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# SUPPLEMENT REGISTRIES

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# Insights from Hip Registries: the Continued Rise of Ceramic in Clinical Use

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In medicine, staying informed about trends and advancements is not just an obligation, but a necessity to ensure the highest standard of patient care. In this new edition of CeraNews, we explore insights from the seven most utilized registries worldwide.

This comprehensive review offers a international view of current usage and developments in hip replacement with a special focus on bearings, highlighting fixation techniques, material used and new trends. This analysis aims to reflect the clinical outcomes and the clinical practice of hospitals with one unique goal: understanding how the choice of bearings may impact patient outcomes.

While RCTs are invaluable in clinical research, it is undeniable that registries have become an established source of evidence for HCPs. Real-world data compiled by registries year after year provide comprehensive insights into implant performance and patient outcomes.

Comparing the multitude and heterogeneity of registry data is complex. Nevertheless, the real-world data speaks for itself. The registries annual reports covering arthroplasty year 2021 still reflect the effects of the pandemic. Aside from these effects, for the first time the usage of ceramic femoral heads exceeded that of metal femoral heads in the England, Wales, Northern Ireland, the Isle of Man and Guernsey, and cumulative data from the USA reported usage at 76.3%, a rise of 3% from 2020. Correspondingly the use of metal femoral heads has once again declined. The seven selected registries are defined as the most relevant due to the number of procedures recorded annually and/or the quality of the data collected and analysed.

Registry dataset analyses summarized in the annual reports reflect year on year the increasingly better outcomes of ceramic bearings compared to metal bearings. Revision rates have remained consistently low, or equivalent to those of other bearings with all fixation options up to fifteen years. Good results were also noted in England, Wales, Northern Ireland, the Isle of Man and Guernsey with Ceramic-on-Ceramic and Ceramic-on-Poly bearings in younger patients. Regardless of the fixation method, the New Zealand Joint Registry highlights lower revision rates for Ceramic-on-Ceramic than both Ceramic-on-Poly and Metal-on-Poly.

Clinical outcomes for Ceramic-on-Ceramic resurfacing are increasingly available due to the growing number of procedures. 298 Ceramic-on-Ceramic resurfacing procedures alone were recorded in Australia. The significantly better outcomes for Ceramic-on-Ceramic compared to Metal-on-Metal in the short-term are positive signs for future success. A cumulative



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revision rate of 0.3 (0.0, 2.5) is reported at one year, which is significantly lower than that for Metal-on-Metal resurfacing combinations.

While the use of dual mobility bearings continues to steadily increase internationally, currently the NJR is the only registry reporting the use of ceramic heads in dual mobility constructs. In 2021 almost one-third of the total dual mobility constructs implanted had a ceramic femoral head.

With excellent survival rates, hip replacement remains without any doubt the "operation of the century"*. Still some challenges remain, though. Let's continue to learn, to advance together and to offer patients the best possible outcomes. Arthroplasty registries have proven to be effective in advancing these objectives for patient safety. A harmonization of registries could possibly expand the pool of real-data, enabling a comprehensive analysis of implants globally.

Happy reading!

Dr. Alessandro Alan Porporati

* Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. *Lancet.* 2007;370(9597):1508-1519. doi:10.1016/S0140-6736(07)60457-7.



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# Preamble

Analysing registry data can be complex due to differences in the definitions used, which are dependent on the culture, healthcare systems, response patterns, priorities, and needs. The International Society of Arthroplasty Registries (ISAR) is working on the harmonisation of definitions, data collection and reporting across registries. The aggregation of data for procedures recorded by different registries aims to enable international comparisons and to identify issues with medical devices.

This CeraNews issue extracts and summarizes the data and trends related to the usage of bearing materials and especially ceramic bearings, and the reasons for revision and trends in total hip replacement using the data on hip procedures from the annual reports 2022 of seven registries selected for their historical perspective and data collection. The analysis is limited to the most commonly used materials, *i.e.*, ceramic, ceramicised metal and metal (cobalt chrome) for femoral heads; (cross-linked) polyethylene and ceramic for inserts. The bearing types considered are therefore Ceramic-on-Ceramic, Ceramic-on-Polyethylene, Metal-on-Polyethylene and Ceramicised metal-on-Polyethylene.

**Ceramic** - No differentiation between the ceramic materials. The only registry that differentiates between ceramic materials is the AOA NJRR which is in its analysis examines only the newest generation materials. Therefore, the following analysis was generalized to ceramic without distinguishing between alumina and mixed ceramics.

**Polyethylene** – The classification according to the irradiation dose is not harmonised across the registries. The only registry that differentiates polyethylene according to irradiation dose is the German registry, whereas, at the other extreme, the NJR makes no differentiation at all. This summary tries to reflect the results of modern prosthetics as closely as possible.



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# Executive Summary

**This summary takes the most relevant information about total hip arthroplasty procedures from the 2022 annual reports of seven national arthroplasty registries (NJR, AOA NJRR, EPRD, AJRR, NZJR, SAR and LROI). These registries have been selected as they have been defined as the most relevant, in terms of the number of procedures recorded, and the quality of the data collected.**

- Across all seven registries, the impact of the COVID-19 pandemic on the volume of hip replacements eased in operation year 2021.
- In 2022, the NJR and AOA NJRR have began introducing PROMs in a separate section, reporting PROMs at the implant brand level however is still in development.
- A trend toward hybrid fixation can be observed in six national registries, apart from the AJRR.
- When only considering femoral head diameter in THR, 32mm is the most common head size according to the European registries and NZJR, whereas the AOA NJRR and AJRR report a larger usage of 36mm heads.

**Ceramic** - According to annual data, 51% of all THR recorded in the NJR, 89.4% in the EPRD, 27% in the SAR, and 72.8% in the LROI were performed with ceramic femoral heads. This accounts for an increase of more than 3% in the NJR, 0.3% in the EPRD, 1% in SAR, 3.9% in the LROI compared to 2020. 2021 was the first year in which the use of ceramic femoral heads exceeded that of metal femoral heads in the NJR. The AJRR reported cumulative data of ceramic femoral heads usage (2012-2021) at 76.3% in 2021, with a 3% increase from 2020. The use of CoP bearings has generally increased in 2021. CoP has become the most preferred bearing option of THR in the NJR, EPRD, AJRR, NZJR and LROI. The increased use of CoP bearings is mainly at the expense of MoP and CoC bearings.

**Dual Mobility** - A steady increase in use for primary THR and revision procedures can be observed. The NJR is currently the only registry reporting the use of ceramic heads with dual mobility constructs, and almost one-third of the total dual mobilities implanted in a primary procedure in 2021 had a ceramic head. The NJR confirms that the CoPoM dual mobility bearings show lower revision trend than the MoPoM combinations, but with no statistical significance.

**Resurfacing** - 298 CoC hip resurfacing (ReCerf®/MatOrtho®) procedures have been documented by the AOA NJRR with a cumulative revision rate of 0.3 (0.0, 2.5) at 1 year, which has a lower rate of revision compared to two MoM resurfacing systems at 1 year, with 1.1 (0.7, 1.5) and 1.4 (1.2, 1.6), respectively.



