■ ARTHROPLASTY

An analysis of the effect of the COVID-19-induced joint replacement deficit in England, Wales, and Northern Ireland suggests recovery will be protracted

AN ANALYSIS OF THE NATIONAL JOINT REGISTRY

J. M. R. French,
K. Deere,
T. Jones,
D. J. Pegg,
M. R. Reed,
M. R. Whitehouse,
A. Sayers

From University of Bristol, Bristol, UK

Aims

The COVID-19 pandemic has disrupted the provision of arthroplasty services in England, Wales, and Northern Ireland. This study aimed to quantify the backlog, analyze national trends, and predict time to recovery.

Methods

We performed an analysis of the mandatory prospective national registry of all independent and publicly funded hip, knee, shoulder, elbow, and ankle replacements in England, Wales, and Northern Ireland between January 2019 and December 2022 inclusive, totalling 729,642 operations. The deficit was calculated per year compared to a continuation of 2019 volume. Total deficit of cases between 2020 to 2022 was expressed as a percentage of 2019 volume. Sub-analyses were performed based on procedure type, country, and unit sector.

Results

Between January 2020 and December 2022, there was a deficit of 158,994 joint replacements. This is equivalent to over two-thirds of a year of normal expected operating activity (71.6%). There were 104,724 (-47.1%) fewer performed in 2020, 41,928 (-18.9%) fewer performed in 2021, and 12,342 (-5.6%) fewer performed in 2022, respectively, than in 2019. Independent-sector procedures increased to make it the predominant arthroplasty provider (53% in 2022). NHS activity was 73.2% of 2019 levels, while independent activity increased to 126.8%. Wales (-136.3%) and Northern Ireland (-121.3%) recorded deficits of more than a year's worth of procedures, substantially more than England (-66.7%). It would take until 2031 to eliminate this deficit with an immediate expansion of capacity over 2019 levels by 10%.

Conclusion

The arthroplasty deficit following the COVID-19 pandemic is now equivalent to over two-thirds of a year of normal operating activity, and continues to increase. Patients awaiting different types of arthroplasty, in each country, have been affected disproportionately. A rapid and significant expansion in services is required to address the deficit, and will still take many years to rectify.

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Correspondence should be sent to J. M. R. French; email: jonathan.french@bristol.ac.uk

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Introduction

Arthroplasty is a common and highly effective surgical procedure used to treat a variety of musculoskeletal problems including osteoarthritis and acute trauma. Joint replacements are long-lasting, with over half of hip and knee replacements lasting in excess of 25 years, and 90% of shoulder replacements lasting in excess of ten years.[1–3] Patient-reported outcome scores following surgery are generally high.[4] With an

Table I. Descriptive statistics of provision and change of arthroplasties performed by joint and nation, from years 2019 to 2022 inclusive.

