411 patients remained available for analysis (figure 1). The mean age of the cohort was 75.36 years (SD 7.78) and the majority of the patients were female (72.48%). The demographics of those patients by operative year are presented in (Supplementary Table 1).

The Kaplan-Meier curve for implant revision is presented in figure 2 with cumulative revision rate in the Supplementary Table 2. There was no significant trend over time (log rank test p=0.95). On logistic regression analysis, there was no significant improvement in revision rate by year (OR 0.99 (0.95–1.03) p=0.79). When adjusting

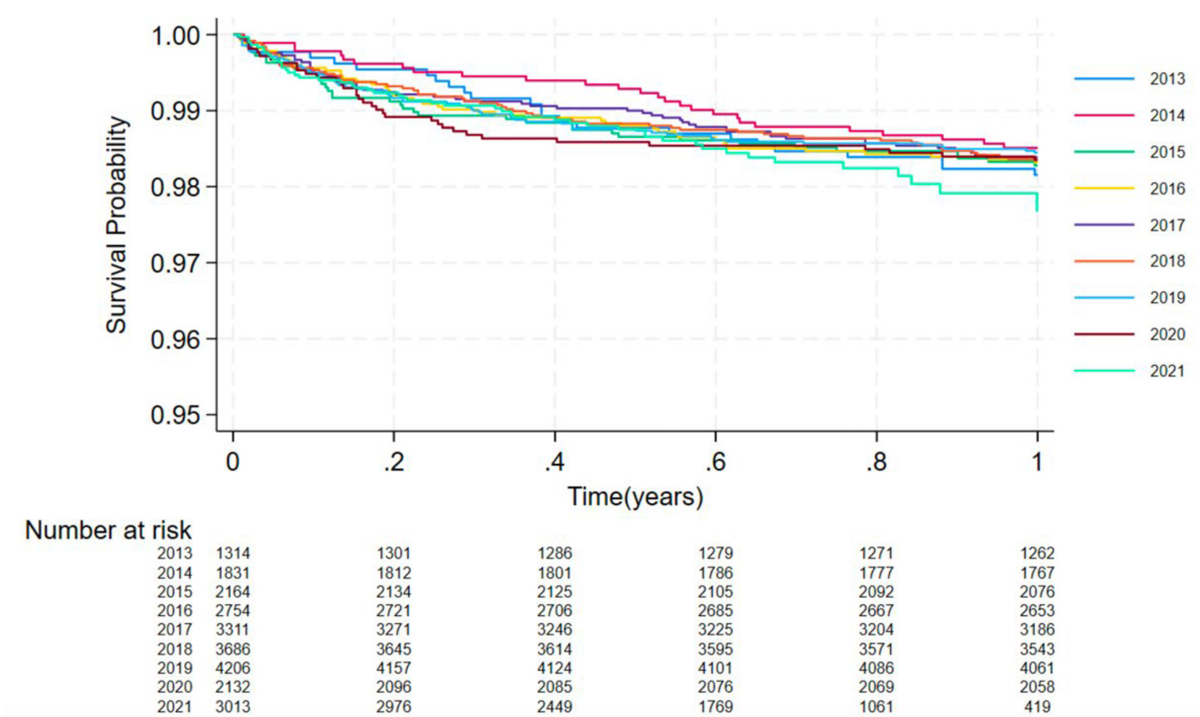
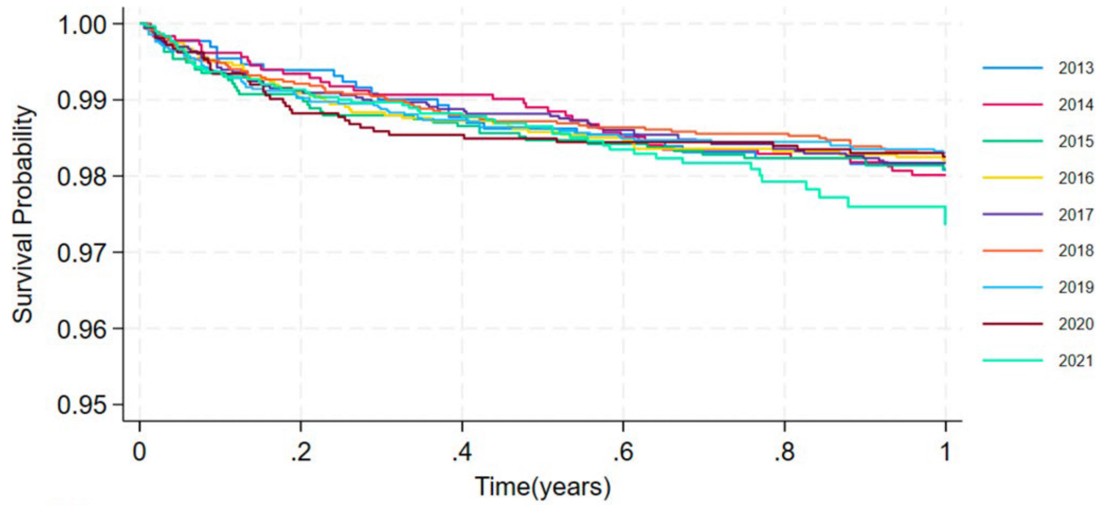