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**Revision** - Of the most common reasons for revision, (aseptic) loosening, infection, dislocation and (periprosthetic) fractures top the list in varying order. Infection has become the most common reason for all revision procedures in Australia (22.7%, 1999-2021) and the United States (20.1%, 2012-2021). Revision rates for infection in other registries have been increasing year on year. According to the NJR, the revision rates for CoP bearings remain consistently low or equivalent to those of other bearings in all fixation options up to fifteen years. Notably, the NJR shows that good results were obtained with CoC and CoP bearings in young patients. The AOA NJRR shows a statistically significant lower rate of revision of CoXLPE in comparison with MoXLPE after 1.5 years (HR=0.79 (0.74,0.84), p<0.001). According to the EPRD, among all bearing couples, CoC show in the short-, and mid-term, the lowest failure rates. Regardless of the fixation method, the NZJR shows that the revision rate for CoC bearings is lower than that for CoP and MoP. The revision rate for CoP is also lower than that of MoP.



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# General Information of National Joint Registries

| | NJR | AOA NJRR | EPRD | AJRR | NZJR | SAR | LROI |
|---|---|---|---|---|---|---|---|
| Name | National Joint Registry | Australian Orthopaedic Association National Joint Replacement Registry | Endoprothesen-register Deutschland | American Joint Replacement Registry | The New Zealand Joint Registry | Swedish Arthroplasty Register | Dutch Arthroplasty Register |
| Area Coverage | England, Wales, Northern Ireland, the Isle of Man and Guernsey | Australia | Germany | USA[1] | New Zealand | Sweden | Netherlands |
| Participation | Mandatory | Mandatory | Voluntary (from 2025 Mandatory) | Voluntary | Voluntary | Mandatory | Mandatory |
| Completeness | >99% | 99.2% | 70% | ___ | 70-75% | approx. 98% | >97% |
| Data collection period | 2003-2021 | 1999-2021 | 2012-2021 | 2012-2021 | 1997-2021 | 1975-2021 | 2007-2021 |
| Type of Joint | Hips, knees, ankles, elbows, and shoulders | Hips, knees, and shoulders | Hips and knees | Hips and knees | Hips, knees, ankles, elbows, and shoulders | Hips and knees | Hips, knees, ankles, shoulders, elbows, wrists, and fingers |
| Total number of primary hip joint replacement procedures for analysis | 1,344,357 (THRs: 91.4% All resurfacing: 3.1% Unconfirmed: 2.9%, 2003-2021) | 599,398 (THRs: 96.8% Resurfacing: 3.2%, 1999-2021) | THRs: 139,647 (2021)* | THRs: 821,640 (2012-2021) (Elective primary THR) | THRs: 164,363 (1997-2021) | (Total and hemi) HRs: 510,977 (1979-2021) | THRs: 386,956 (2007-2021) |

Evaluation of the data by CeramTec based on the demographic information provided by Annual Reports 2022 of NJR[1], AOA NJRR[2], EPRD[3], AJRR[4], NZJR[5], SAR[6] and LROI[7].
[1] Over 2.8 million procedures from 1,251 institutions in all 50 states and the District of Columbia are recorded by end of 2021.
* Indicates single year data only generated in 2021.

*Table 1: General information of national joint registries.*



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| | NJR | AOA NJRR | EPRD | AJRR | NZJR | SAR | LROI |
|---|---|---|---|---|---|---|---|
| Gender | Male 40.2% | Male 45.1% | Male* 41% | — | Male 46.41% | Male 42% | Male* 35% |
| | Female 59.8% | Female 54.9% | Female* 59% | | Female 53.59% | Female 58% | Female* 65% |
| Mean age years (SD) | 68.1 (11.4) | 67.8 (11.5) | 70* | 65.7 (11.3) | Male 65.89 | 68.5 (10.73) | 69.4 (10.4)* |
| | | | | | Female 68.57 | | |
| Main Surgery Indication | Osteoarthritis (88.0%) | Osteoarthritis (88.3%) | — | — | Osteoarthritis (88.1%) | Osteoarthritis (80.9%) | Osteoarthritis (86.1%)* |
| ASA Score | ASA 1: 15.3%<br>ASA 2: 67.6%<br>ASA 3: 16.5%<br>ASA 4: 0.6%<br>ASA 5: <0.1% | ASA 1: 9.3%<br>ASA 2: 52.7%<br>ASA 3: 36%<br>ASA 4: 2%<br>ASA 5: 0 | Mean ASA: 2.2%* | — | — | ASA 1: 20.6%<br>ASA 2: 59.1%<br>ASA 3: 19.7%<br>ASA 4: 0.6% | ASA 1: 14%*<br>ASA 2: 62%*<br>ASA 3-5: 24%* |
| BMI (kg/m²) | — | — | Mean BMI: 27.3* | — | Mean BMI: 29.1 | — | Mean BMI: 27.1 (4.6)* |
| Revision Rate / Survival Rate | Cumulative revision (95% CI): 7.81% (7.65%-7.98%) at 18-year | Revision burden in 2021: 7.6%<br><br>Cumulative revision (95% CI): 11.9% (11.6%-12.2%) at 20-year | Cumulative revision of elective THRs with uncemented stem fixation (95% CI): 4.1% (4.0%-4.2%) at 7-year<br><br>Cumulative revision of elective THRs with cemented stem fixation (95% CI): 3.8% (3.5%-4.0%) at 7-year | Revision burden of all THRs in 2021: 9.2% | Cumulative survival: 85.91% at 20-year | Revision rate decreased in the past two decades from just under 13.5% to approximately 10% in the period 2019-2021 | Cumulative revision of THRs (95% CI): 5.8% (5.6%-5.9%) at 13-year |
| Total number of primary hip joint replacements in 2021 | 84,998<br>(THRs: 97.7%<br>All resurfacing: 0.8%<br>unconfirmed: 1.5%) | THRs: 41,984 | THRs: 139,647 | — | — | THRs: 17,390 | THRs: 31,514 |

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# Fixation and Bearings in Hip Replacement

A clear overall trend toward hybrid fixation can be observed in all six identified national registries at the expense of cemented fixations, except the AJRR, which categorizes fixation methods into uncemented and cemented fixation stem groups.

Uncemented fixation remains the most often used method in Australia, Germany, United States, New Zealand, and the Netherlands. The use of cemented fixation has decreased year on year in Sweden but still accounts for 52% of all THR procedures.

The usage of hybrid fixations recorded by the NJR and AOA NJRR achieved 38.1% and 36.3%, respectively. Hybrid fixation is the most popular choice for hip replacement recorded by the NJR.