Joint	2019	2020		2021		2022		2020 to 2022
	Total, n	Total, n	Change, n (%)	Total, n	Change, n (%)	Total, n	Change, n (%)	Total change, n (%)
All countries								
Hip	102,255	58,410	-43,845 (-42.9)	90,409	-11,846 (-11.6)	101,437	-818 (-0.8)	-56,509 (-55.3)
Knee	109,898	53,475	-56,423 (-51.3)	82,010	-27,888 (-25.4)	99,797	-10,101 (-9.2)	-94,412 (-85.9)
Shoulder	7,912	4,284	-3,628 (-45.9)	6,125	-1,787 (-22.6)	6,853	-1,059 (-13.4)	-6,474 (-81.8)
Elbow	1,069	771	-298 (-27.9)	940	-129 (-12.1)	834	-235 (-22)	-662 (-61.9)
Ankle	1,025	495	-530 (-51.7)	747	-278 (-27.1)	896	-129 (-12.6)	-937 (-91.4)
Total	222,159	117,435	-104,724 (-47.1)	180,231	-41,928 (-18.9)	209,817	-12,342 (-5.6)	-158,994 (-71.6)
England								
Hip	94,387	55,167	-39,220 (-41.6)	85,314	-9,073 (-9.6)	94,382	-5 (0)	-48,298 (-51.2)
Knee	101,801	50,998	-50,803 (-49.9)	78,470	-23,331 (-22.9)	94,446	-7,355 (-7.2)	-81,489 (-80)
Shoulder	7,543	4,143	-3,400 (-45.1)	5,926	-1,617 (-21.4)	6,571	-972 (-12.9)	-5,989 (-79.4)
Elbow	1,008	741	-267 (-26.5)	882	-126 (-12.5)	798	-210 (-20.8)	-603 (-59.8)
Ankle	977	475	-502 (-51.4)	718	-259 (-26.5)	860	-117 (-12)	-878 (-89.9)
Total	205,716	111,524	-94,192 (-45.8)	171,310	-34,406 (-16.7)	197,057	-8,659 (-4.2)	-137,257 (-66.7)
Wales								
Hip	5,551	2,142	-3,409 (-61.4)	3,607	-1,944 (-35)	4,660	-891 (-16.1)	-6,244 (-112.5)
Knee	6,056	1,808	-4,248 (-70.1)	2,759	-3,297 (-54.4)	4,023	-2,033 (-33.6)	-9,578 (-158.2)
Shoulder	288	109	-179 (-62.2)	155	-133 (-46.2)	209	-79 (-27.4)	-391 (-135.8)
Elbow	44	18	-26 (-59.1)	43	-1 (-2.3)	19	-25 (-56.8)	-52 (-118.2)
Ankle	32	9	-23 (-71.9)	19	-13 (-40.6)	20	-12 (-37.5)	-48 (-150)
Total	11,971	4,086	-7,885 (-65.9)	6,583	-5,388 (-45)	8,931	-3,040 (-25.4)	-16,313 (-136.3)
Northern Ireland								
Hip	2,317	1,101	-1,216 (-52.5)	1,488	-829 (-35.8)	2,395	78 (3.4)	-1,967 (-84.9)
Knee	2,041	669	-1,372 (-67.2)	781	-1,260 (-61.7)	1,328	-713 (-34.9)	-3,345 (-163.9)
Shoulder	81	32	-49 (-60.5)	44	-37 (-45.7)	73	-8 (-9.9)	-94 (-116)
Elbow	17	12	-5 (-29.4)	15	-2 (-11.8)	17	0 (0)	-7 (-41.2)
Ankle	16	11	-5 (-31.3)	10	-6 (-37.5)	16	0 (0)	-11 (-68.8)
Total	4,472	1,825	-2,647 (-59.2)	2,338	-2,134 (-47.7)	3,829	-643 (-14.4)	-5,424 (-121.3)

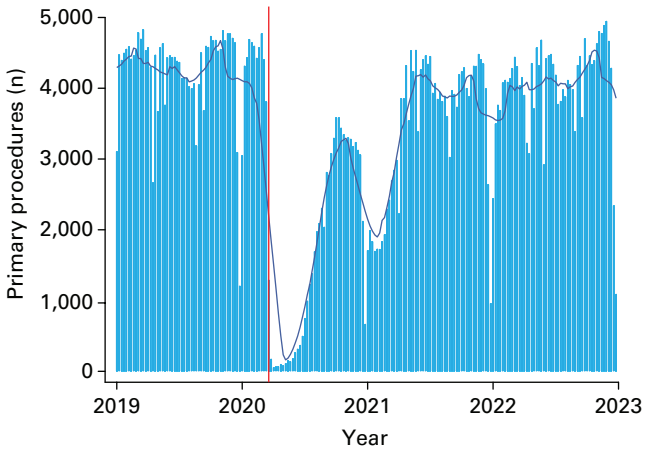

Fig. 1

Combined weekly number of elective hip, knee, shoulder, elbow, and ankle arthroplasties done in England, Wales, and Northern Ireland, January 2019 to December 2022. The red line indicates the first national lockdown. The blue line represents the three-month rolling mean.