Figure 2 Kaplan-Meier curve for implant survival (revision).



Number at risk

	0	.2	.4	.6	.8	1
2013	1314	1299	1284	1277	1269	1261
2014	1831	1807	1795	1778	1769	1758
2015	2164	2132	2121	2101	2088	2073
2016	2754	2718	2701	2681	2664	2650
2017	3311	3267	3241	3220	3198	3180
2018	3686	3641	3610	3591	3568	3541
2019	4206	4151	4119	4096	4081	4055
2020	2132	2094	2083	2074	2067	2056
2021	3013	2974	2447	1768	1060	418

Figure 3 Kaplan-Meier curve for implant survival (revision/re-operation).

for the confounders that have been shown to affect RSA outcome, there was again no significant improvement in revision rates at 1 year (OR 0.99 (0.94–1.03) p=0.51).

The Kaplan-Meier curve for combined revision and non-revision re-operation is presented in figure 3 with revision/re-operation rate presented in (Supplementary table 3). There was no significant trend shown over the consecutive years (log rank test p=0.92).

On logistic regression analysis of incidence of re-operation between years, there was no significant improvement in re-operation (OR 0.94 (0.87–1.01) p=0.08); however, when the model was adjusted for confounding, there was a significant reduction in re-operations over time (OR 0.93 (0.86–0.99) p=0.03). The types of re-operation with frequencies of occurrence are presented in Supplementary table 4.

2.07% of all patients died within 1 year of having an RSA. The Kaplan-Meier curve for mortality is presented in figure 4 and mortality rate at 1 year presented in Supplementary table 5. There was no significant trend shown over the consecutive years (log rank test p=0.23).

On logistic regression analysis of mortality, there was no significant improvement in mortality in the unadjusted model (0.99 (0.95–1.02) p=0.44); however, when adjusting for confounders, there was a significant reduction in mortality (0.96 (0.92–1.00) p=0.04).

Mean LOS is presented in Supplementary Table 6 by operative year. On linear regression analysis, the unadjusted and adjusted model both showed that LOS significantly improved over time (RC −0.21 (−0.23 to −0.18) p=<0.001 and RC −0.24 (−0.2 to −0.21) p=<0.001, respectively).

The number of patients with available preoperative and 6-month OSS scores is presented in table 1 as well as those with paired preoperative and 6-month scores. On linear regression analysis in both the unadjusted model and adjusted regression model, there was a significant improvement in preoperative to 6-month scores as time progressed (RC 0.49 (0.26–0.72) with p ≤0.001 and RC 0.51 (0.29–0.74) p=<0.001, respectively). In all years, a MCID was seen at 6 months postoperatively. A sensitivity analysis was completed for elective indications due to lack of guidance on pre-operative OSS scores in trauma cases (supplementary Table 7) (online supplemental table 7). With trauma cases removed, there remained a significant improvement in preoperative to 6-month OSS score over the study period (unadjusted RC 0.46 (0.24–0.69) p≤0.001 and adjusted RC 0.50 (0.28–0.73)).