## THR Fixation

### NJR

According to the annual data in 2021, 21.8% of primary hip replacements have been recorded in the NJR dataset as cemented fixation, 35.4% as uncemented fixation, and 38.1% as hybrid fixation. Between 2006 and 2021, the usage of cemented fixation in all hips has decreased by almost half, while the percentage of hybrid fixation has increased by more than 2.5 times.[1]

### AOA NJRR

There is a continuing trend in favour of uncemented fixation in Australia, from 51.3% in 2003 to 60.8% in 2020, then 61.6% in 2021. The percentage of hybrid fixation decreased slightly from 36.8% in 2020 to 36.3% in 2021, while the numbers for cemented fixation decreased significantly from 13.9% in 2003 to 2.4% in 2020, then 2.1% in 2021.[2]

### EPRD

Considering the procedures recorded in the registry dataset with the type of fixation, uncemented fixation remains the clear favorite despite a slight reduction from 78.6% in 2019 to 77.9% in 2020, then 76.9% in 2021. Hybrid fixation increased from 15.2% in 2019 to 16.8% in 2020, then 17.5% in 2021.[3]

### AJRR

In the United States, uncemented femoral stem fixation remains the preferred option. According to the statistical data for operation year 2021, it was used in 95.2% of all elective



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primary THR procedures from 2012 to 2021. The highest use, so far, of cemented femoral stems was recorded at 4.8% in 2021 by AJRR.[4]

### NZJR

The usage of cemented hip replacement has fallen to about 5% in 2021. There has been an increasing trend toward hybrid fixation between 2010 and 2020, with a slight decrease in 2021, while uncemented is still the most popular procedure.[5]

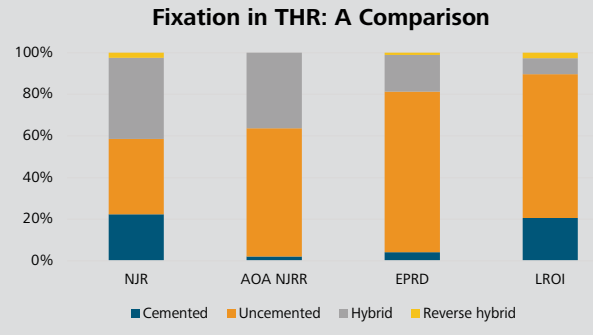
### SAR

The use of cemented fixation has decreased every year over the past 20 years until 2020. In 2021, a small increase in the proportion of patients with cemented fixation is recorded, from 50% to 52%. The increase of cemented fixation has mainly taken place in the age groups of 65-74 years and 75-84 years. The registry continues to encourage the use of cemented fixation in patients older than 70 years. The proportion of hybrid prostheses has increased from 7.1% in 2020 to 8% in 2021.[6]

### LROI

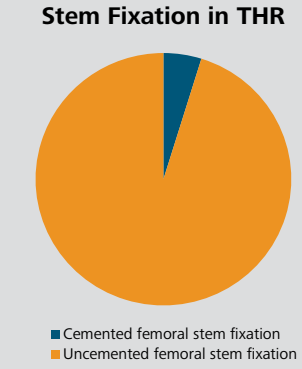
The uncemented fixation remains, in 2021, the preferred fixation in the Netherlands, with a continuous increase from 62.6% in 2012 to 69.1% in 2021. The use of cement fixation has therefore respectively decreased slightly every year to 20.5% in 2021. There is a trend of increasing use of hybrid fixation from 4.1% in 2012 to 7.7% in 2021.[7]

*Figure 1a (left): Distribution of fixation methods in primary THRs in 2021 (Annual Data): in Australia, Germany, Netherlands as well as England, Wales, Northern Ireland, the Isle of Man and Guernsey.*




Evaluation of the data by CeramTec is based on NJR Annual Report 2022 Page 49 Table 3.H2[1], AOA NJRR Annual Report 2022 Page 49 Figure HT3[2], EPRD Annual Report 2022 Page 28 Table 5[3], and LROI Annual Report 2022 Page 17 Figure Fixation[7]. For the comparison of THR fixation methods, unconfirmed data and all resurfacing data were excluded when analyzing datasets from the NJR, EPRD and LROI. The usage percentage of cemented, uncemented, hybrid and reverse hybrid fixations sum up to 100%.

*Figure 1b (right):Distribution of femoral stem fixation methods in primary THR (2012-2021) in the United States.*




Evaluation of the data by CeramTec is based on AJRR Annual Report 2022 Page 36 Figure 2.22[4].



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## THR by Femoral Head Diameter

**When only considering femoral head diameter in THR, 32mm femoral heads are the most common head size according to the included European registries and NZJR, whereas the AOA NJRR and AJRR report a larger usage of the 36mm heads. There is also a trend towards the use of 36mm femoral heads reported by the NZJR and EPRD.**

**The NJR and AOA NJRR Annual Report 2022 provide information on the size as well as the material of femoral heads used in THR allowing for analysis of the combinations. It should be mentioned that the AOA NJRR provides a prosthesis-specific analysis by femoral head diameter restricted to modern bearing surfaces, which include mixed ceramic/mixed ceramic, and all femoral head materials used in combination with cross-link polyethylene.**

### NJR

In 2021, the most common head size recorded by the NJR was, as in 2020, 32mm, followed by 36mm and 28mm. Both 32mm and 36mm heads in uncemented and hybrid CoP show an increase in use over the years.[1]

### AOA NJRR

For all femoral head materials with non-XLPE, <32mm femoral heads predominated. For the XLPE group, the usage rates of 32mm and >32mm femoral heads were about 2.5 times higher than those of smaller head sizes (<32mm), respectively. The Australian registry also looks at the usage of "mixed ceramic" components in THR. 36-38mm mixed ceramic/mixed ceramic bearings accounted for 73.8% of all primary THR procedures with this bearing surface in patients diagnosed with osteoarthritis in the period 2003-2021.[2]

### EPRD

In 2021, 32mm femoral heads were used in 49.9% (2020: 52.7%) of primary THRs. 36mm heads in 44.4% (2020: 41.4%) of the primary cases. Usage of 28mm heads remains stable and accounts for 5.2% of all primary THR.[3]

### AJRR

The usage of 36mm heads in primary elective THR has shown an increase since 2012, from 47.9% in 2012 to 59.9% in 2021. The usage of 32mm heads decreased correspondingly from 33.1% to 18.6% over this time. Hip replacements with head sizes ≥40mm have grown slowly from 5.6% in 2013 to 8.2% in 2021.[4]



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### NZJR

New Zealand shows a trend towards 36mm heads since 2017. 32mm heads are used in over 50% of the primary THR.[5]

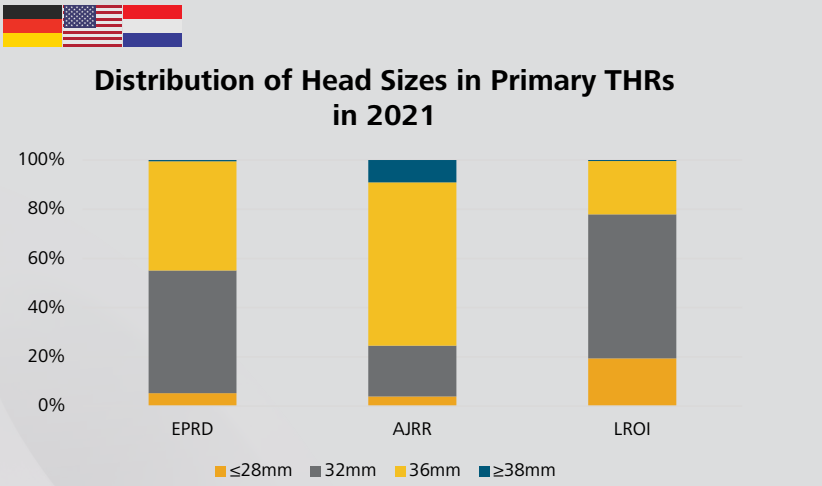
### SAR

The use of the 32mm head continues to increase, while the use of the 36mm head remains steady at 10% of all reported THRs in 2021, and other recent years.[6]

### LROI

The most common head size was still 32mm in 2021 in the Netherlands, with a usage rate of 63.7% in 2021. The use of the 36mm head has shown a slight increase from 23.4% in 2020 to 25.6% in 2021. The usage of small head sizes (22-28mm) has decreased tremendously, from 33.2% in 2012 to 10.3% in 2021. Large head sizes (≥38mm) account for only 0.3%.[7]

*Figure 2: Distribution of head sizes in primary THRs in 2021: in Germany, the United States and Netherlands.*




Evaluation of the data by CeramTec based on EPRD Annual Report 2022 Page 30 Table 11[3], AJRR Annual Report 2022 Page 28 Figure 2.11[4] and LROI Annual Report 2022 Figure on Page 19[7]. The data in EPRD indicates single year data only generated in 2021.