ageing and increasingly active population, a steady rise in demand for arthroplasty is expected over the next few decades.[5]

The COVID-19 pandemic had an unprecedented impact on populations around the world. The first UK national lockdown commenced on 23 March 2020, with various restrictions imposed intermittently across the devolved nations over approximately the next year, before the cessation of restrictions in July 2021.[6] The response to the pandemic required a rapid and significant reorganization of health services to provide acute care for patients with COVID-19, and prioritization of services such as cancer care involving reallocation of resources that would have otherwise been used for elective procedures such as arthroplasty.[7]

In 2019, prior to the pandemic, over 200,000 primary hip, knee, shoulder, elbow, and ankle replacements were performed in England, Wales, and Northern Ireland. Up to this point there had been a steady yearly increase in joint replacement provision of around 5% per year.[8] In 2020, there was a substantial reduction by approximately 100,000 procedures.[9] It was reported that the number of NHS patients awaiting hip or knee arthroplasty describing their quality of life as "worse than death" nearly doubled in this period.[10] Increased numbers of patients on waiting lists have economic and healthcare effects from loss of independence and productivity, deconditioning, and increased pressure on acute services, ultimately resulting in poorer outcomes and widening of inequality.[7,11,12]

Recovery from the COVID-19 pandemic-induced deficit in joint replacement in the UK will require expansion of services in the public (NHS) and independent sectors.[13] We previously used the National Joint Registry (NJR), a mandatory register for