DISCUSSION

This study showed that between 2013 and 2021 revision rates did not significantly improve. When adjusting for confounders such as age, gender, ASA, comorbidities, surgeon volume and deprivation and indication, the likelihood of requiring a revision slightly decreased; however, this was not significant (p=0.51) and therefore, while there is a trend, it is not definitive. After adjusting for confounding, non-revision re-operation rates did show an improvement; however, it is important to note the number of re-operations was low at <1% for all years. Despite the lack of improvement in revision, rates remained low throughout the time period, with revision being <2% at 1 year for all years with the exception of 2021.

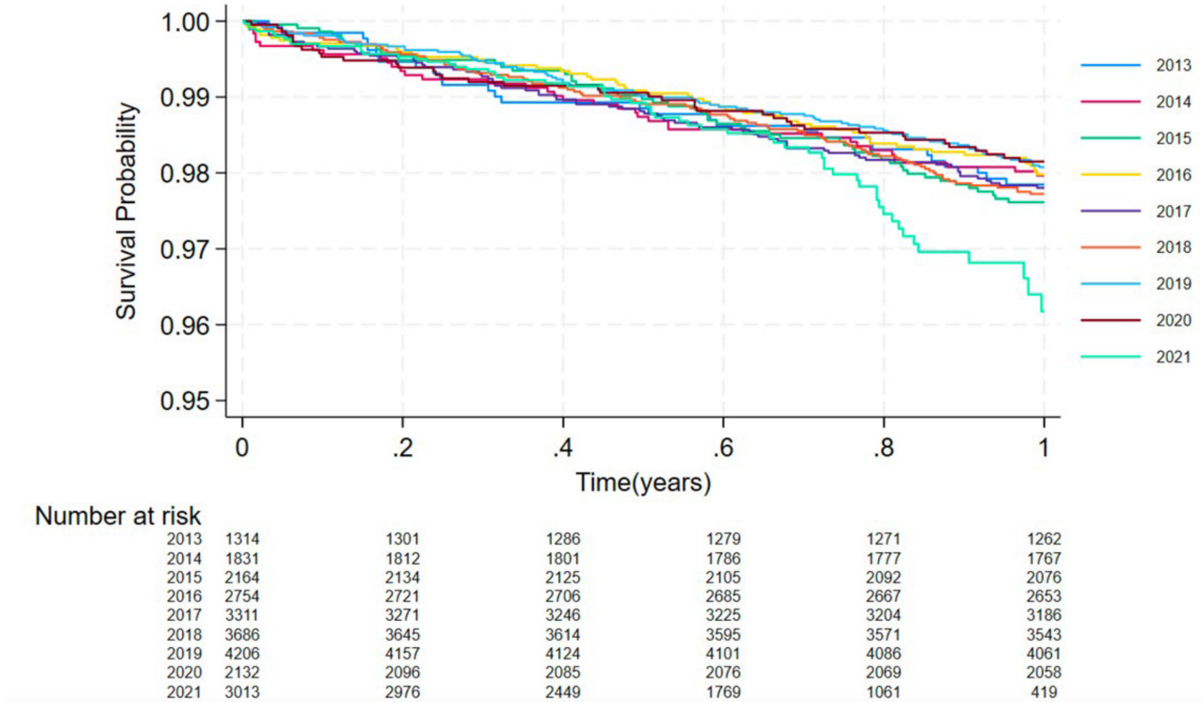


Figure 4 Kaplan Meier curve for mortality.

In 2021 in both revision and mortality, there was an increase in rates (2.82% and 3.49%). 2021 followed the COVID-19 pandemic in 2020 when elective joint arthroplasty operations were largely suspended and then slowly reintroduced into practice.[26] Waiting lists following the pandemic in 2020 were significantly lengthened and double the amount of patients awaiting knee and hip arthroplasty were said to be experiencing symptoms 'worse than death' while awaiting surgery.[27 28] Delayed operations may lead to worsening of joint disease, and this has been shown to have worse outcomes in hip and knee arthroplasty, which may explain this uptick in revisions in 2021.[29] Revision and mortality outcomes related to glenoid bone loss or severity of osteoarthritis in RSA have not been examined; however, it has been shown that PROMs are not affected by disease, severity and with OSS scores in this study showing continued improvement by year, including in 2021, further supporting this.[29] In terms of indications, in 2021, there was an increase in RSA done for trauma from 14.76% in 2019 to 19.35% and this could have contributed to an increase in mortality. In the unadjusted model, no significant reduction in mortality was observed. However, after adjusting for potential confounders such as an indication of trauma and comorbidities, a significant decline in mortality emerged over the study period. These findings suggest that the elevated