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## Distribution of Femoral Heads by Material

### NJR

2021 is the first year in which the use of ceramic femoral heads exceeded that of metal femoral heads. The use of ceramic femoral heads reached 51% in all primary THRs, compared to 48% in 2020. Correspondingly, the use of metal femoral heads decreased from 47.7% in 2020 to 45.2% in 2021.[1]

### AOA NJRR

A steady increase in the use of ceramic heads can be observed since 2014. Consequently, a decrease in the usage of metal heads has also been recorded by the registry in the same period.[2]

### EPRD

In Germany, the trend toward ceramic femoral heads is still increasing, accounting for 89.4% of all primary THRs in 2021. Every year, since 2018, around 3% of all primary THR in Germany use ceramicised metal heads.[3]

### AJRR

In the United States, the percentage of ceramic femoral heads in all elective THR (2012-2021) has been continuously rising from 38% in 2012 to 76.3% in 2021. Correspondingly, AJRR reports a continuous decline in the usage of CoCr heads from 55.9% in 2012 to 13.8% in 2021 and explains this trend by the surgeons' concern over trunnion and taper corrosion with CoCr heads. The use of ceramicised metal heads has increased nearly two-fold in 2021 compared to that in 2012.[4]

### NZJR

According to the NZJR Annual Report 2022, the use of ceramic femoral heads has continuously increased since 2013. Their use surpassed that of the metal heads in 2017.[5]

### SAR

In Sweden, the use of ceramic femoral heads has continuously increased over the years. However, metal remains the most used head material in hip procedures.[6]

### LROI

In the Netherlands, the use of ceramic femoral heads has been increasing continuously since 2012, from 63.1% to 72.8% in 2021. Correspondingly, the use of metal femoral heads has decreased from 32.1% in 2012 to 16.5% in 2021. There is a slight upward trend in the use of ceramicised metal heads, with 4.8% in 2012 to 10.2% in 2021.[7]



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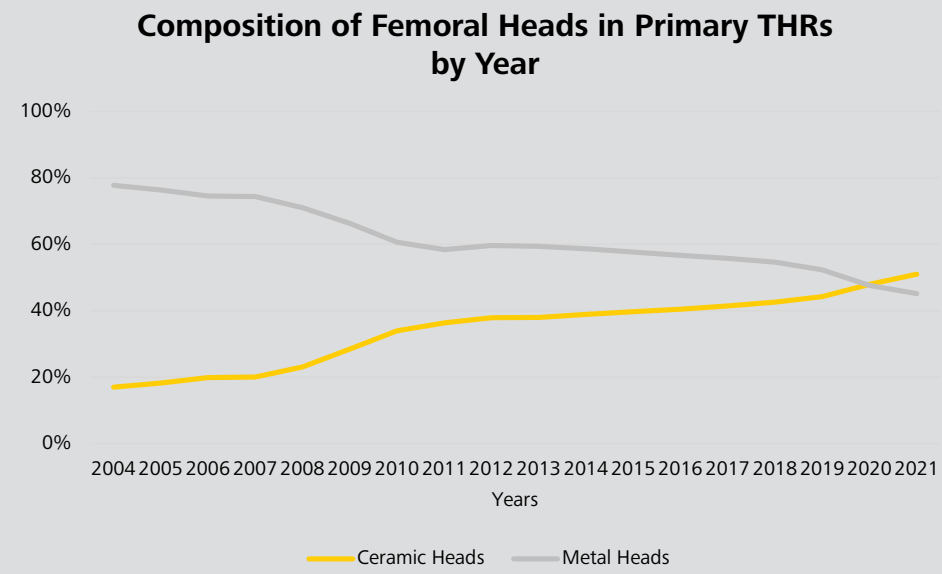
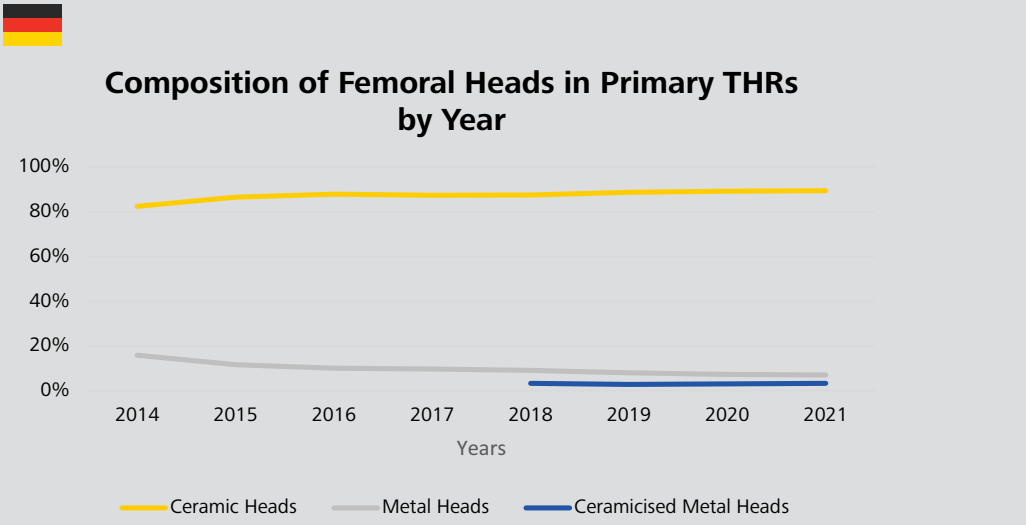
*Figure 3: Composition of femoral heads in primary THR by year in England, Wales, Northern Ireland, the Isle of Man and Guernsey.*




Evaluation of the data by CeramTec is based on NJR Annual Report 2022 Page 53 Table 3.H2[1]. The usage rates of ceramic and metal heads correspond to the sum of the usage rates of the bearings containing ceramic and metal heads, respectively. In order for the total number to be equal to the number of THRs, all data relating to hip resurfacing were excluded from the percentage calculation.

*Figure 4: Composition of femoral heads in primary THR by year in Germany.*




Evaluation of the data by CeramTec is based on EPRD Annual Reports 2014 to 2022 (For operation year 2014, the number indicates percentage of all primary hip replacements. For operation years 2015 to 2021, the numbers indicate percentage of all primary THR)[3, 8-14]. The usage rates of ceramic, metal and ceramicised metal heads correspond to the sum of the usage rates of the bearings containing ceramic, metal and ceramicised heads, respectively.