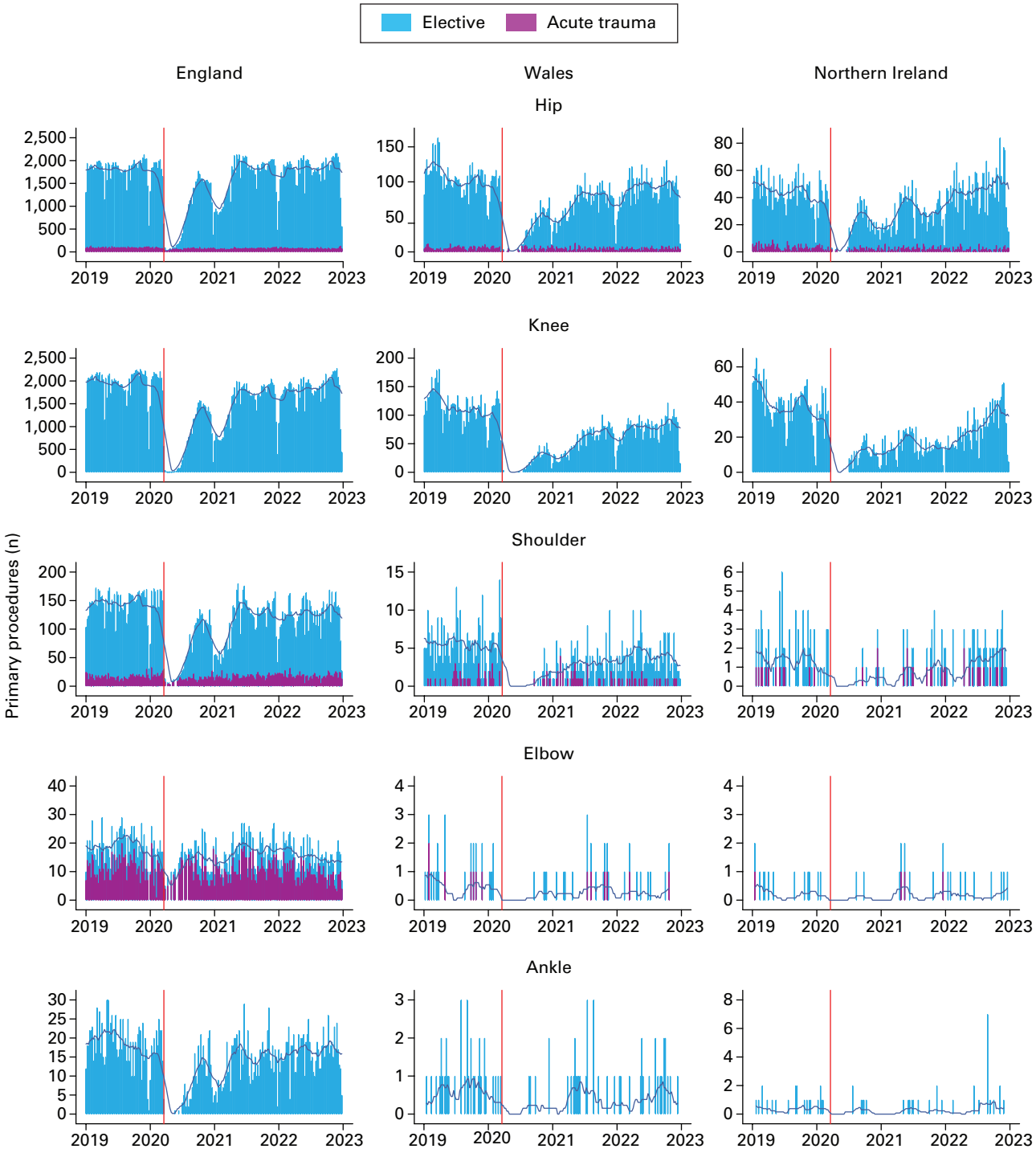

Fig. 2

Weekly number of primary arthroplasties between 2019 to 2022 stratified by type of joint and nation. The red line indicates the first national lockdown. The blue line represents the three-month rolling mean.

all hip, knee, shoulder, elbow, and ankle joint replacement in England, Wales, and Northern Ireland, to analyze provision of procedures during the first year of the pandemic.[9]

We aimed to provide an updated analysis of the impact of the COVID-19 pandemic on joint replacement services in England, Wales, and Northern Ireland to include the three years following the pandemic. More than one complete year's data were available following the end of all restrictions. We aimed to evaluate the extent of recovery, to quantify any expansion of services required to address the accumulated deficit of arthroplasty

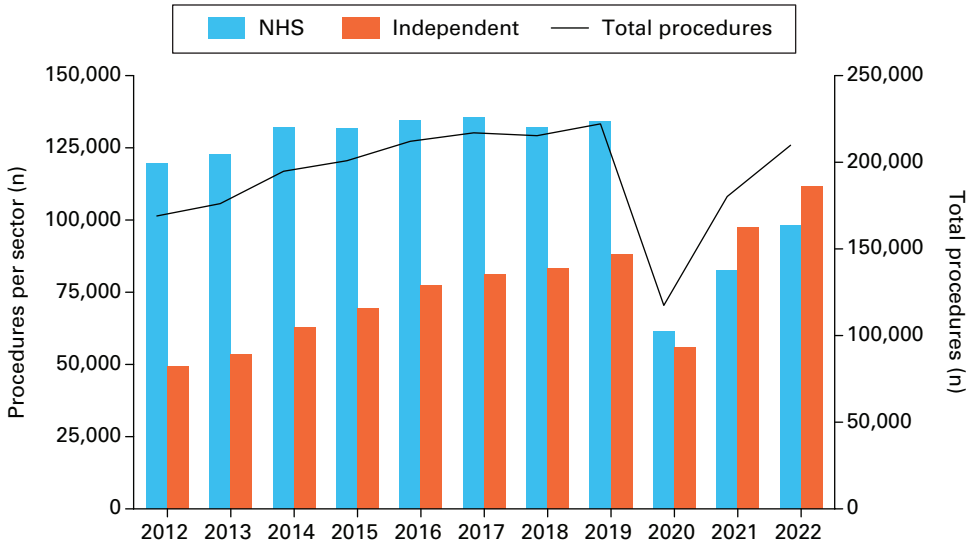

Fig. 3

Annual procedure counts for primary hip, knee, shoulder, elbow, and ankle arthroplasties in England, Wales, and Northern Ireland, split between NHS (public) and independent-sector units.