Table 1 Available PROMs scores with mean scores

Year	Number of completed preoperatively scores	Mean preoperatively (SD)	Number of completed 6-month scores	Mean 6-month (SD)	Number of completed preoperatively to 6-month scores (%)	Mean difference (SD)
2013	319	15.4 (8.4)	591	31.7 (11.4)	161 (12.3)	15.8 (11.4)
2014	499	15.78 (8.6)	118	33.9 (10.2)	33 (1.8)	17.5 (10.5)
2015	594	15.2 (8.1)	343	32.8 (11.3)	100 (4.6)	17.0 (11.3)
2016	633	15.7 (8.4)	10	36.6 (9.1)	2 (0.1)	23.5 (21.9)
2017	732	15.7 (8.7)	2252	34.0 (11.1)	520 (15.7)	19.3 (12.0)
2018	712	15.3 (8.6)	2569	34.1 (11.1)	524 (14.2)	19.3 (11.8)
2019	925	15.4 (8.4)	1744	34.9 (10.7)	371 (8.8)	19.2 (11.5)
2020	494	14.9 (8.9)	215	35.8 (10.1)	193 (9.1)	20.2 (11.4)
2021	642	15.3 (8.7)	409	35.76 (10.4)	360 (12.0)	20.3 (12.1)

PROMs, Patient Reported Outcome Measures.

mortality rate observed in that specific year may be attributable to differences in the patient cohort during that time.

Length of stay, when adjusted for confounders described, showed a significant improvement with an average reduction in stay of 0.24 days per annum over the time period with stays improving from 3.94 days in 2013 to 2.44 days in 2021 (p<0.001). A US study looking at total shoulder arthroplasty comparing patients having their procedure in 2005–2010 and 2015–2018 also showed a reduction in LOS (0.6 days over the two time periods).[30] It is projected that the demand for shoulder arthroplasty between 2011 and 2030 will increase by 755% and shorter stays following shoulder arthroplasty will decrease costs to the healthcare provider, reduce the risk of hospital-acquired infections as well as improving patient satisfaction and help progression through and increasing waiting lists.[31–33] Day case hip and knee arthroplasty is well established with developed evidence-based pathways in the UK; however, no such guidelines exist for shoulder arthroplasty.[34] There is limited literature regarding day case RSA; however, with increasing pressures on health services and the projected growth expected, further improvements in LOS and guidance on day case surgery should be a target for further research.

Patients OSS score improvement between their preoperative and 6-month scores was significantly improved over the time period. Mean OSS improved on average by 0.51 points per year, with a mean in 2013 of 15.84 to 20.29 in 2021 (p<0.001). A US study looking at patient outcomes in the form of ASES for RSA found a yearly mean increase in ASES of 1.64 (p<0.001; 95% CI, 0.81 to 2.47) concluding that this may indicate that advances in shoulder arthroplasty have resulted in better patient outcomes over time.[10] This improvement in OSS is likely multifactorial. Data from NJR show that reverse shoulder replacements are increasingly conducted by higher volume orthopaedic consultants and, as mentioned, the implant has developed over time with the aim to improve patient satisfaction.[2 6] Looking at the primary indication for RSA implantation, over the time period, the case mix changed. In 2013, 58.37% of cases were done for cuff tear arthropathy (CTA); however, by 2021, this had fallen to 31.60% with primary osteoarthritis (OA) being the most common indication (32.36%). A systematic review by indication for RSA has shown significant improvement in constant scores for those with primary OA versus those with CTA; therefore, the improvement in OSS in this study may be reflective of the change in case mix.[35] Aside from surgeon and implant factors, there has been a research focus and developments in optimum patient rehabilitation which may further improve a patients experience.[36 37]