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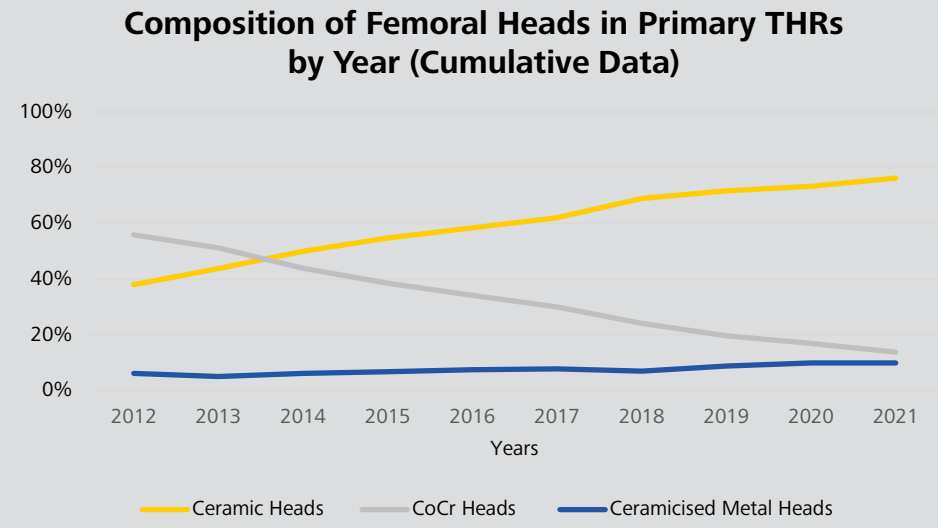
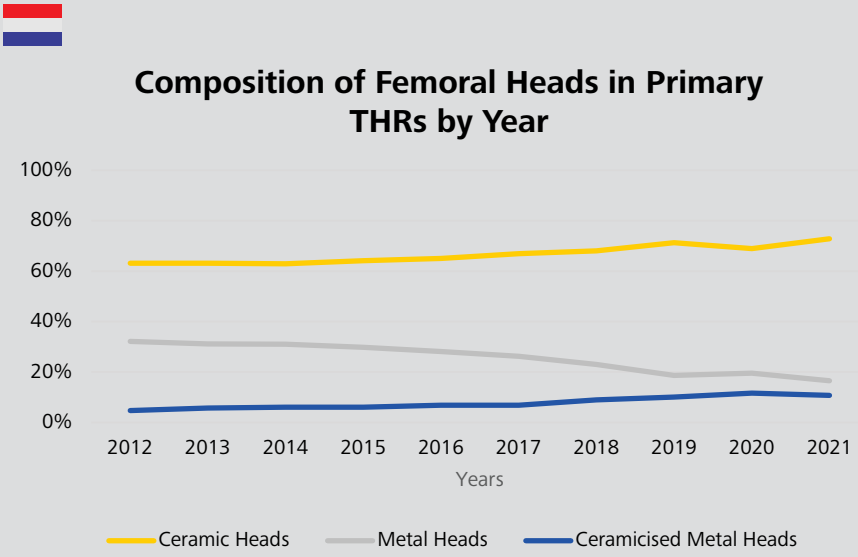
*Figure 5: Composition of femoral heads in primary THR by year (cumulative data) in the United States.*




Evaluation of the data by CeramTec is based on AJRR Annual report 2022 Page 33 Figure 2.16[4].

*Figure 6: Composition of femoral heads in primary THR by year in the Netherlands.*




Evaluation of the data by CeramTec is based on LROI Annual report 2022 Page 22 Figure[7]. The usage rate of ceramic heads is equal to the percentage of Ceramics/Zo plus Ceramics, the usage rate of metal heads is equal to the percentage of Cobalt chrome plus Stainless steel, the usage rate of Ceramicised Metal Heads is that of oxidized zirconium.



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## Bearing Surfaces
## Ceramic-on-Poly: The most preferred option

**In most countries, CoP has become the most preferred bearing option in THR.**

### NJR

The use of CoP bearing increased from 8.9% in 2007 to 46.7% in 2021 in England, Wales, Northern Ireland, the Isle of Man and Guernsey. This is also the first year that the annual use of CoP bearings exceeded that of MoP. The use of MoP bearings has decreased from 74.6% in 2004 to 45.2% in 2021. According to the last annual report, CoC bearings were implanted in 4.3% of all primary THRs with a known bearing type. The use of CoP is preferred in both uncemented and hybrid hips. Hybrid CoP was the most frequently implanted construct in 2021, as in 2020, accounting for 20.9% of all primary hip replacements, followed by uncemented CoP (19%) and cemented MoP (15.9%).[1]

### AOA NJRR

In Australia, almost all, 96.8%, of the bearings implanted in 2021 consisted of mixed ceramic- and metal-on-cross-linked polyethylene, and mixed ceramic-on-mixed ceramic. These are defined as "modern bearing surfaces" by the registry. The hard-on-soft bearings with a ceramic head account for approximately half of the bearing surfaces implanted. CoC with mixed ceramic constitute 99.9% of all procedures with a CoC bearing. When polyethylene was used, in 97.2% of the procedures in 2021, it was XLPE. The usage of metal heads and CoC is gradually decreasing.[2]

### EPRD

In Germany, the use of CoP bearings continuously grew from 67% in 2014 to 81.3% in 2021. There was a corresponding decrease in the use of CoC bearings from 15.4% to 8.1% and for MoP bearings from 15.8% to 6.9% over this time. Approximately 3% of primary THRs are performed with CMoP (ceramicised metal-on-polyethylene) femoral heads in Germany, there has been no significant change in this number since 2018.[3,8-14]

### AJRR

Between 2012 and 2021 the share of CoP bearings almost doubled to 62.6% in the United States. In the same period MoP dropped from 54.2% to 12.8%. The use of CMoP has doubled between 2012 and 2021 from 5.6% to 11.2%.[4]

### NZJR

In New Zealand, the CoP bearing surface continues to increase from 42% in 2017 to 54% in 2021. Correspondingly, the use of MoP has continuously decreased since 2013. There is also a slow decrease in the use of CoC since 2011.[5]



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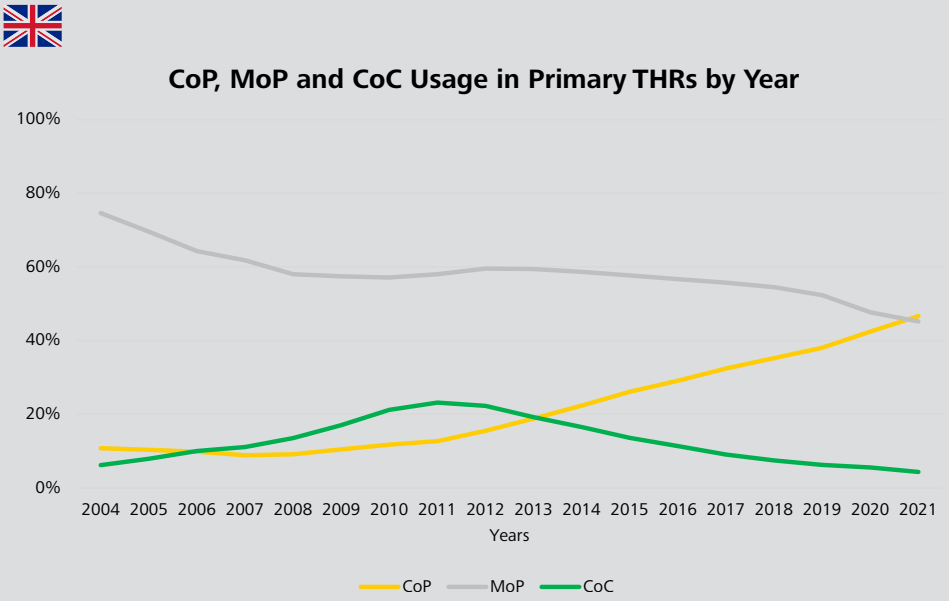
### SAR