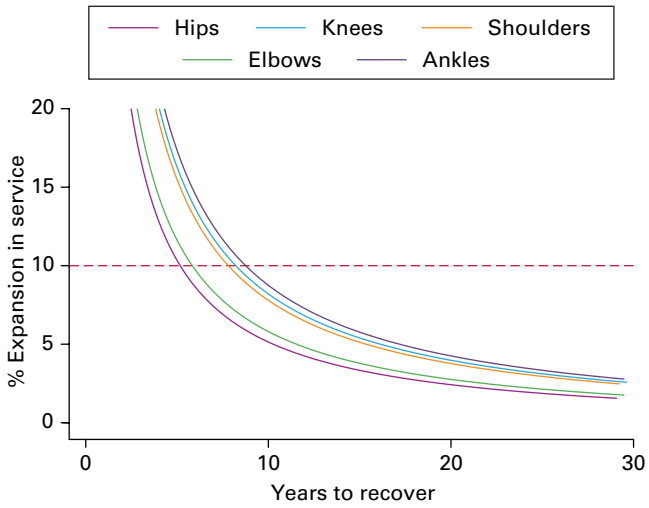

Fig. 4

Predicted years-to-recovery of the 2020 to 2022 deficit of arthroplasties following expansion of provision compared to 2019 in England, Wales, and Northern Ireland, stratified by type of joint affected. The red dashed line indicates a 10% expansion in service compared to 2019.

provision compared to pre-pandemic levels, and to estimate the time for recovery assuming no increase in demand for arthroplasty occurs beyond 2019 rates.

Methods

Data source. In this prospective observational registry-based study we analyzed data from the NJR.[8] Data access was granted after application through the NJR Research Committee. Ethical approval was not required, in line with Medical Research Council and NHS England guidelines. We collected data on hip, knee, shoulder, elbow, and ankle primary arthroplasties entered into the registry from hospitals in England, Wales, and Northern Ireland from January 2019 to the end of December 2022. A data quality audit in 2019/2020 showed over a 97% and 98% capture of all primary hip and knee data, respectively.[8]

The NJR data were prepared for this analysis in the same manner as described in the NJR 2022 19th Annual Report.[8] Data were cleaned by removing records with missing information, removing duplicate procedures, and removing records where we were unable to ascertain a logical sequence of primary and revision procedures. The cleaning process resulted in 3,111,950 primary procedures from the entire NJR dataset (see Supplementary Figures a to e). Date restrictions were then applied, leaving 729,642 procedures for analysis.

Statistical analysis. We used descriptive statistics to illustrate the provision of joint replacement in the study period for each type of joint replacement, dividing procedures into acute (those performed for acute trauma indications) and elective indications where possible. Counts were displayed both annually since inception of the NJR (Supplementary Figure f) and as weekly counts of procedures in 2019 compared to 2020 to 2022 by each joint, with a weekly three-month centred rolling mean. Hospitals in which the arthroplasties were performed were also classified as either public- (NHS) or independent-sector facilities, and yearly counts were compared.

The time to recovery and the expansion in services required to achieve 2019 rates, and to catch up on any deficit incurred due to the impact of COVID-19, assuming demand remained unchanged from 2019 levels, were also calculated. We assume that the years to recovery is estimated by the deficit in procedures expressed as a percentage expansion of services compared to 2019, i.e. a 50,000 procedure deficit between 2020 and 2022 will take five years to recover assuming a baseline provision of 100,000 patients and a 10% expansion in surgical provision.