This is the first study looking at both clinical outcomes and PROMs for RSA by year of operation. The study does, however, have limitations. Due to the combining of databases, the sample size was reduced; however, the sample sizes per year remained large for analysis of clinical outcomes. Due to PROMS not being mandatory until 2017 the percentage of paired results at preoperative and 6 months was low, particularly between 2014 and 2016. The analysis done for OSS looked at trends over time using operative year as a continuous outcome, therefore minimising the impact of these years on the overall analysis and conclusions. In the analysis of LOS, year was treated as a categorical variable, with each year represented by approximately 1800 observations. While this approach captures year-specific effects, it limits the ability to model continuous trends over time and fully use the year-to-year variability. Additionally, potential correlation among observations within each year was not directly modelled, which may affect the robustness of the estimates. The analysis finished at the end of 2021 when the recovery from the COVID-19 pandemic was ongoing. Further research in outcomes following return to normal practice should be done to review if revision and mortality rates in 2021 return to pre-pandemic levels. Although the study adjusted for multiple confounding factors that may have affected performance, RSA implants differ in terms of design, for example, medialised or lateralised and neck shaft angle. This level of categorisation of implants is not available within the NJR dataset; however, given the development of the implant, this should be a target for further research to assess if this has improved RSA outcomes over time.

CONCLUSION

From 2013 to 2021 revision rates for RSA were low and remained similar. There was a reduction in non-revision re-operation and mortality rate over the study period as well as an improvement in functional outcomes and reduced LOS, which demonstrates progress in the quality of care provided to shoulder replacement patients and is suggestive of advancements in surgical techniques, perioperative management and rehabilitation strategies.

Author affiliations
[1]Department of Bioengineering, Cutrale Perioperative and Ageing Group, Imperial College London, London, UK
[2]Department of Primary Care and Public Health, School of Public Health, Imperial College London, London, UK
[3]Department of Health Sciences, Hull York Medical School, University of York, Heslington, York, UK
[4]Department of Trauma and Orthopaedics, Imperial College Healthcare NHS Foundation Trust, London, UK
[5]Cutrale of Perioperative and Ageing Group, Department of Bioengineering, Imperial College London, London, UK

Acknowledgments We thank the NJR research committee and staff at the NJR for facilitating this work. The authors have conformed to the NJR's standard protocol for data access and publication. The views expressed represent those of the authors and do not necessarily reflect those of the NJR steering committee, research subcommittee or HQIP.

ICMJEI COI statement O O'Malley is a Royal College of Surgeons of England research fellow funded by The Arthritis Research Trust Research Fellowship with support from the Rosetrees Trust. A Rangan reports an institutional grant from National Institute for Health and Care Research (NIHR) and AOUK&I, as well as research and educational grants from DePuy J&J, unrelated to this study. A Rangan

is also an elected trustee of the British Orthopaedic Association and is on the funding committee of NIHR i4i. None of the interests above affect the completion of this work. All other authors have no completing interest to declare.

Contributors OOM: conceptualisation, data curation, investigation, methodology, writing – original draft, writing reviewing and editing. AD: methodology, formal analysis, writing- review and editing. MTAS: methodology, formal analysis. AR: supervision, writing – review and editing. SS: conceptualisation, supervision, writing – review and editing. PR: conceptualisation, supervision, writing – review and editing. Guarantor: PR.

The authors disclose receipt of the following financial or material support for the research, authorship, and/or publication of this article: an institutional British Elbow and Shoulder Society pump primer research grant, and a Royal College of Surgeons Research Fellowship.

Competing interests None declared.

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

Patient consent for publication Not applicable.

Ethical Review This study used pseudo-anonymised, routinely collected data from an established clinical registry, and patient consent is obtained by the NJR. According to Health Research Authority guidance, ethical approval was not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement The data in this study were requested from the National Joint registry. The data are not publicly available and cannot be shared by the corresponding author. Data are not available from the authors; however, data are available on request from the National Joint Registry.