Of all primary THRs, the proportion of CoP articulation continues to increase, from 21% in 2019 to 26% in 2020, then 27% in 2021.[6]

### LROI

The annual use of CoP increased from 51.3% in 2012 to 68.6% in 2021 in all primary THRs. Consequently, the use of MoP bearings decreased from 31% in 2012 to 15.6% in 2021. The use of CoC bearings decreased from 11.4% in 2012 to 4.7% in 2021. The use of CMoP has increased more than two-fold to 10.7% in 2021 from 4.8% in 2012.[7]

*Figure 7: Usage of CoP, MoP and CoC in primary THR by year in England, Wales, Northern Ireland, the Isle of Man and Guernsey.*




Evaluation of the data by CeramTec is based on the NJR Annual Report 2022 Page 53 Table 3.H2[1]. The usage rates of CoP, MoP and CoC correspond to the sum of the usage rates of CoP, MoP and CoC bearings with different fixation methods, respectively. In order for the total number to be equal to the number of THRs, all data relating to hip resurfacing were excluded from the percentage calculation.



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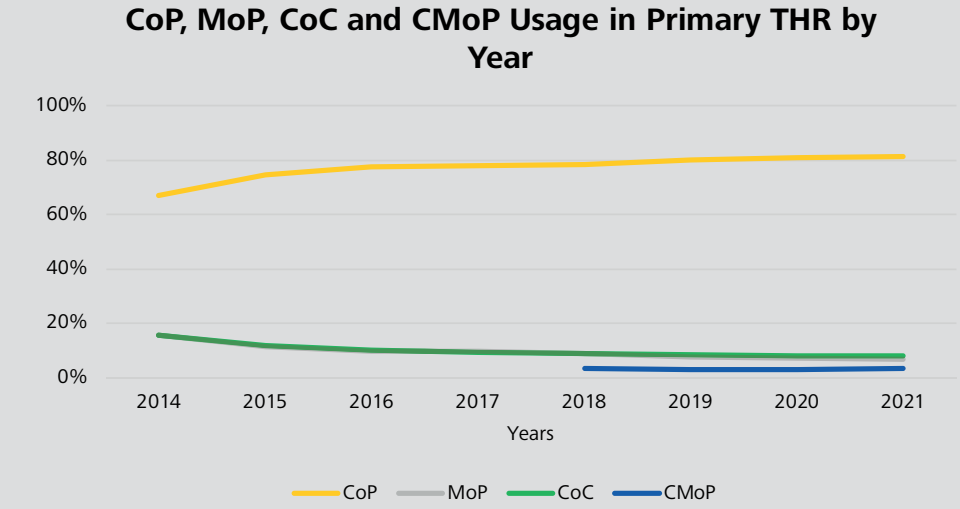
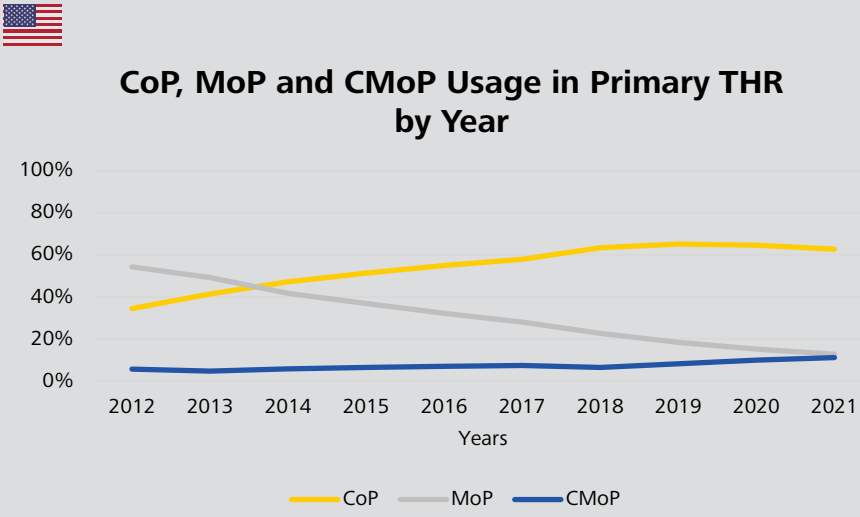
*Figure 8: Usage of CoP, MoP, CoC and CMoP in primary THR by year in Germany.*




Evaluation of the data by CeramTec is based on the EPRD Annual Reports 2014 to 2022 (For operation year 2014, the number indicates percentage of all primary hip replacements. For operation years 2015 to 2021, the numbers indicate percentage of all primary THR)[3, 8-14]. The usage rates of CoP, MoP and CMoP correspond to the sum of the usage rates of bearings containing ceramic, metal and ceramicised metal heads in conjunction with different polyethylene types, respectively.

*Figure 9: Usage of CoP, MoP and CMoP in primary THR by year in the United States.*




Evaluation of the data by CeramTec is based on the AJRR Annual report 2022 Page 34 Figure 2.18[4].



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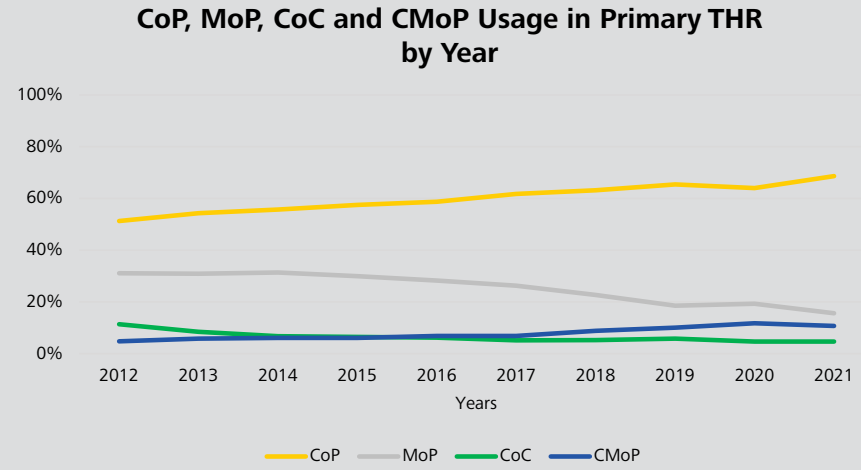
*Figure 10: Usage of CoP, MoP, CoC and CMoP in primary THR by year in the Netherlands.*




Evaluation of the data by CeramTec is based on LROI Annual Reports 2022 Page 22[7].