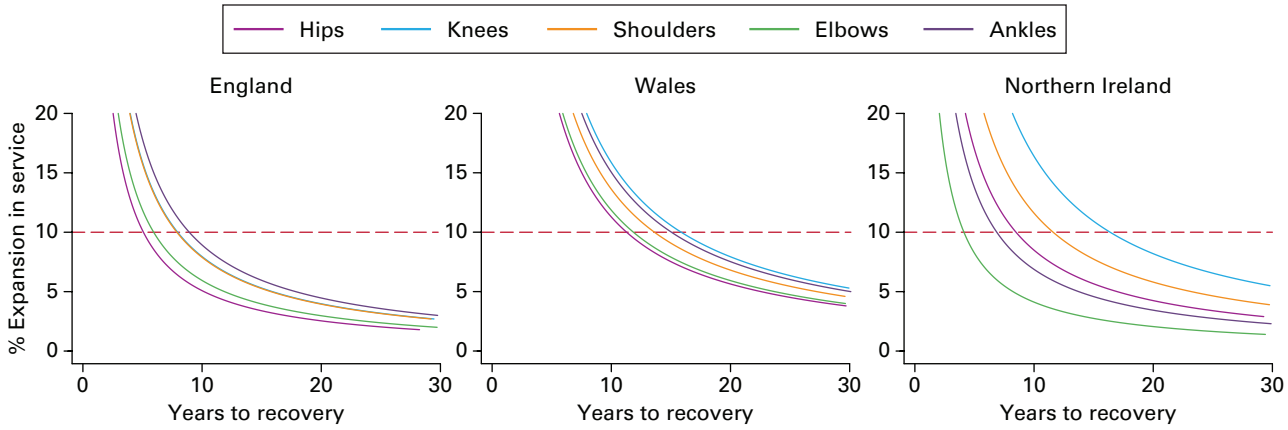

Fig. 5

Years-to-recovery from 2020 to 2022 deficit following expansion of provision compared to 2019 stratified by country and joint affected. The red dashed line indicates a 10% expansion in service compared to 2019.

We have simplistically assumed a static baseline (2019 levels), although the secular patterns prior to this suggest the need for increasing service provision (Supplementary Figure f) so these estimates are likely to be conservative.

$$years\ to\ recovery = \frac{(N_{2019}-N_{2020})+(N_{2019}-N_{2021})+(N_{2019}-N_{2022})}{\frac{N_{2019}}{100}.\%expansion}$$

The deficit was expressed both as a combined number of cases not performed between 2020 and 2022 compared to 2019, and for each individual year compared to 2019. Time to recovery was calculated for England, Wales, and Northern Ireland overall and for each nation separately. All analyses were conducted in Stata MP 17 (StataCorp, USA).

Results

Overall, there was a deficit of 158,994 arthroplasties (hip, knee, shoulder, elbow, ankle) collectively between 2020 and 2022 compared to a continuation of 2019 levels (222,159 procedures; Figure 1). The total deficit between 2020 and 2022 amounted to 71.6% of the annual volume of 2019. By year, there were 104,724 (-47.1% compared to 2019) fewer performed in 2020, 41,928 (-18.9%) fewer performed in 2021, and 12,342 (-5.6%) fewer performed in 2022 (Table I).

The largest reduction in absolute number (94,412) affected knees with ankles showing the largest reduction in relative number (-91.4% combined deficit 2020 to 2022 as a proportion of 2019 activity). Hip arthroplasty was the closest to recovering to 2019 levels by 2022 (-0.8%).

Wales (-136.3%) and Northern Ireland (-121.3%) both recorded deficits of more than one year's worth of procedures between 2020 to 2022 compared to a continuation of 2019 levels, and compared to eight months' worth (-66.7%) in England. Hip arthroplasties in England specifically had returned to 2019 levels by 2022, with other joints and countries reporting comparatively fewer procedures (Figure 2).

The proportion of procedures performed in the independent sector showed an increase between 2020 and 2022 (39.6% procedures performed in independent institutions in 2019 compared to 53.2% in 2022). Public-sector procedure volume showed a greater reduction in this period than procedures performed in independent-sector units. While independent-sector volumes had surpassed 2019 levels by 2021, a deficit remained in NHS volumes in 2022 (Figure 3; Supplementary Table i).