ORCID iDs
Olivia O'Malley http://orcid.org/0000-0002-9674-1553
Andrew Davies http://orcid.org/0000-0002-2079-9919
Mansour Taghavi Azar Sharabiani http://orcid.org/0000-0003-3808-277X
Amar Rangan http://orcid.org/0000-0002-5452-8578

REFERENCES

1 O'Malley O, Davies A, Sharabani MTA, *et al*. Revision of reverse shoulder arthroplasty by indication: a National Joint Registry study. *Bone Jt Open* 2025;6:691–9.
2 National JointRegistry. NJR 21st annual report 2024 shoulders. 2024. Available: https://reports.njrcentre.org.uk/Portals/0/PDFdownloads/NJR%2021st%20Annual%20Report%202024_Shoulders.pdf
3 Fisher C, Soh S-E, Page RS, *et al*. Forecasting the future burden of primary total shoulder replacement in Australia. *Osteoarthr Cartil* 2023;31:1636–43.
4 Baskaran P, Renna MS, Simpson AI. The evolution of reverse shoulder arthroplasty: a review of complications and the rising concern of overuse. *Br J Hosp Med* 2025;86:1–23.
5 Flatow EL, Harrison AK. A history of reverse total shoulder arthroplasty. *Clin Orthop Relat Res* 2011;469:2432–9.
6 Frank JK, Siegert P, Plachel F, *et al*. The evolution of reverse total shoulder arthroplasty-from the first steps to novel implant designs and surgical techniques. *J Clin Med* 2022;11:1512.
7 Sadoghi P, Vavken J, Leithner A, *et al*. Benefit of intraoperative navigation on glenoid component positioning during total shoulder arthroplasty. *Arch Orthop Trauma Surg* 2015;135:41–7.
8 Burns DM, Frank T, Whyne CM, *et al*. Glenoid component positioning and guidance techniques in anatomic and reverse total shoulder arthroplasty: A systematic review and meta-analysis. *Shoulder Elbow* 2019;11:16–28.
9 Somerson JS, Neradilek MB, Hsu JE, *et al*. Is there evidence that the outcomes of primary anatomic and reverse shoulder arthroplasty are getting better? *Int Orthop* 2017;41:1235–44.
10 Mathew JI, Nicholson AD, Finocchiaro A, *et al*. Outcomes of shoulder arthroplasty by year of index procedure: are we getting better? *J Shoulder Elbow Surg* 2022;31:245–51.
11 National Joint Registry Editorial Board. NJR 20th annual report 2023. 2023 Available: https://reports.njrcentre.org.uk/Portals/0/PDFdownloads/NJR%2020th%20Annual%20Report%202023.pdf
12 National Joint Registry Editorial Board. NJR 13th annual report 2016. 2016 Available: https://reports.njrcentre.org.uk/Portals/0/PDFdownloads/NJR%2013th%20Annual%20Report%202016.pdf
13 Dawson J, Hill G, Fitzpatrick R, *et al*. Comparison of clinical and patient-based measures to assess medium-term outcomes following shoulder surgery for disorders of the rotator cuff. *Arthritis Rheum* 2002;47:513–9.
14 Dawson J, Rogers K, Fitzpatrick R, *et al*. The Oxford shoulder score revisited. *Arch Orthop Trauma Surg* 2009;129:119–23.
15 Dawson J, Fitzpatrick R, Carr A. Questionnaire on the perceptions of patients about shoulder surgery. *J Bone Joint Surg Br* 1996;78:593–600.
16 Concept: charlson comorbidity index. Available: http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?printer=Y&conceptID=1098 [Accessed 12 Apr 2024].
17 Nyring MRK, Olsen BS, Amundsen A, *et al*. Minimal Clinically Important Differences (MCID) for the Western Ontario Osteoarthritis of the Shoulder Index (WOOS) and the Oxford Shoulder Score (OSS). *Patient Relat Outcome Meas* 2021;12:299–306.
18 Craig RS, Lane JCE, Carr AJ, *et al*. Serious adverse events and lifetime risk of reoperation after elective shoulder replacement: population based cohort study using hospital episode statistics for England. *BMJ* 2019;364:l298.
19 Johnson CC, Sodha S, Garzon-Muvdi J, *et al*. Does preoperative American Society of Anesthesiologists score relate to complications after total shoulder arthroplasty? *Clin Orthop Relat Res* 2014;472:1589–96.
20 Higher complication rates following primary total shoulder arthroplasty in patients presenting from areas of higher social deprivation. Bone & Joint. Available: https://boneandjoint.org.uk/article/10.1302/0301-620X.106B2.BJJ-2023-0785.R1 [Accessed 24 Apr 2024].
21 Paltoglou N, Page R, Gill S. DOES HEALTHCARE SETTING INFLUENCE OUTCOMES FOLLOWING SHOULDER ARTHROPLASTY? *Bone Joint J* 2023;105-B:33.
22 Valsamis EM, Collins GS, Pinedo-Villanueva R, *et al*. Association between surgeon volume and patient outcomes after elective shoulder replacement surgery using data from the National Joint Registry and Hospital Episode Statistics for England: population based cohort study. *BMJ* 2023;381:e075355.
23 National Health Service. *ICD-10-5TH-Edition*.Available: https://classbrowser.nhs.uk/#/book/ICD-10-5TH-Edition/vol1/block-b20-b24.htm+B20 [accessed 12 Apr 2024].
24 Quan H, Sundararajan V, Halfon P, *et al*. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005;43:1130–9.
25 von Elm E, Altman DG, Egger M, *et al*. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008;61:344–9.
26 Brittain R. The effects of the covid-19 pandemic on joint replacement surgery: the patient perspective. In: *The national joint registry 18th annual report 2021*. National Joint Registry, 2021. Available: https://www.ncbi.nlm.nih.gov/books/NBK576856/ [accessed 9 Oct 2024].
27 Clement ND, Scott CEH, Murray JRD, *et al*. The number of patients "worse than death" while waiting for a hip or knee arthroplasty has nearly doubled during the COVID-19 pandemic. *Bone Joint J* 2021;103-B:672–80.
28 French JMR, Deere K, Jones T, *et al*. An analysis of the effect of the COVID-19-induced joint replacement deficit in England, Wales, and Northern Ireland suggests recovery will be protracted. *Bone Joint J* 2024;106-B:834–41.
29 Shah NS, Foote AM, Steele CA, *et al*. Does preoperative disease severity influence outcomes in reverse shoulder arthroplasty for cuff tear arthropathy? *J Shoulder Elbow Surg* 2021;30:2745–52.
30 Bixby EC, Boddapati V, Anderson MJJ, *et al*. Trends in total shoulder arthroplasty from 2005 to 2018: lower complications rates and