## Dual Mobility (DM)

**The usage of dual mobility bearings has steadily increased over the years. The data on dual mobility bearings are reported by registries including NJR, AOA NJRR, EPRD, AJRR, SAR and LROI.**

### NJR

Before 2013, dual mobility was scarcely used. An increase from less than 0.1% in 2004 to 2.4% of all primary hip replacements in 2020 can be observed, with a slight decrease in 2021 to 2.2%, possibly due to the pandemic.[1]

### AOA NJRR

In Australia, the annual use of dual mobility constructs is increasing. Their use has grown by 22.3% since 2020. Compared to other acetabular prostheses, dual mobility implants are used most frequently for a fractured neck of the femur, tumor and failed internal fixation.[2]

### EPRD

The German registry first included dual mobility bearings in the analysis of the Annual Report 2019. In 2021, this implant type accounted for 1.9% of all bearings in primary THR, whereas in acetabular revision a dual mobility cup was chosen in 31.9% of cases.[3,12-14]



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### AJRR

In the United States, the use of dual mobility in both primary and revision hip arthroplasty has continued to increase since 2012, and has remained relatively stable over last three years. The usage rate of dual mobility for all bearings used in elective primary THR accounted for 13.4% in 2021, an increase compared to that of last year (10.4%). Dual mobility was used in 21.6% of all revision procedures. This type of construct is used in all patient age groups, most commonly in older patients (>90 years), accounting for 10.6% of patients with this construct, and in younger patients (<50 years), with 9.2%.[4]

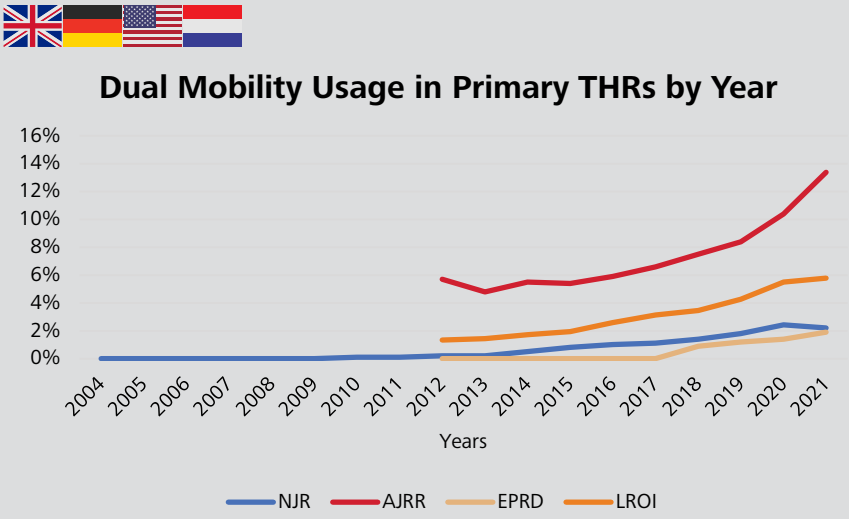
### SAR

Dual mobility is used mainly for revisions. Dual mobility was first reported in 2002 (one revision case) and increased to 500 revision operations in 2018, then slightly decreased afterwards. Around 370 dual mobility cases were reported in 2021, possibly due to the a decrease in the number of revision procedures.[6]

### LROI

In the Netherlands, a dual mobility cup was used in 5.8% of all primary THRs in 2021, which has increased from 1.3% in 2012. This type of acetabulum has been used mainly for hip revision surgeries in the Netherlands, accounting for 54.3% of all hip revision surgeries in 2021, an increase from 26.4% in 2012.[7]

*Figure 11: Annual use of dual mobility bearings in primary THR in the NJR, AJRR, EPRD, and LROI.*




Evaluation of the data by CeramTec is based on the NJR Annual Report 2022 Page 53 Table 3.H2[1], EPRD Annual Report 2019 to 2022[3,12-14], and AJRR Annual Report 2022 Page 28 Figure 2.11[4] and LROI Annual Report 2022 Page 19 Figure[7]. For the data from the NJR, the usage rates of dual mobility correspond to the sum of the usage rates of dual mobility bearings with different fixation methods. In order for the total number to be equal to the number of THRs, all data relating to hip resurfacing were excluded from the percentage calculation.



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# Clinical Outcomes

## Reasons for Revision

**The national registries use slightly different terminology when identifying reasons for revision. There are also some differences in the ranking systems of the reasons for revision between countries. However, (aseptic) loosening, infection, dislocation and (periprosthetic) fractures are found at the top of these lists in varying orders.**

### NJR

In the UK, 3% (40,387) of the 1,344,357 primary hip replacements recorded in the NJR Annual Report 2021 are associated with a first revision. The most common reasons for revision recorded by the NJR were aseptic loosening, dislocation/subluxation, periprosthetic fracture, infection, and adverse soft tissue reaction to particulate debris.[1]

### AOA NJRR

In 2021, periprosthetic joint infection (22.7%) became the most common reason for revision for all primary conventional total hip replacements, followed by prosthesis dislocation/instability (22%), (periprosthetic) fracture (21.8%) and loosening (21.0%).[2]

### EPRD

The German registry provides annual data on reasons for revision. In 2021, loosening (24.4%), infection (16.7%) and periprosthetic fracture (14.3%) were the most frequent causes for revision. The revision rate due to loosening has has decreased year on year. The rates for revision due to infection increased from 10% in 2014 to 18.9% in 2017, dropped off to 15.8% in 2020, then slightly increased to 16.7% in 2021.[3,8-14]

### AJRR

When looking at revisions in the US registry, of all hip revisions, infection and inflammatory reaction (20.1%) remain the most common reasons, followed by instability related codes (18.3%) and aseptic loosening (15.9%).[4]

### NZJR

Since 1999, the six main reasons for revision after THR procedures in New Zealand are: loosening (of the acetabular and femoral component, respectively), dislocation/instability, unexplained pain, deep infection and femur fracture. Deep infection and dislocation more



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often happen within the first year after surgery. On the other end of the scale, loosening is a more common indication for revision beyond 10 years after surgery.[5]