An immediate 5% expansion in provision of hip, knee, shoulder, elbow, and ankle arthroplasty compared to 2019 levels would be required to address this deficit in procedures within approximately 20 years (by 2040). A 10% expansion in provision compared to 2019 levels would be required to address the deficit within approximately ten years (by 2031). Figure 4 illustrates the years to recovery following expansion of provision compared to 2019 rates across England, Wales, and Northern Ireland stratified by joint. For Wales and Northern Ireland specifically, an immediate expansion of 15% would be required to address the deficit within approximately ten years (Figure 5; Supplementary Table ii).

Discussion

The COVID-19 pandemic has markedly disrupted the provision of elective arthroplasty. The deficit now totals approximately 160,000 procedures – the equivalent of almost three quarters of a year of normal activity – and continues to increase. The recovery from the pandemic to address the incurred deficit will require an expansion of services compared to pre-pandemic levels, but does not appear to have commenced. Knee, shoulder, and ankle arthroplasty have been affected relatively more severely than hip and elbow arthroplasty. Wales and Northern Ireland recorded deficits of more than a year's worth of procedures, substantially more than England. An immediate expansion of capacity of 10% would be required to address the deficit within approximately ten years. NHS providers have been more affected than the independent sector, which has now become the predominant provider for arthroplasty when collectively looking at England, Wales, and Northern Ireland.

The strength of this study is that the data included in this analysis have national coverage in both independent and NHS

providers of arthroplasty, with mandatory data capture to the NJR and primary case ascertainment in excess of 97% for hip and knee arthroplasties.[8] This has enabled a comprehensive, detailed assessment of the impact of the COVID-19 pandemic, and the changes required for recovery.

Limitations include factors that might make predictions conservative, such as the assumption that the latent demand for joint replacement will be the same as 2019 rather than following the historical yearly increase of around 5%.[8] The model used to predict time to recovery did not account for demographic changes including an increasingly elderly and obese population, which could further increase demand.[14,15] By contrast, factors that might exaggerate predictions are an expected modest lag in data entry for the last quarter of 2022 (around 1.4%),[9] and potentially a reduction in compliance in reporting procedures to the NJR because of indirect effects of the COVID-19 pandemic. Furthermore, the deficit will not precisely equal the number of patients awaiting surgery due to the regrettable reality that some on the waiting list will have died during the pandemic, and more will die or become unfit for surgery as waiting times increase.

Previous work on the subject includes a similar analysis from our unit which covered until the end of 2020 and reported a joint replacement deficit of around six months of normal operating activity.[9] Data from the Scottish Arthroplasty Project projected a similar deficit of around 50% for primary hip and knee replacement until the end of 2021,[16] where even with significant increases in capacity generally, orthopaedic waiting times are projected to be one to two years.[17] Estimates from the USA also report a deficit for total hip and knee arthroplasty of approximately 47% in 2020.[18] The Netherlands and Denmark reported 20% and 5% fewer procedures respectively during the latter part of 2020.[19] The effect was smaller in Australia, where registry data showed a deficit of less than 5% in 2020, with full recovery of monthly volumes in the latter half of the year.[20] The present study is unique in covering the three years following the pandemic, building significantly on previous work.

Prolonged waiting times for arthroplasty exceeding six months are associated with significant deterioration in quality of life and increased frailty.[21,22] Worse functional outcomes are also seen postoperatively.[23,24] Wider costs are incurred from deconditioning, disability, need for carers, and loss of contribution to the economy.[12] Recovering from the deficit should therefore be a priority. Strategies to expand capacity within the NHS have included promoting weekend operating with waiting list initiatives, financial incentives for clinicians to delay retirement,[25] and the development of surgical hubs. Other solutions are likely to include a rapid assessment of the clinical and cost-effectiveness of new treatment methods such as day-case joint replacement and enhanced recovery programmes.[26,27] Reducing the inpatient presence of elective services will guard against the impact of winter pressures, when elective surgery is often interrupted.