shorter lengths of stay despite patients with more comorbidities. *JSES Int* 2020;4:657–61.
31 Destine H, Patel NK, Hall A, *et al*. Effect of hospital length of stay on functional outcomes and readmission after total shoulder arthroplasty. *Semin Arthroplast* 2024;34:108–14.
32 Padegimas EM, Zmistowski BM, Clyde CT, *et al*. Length of stay after shoulder arthroplasty-the effect of an orthopedic specialty hospital. *J Shoulder Elbow Surg* 2016;25:1404–11.
33 Padegimas EM, Maltenfort M, Lazarus MD, *et al*. Future patient demand for shoulder arthroplasty by younger patients: national projections. *Clin Orthop Relat Res* 2015;473:1860–7.
34 GIRFT. Ambulatory hip & knee guidance. Available: https://gettingitrighthtfirsttime.co.uk/wp-content/uploads/2023/07/Ambulatory-Hip-and-Knee-Replacement-Guide-March-2023-FINAL-V1-1.pdf [Accessed 16 Aug 2024].
35 Kennedy J, Klifto CS, Ledbetter L, *et al*. Reverse total shoulder arthroplasty clinical and patient-reported outcomes and complications stratified by preoperative diagnosis: a systematic review. *J Shoulder Elbow Surg* 2021;30:929–41.
36 Kornuijt A, de Vries L, van der Weegen W, *et al*. Direct active rehabilitation after reverse total shoulder arthroplasty: an international multicentre prospective cohort safety study with 1-year follow up. *BMJ Open* 2023;13:e070934.
37 Lee J, Consigliere P, Fawzy E, *et al*. Accelerated rehabilitation following reverse total shoulder arthroplasty. *J Shoulder Elbow Surg* 2021;30:e545–57.