Increasing the productivity of current centres by 10%, equivalent to every hospital providing an additional five weeks of joint replacement provision per year, is improbable. An alternative strategy for a 10% expansion in services would roughly equate to 20 new high-volume treatment centres, each providing 500 hip and 500 knee joint arthroplasties annually. Even if these could be constructed, it would be challenging to match the necessary expansion in staffing, as illustrated by the construction of the 'Nightingale Hospitals' in the UK in the initial 12 months of the pandemic.[28]

In the shorter term, further expansion into the independent sector is planned.[29] However, whether the capacity is available remains to be seen. Since the pandemic, independent providers have become the predominant provider of joint replacements, from just under 40% in 2019 to now over 53%. From the patient perspective, this reliance on the independent sector could worsen healthcare inequalities, as independent-sector provision is concentrated in less deprived areas.[30,31] A concern exists for orthopaedic training if high-volume, low-complexity cases are predominantly undertaken in the independent sector.

Our analysis has demonstrated that as a consequence of the COVID-19 pandemic, the provision of primary arthroplasty lagged by approximately 160,000 cases (nine months of normal activity) between 2020 and 2022 in England, Wales, and Northern Ireland. It will require a major effort to overcome this deficit.

Patients awaiting knee, shoulder, and ankle arthroplasty have been more severely affected than those awaiting hip and elbow arthroplasty. Patients in Wales and Northern Ireland have been more severely compromised than those in England. The public sector has been more severely affected than the independent sector, and joint replacements are now predominantly done in non-NHS independent institutions.

Returning to pre-pandemic provision is insufficient to address the deficit. Even with rapid expansion, our study suggests it will take many years, if not decades, to resolve the joint replacement crisis.

Take home message

- Almost three-quarters of a year's worth of normal operating activity has been lost since the start of the COVID-19 pandemic.
- Even with a rapid expansion of services, it will take many years to recover this deficit.

Supplementary material

Inclusion/exclusion flowcharts, annual procedural counts by joint, weekly procedural counts by joint, and annual procedural counts by funding source and provider sector.

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Author information:

J. M. R. French, MRCS, Clinical Research Fellow
K. Deere, MSc, Senior Research Fellow
T. Jones, PhD, Research Fellow
A. Sayers, PhD, Senior Research Fellow
Musculoskeletal Research Unit, Learning and Research Building, Southmead Hospital, University of Bristol Medical School, Bristol, UK.

D. J. Pegg, FRCS, Consultant Trauma & Orthopaedic Surgeon, Mid Cheshire Hospitals Foundation Trust, Leighton Hospital, Crewe, UK.

M. R. Reed, MD, FRCS, Consultant Trauma & Orthopaedic Surgeon, Professor, Northumbria Healthcare NHS Foundation Trust, Ashington, UK.

M. R. Whitehouse, PhD, FRCS, Consultant Trauma & Orthopaedic Surgeon, Professor, Musculoskeletal Research Unit, Learning and Research Building, Southmead Hospital, University of Bristol Medical School, Bristol, UK; National Institute for Health Research Bristol Biomedical Research Centre, University Hospitals Bristol and Weston NHS Foundation Trust and University of Bristol, Bristol, UK.

Author contributions:

J. M. R. French: Formal analysis, Visualization, Writing – original draft, Writing – review and editing, Data curation, Investigation, Methodology, Project administration, Validation.
K. Deere: Supervision, Writing – review and editing, Conceptualization, Methodology, Project administration, Resources, Software.
T. Jones: Methodology, Supervision, Writing – review and editing, Data curation, Formal analysis, Investigation.
D. J. Pegg: Supervision, Visualization, Writing – review and editing, Methodology.
M. R. Reed: Investigation, Supervision, Writing – review and editing.
M. R. Whitehouse: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Writing – review and editing.
A. Sayers: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing.

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presentations, speakers bureaus, manuscript writing or educational events from Heraeus, and is a member of the editorial board of The Bone & Joint Journal and a member of the research committee for the British Orthopaedic Association and the British Hip Society.

Data sharing:
The datasets generated and analyzed in the current study are not publicly available due to data protection regulations. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

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