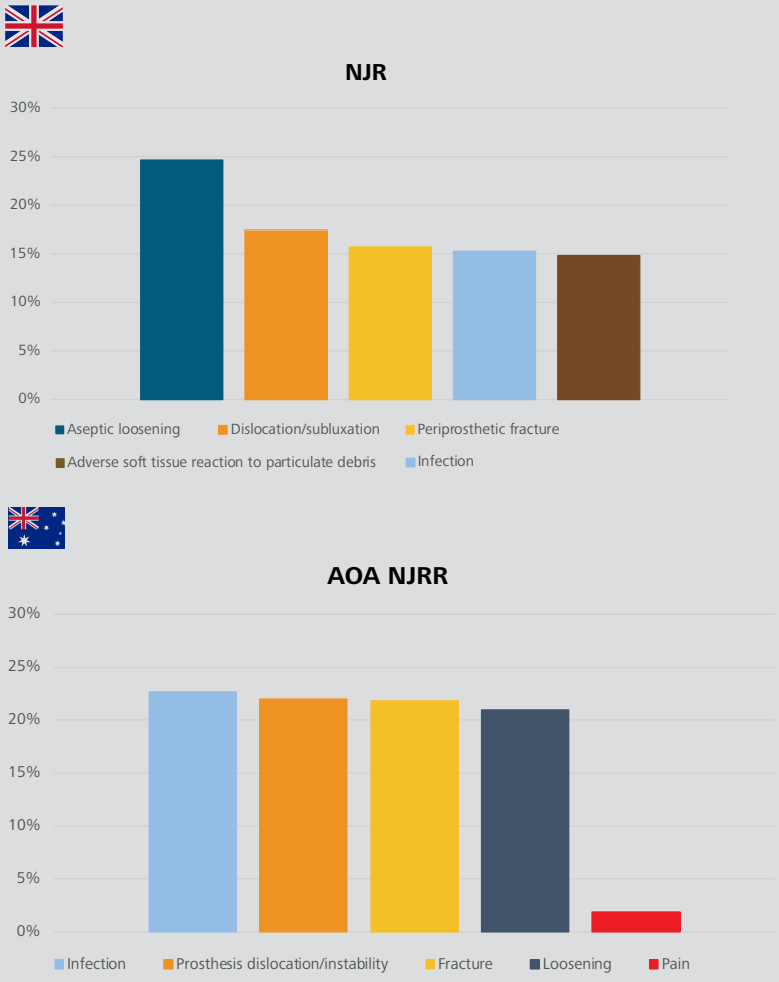
### SAR

The percentage of revisions due to loosening has decreased, while the percentage due to infection has increased.[6]

### LROI

The most common reasons for revision recorded by the LROI of all the revision procedures were loosening of acetabulum component (21.6%), infection (20.5%), dislocation (18.8%), loosening of femur component (18.5%), and inlay wear (16.9%). The annual revision rate for infection increased from 12.3% in 2014 to 25.2% in 2021.[7]

*Figure 12: The most common reasons for revision in England, Wales, Northern Ireland, the Isle of Man and Guernsey, Australia, the USA and the Netherlands.*



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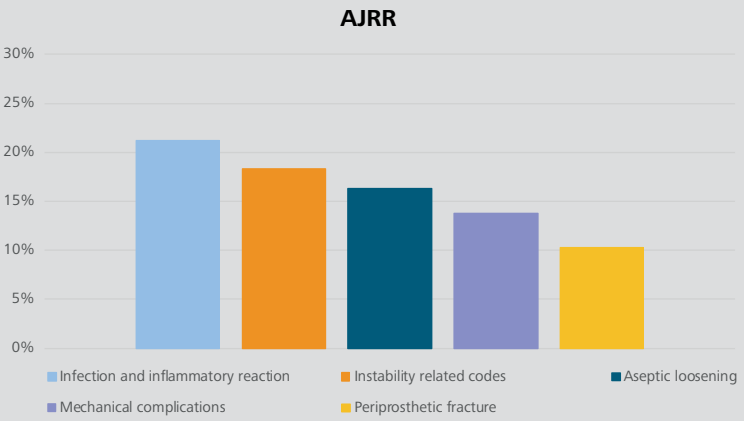


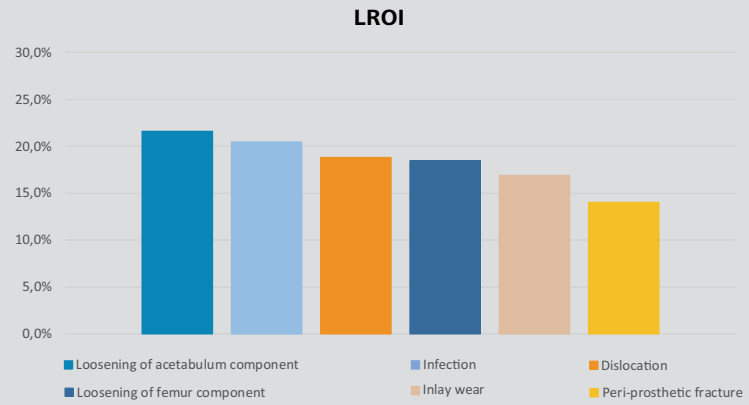


Evaluation of the data by CeramTec is based on the NJR Annual Report 2022 Page 98[1], the reasons for revision recorded in the NJR are not mutually exclusive. AOA NJRR Annual Report 2022 Page 62 Table HT15[2], AJRR Annual Report 2022 Page 51 Figure 2.32[4], and LROI Annual Report 2022 Page 30 Figure[7].



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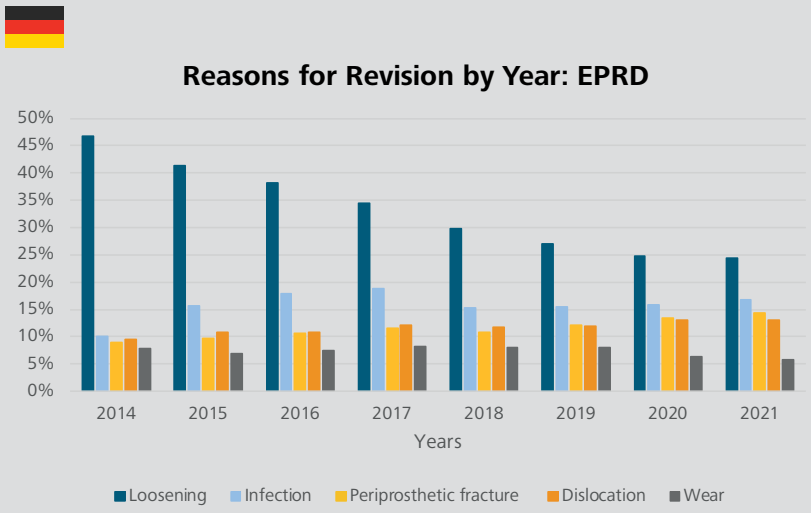
## Trends in Reasons for Revision: Infections on the Rise?

As shown by the EPRD, revision rates due to loosening are decreasing year on year. The revisions with a diagnosis of infection increased from 10% in 2014 to 18.9% in 2017 then dropped to about 15% in 2018, to start the increasing trend again with a 16.7 % in 2021.[3,8-14] Similarly, the revision rates due to infection documented by the AJRR vary from 14.9% to 25.3% over the years 2013 to 2017, then became stable at 23.6% in 2021.[4] In the Netherlands, the annual revision for infection increased from 12.3% in 2014 to 25.2% in 2021. The NZJR also provided a deep analysis of the trends of these six main reasons by year. The revision rate due to deep infection increased from 8.6% in 2012 to 18.9% in 2020, then to 27.8% in 2021. The revision rate due to fracture of the femur steadily increased from 9.3% in 2013 to 20.8% in 2020, with a slight decrease to 19.1% in 2021. In contrast, the rate of revision for unexplained pain has decreased from a peak of 20.6% in 2011 to 9.4% in 2020, falling to the equal lowest point recorded by the registry in the last decade, 3.5% in 2021.[7]

*Figure 13: Reasons for revision by year in Germany.*




Evaluation of the data by CeramTec is based on EPRD Annual Report 2014 to 2021[3, 8-14].



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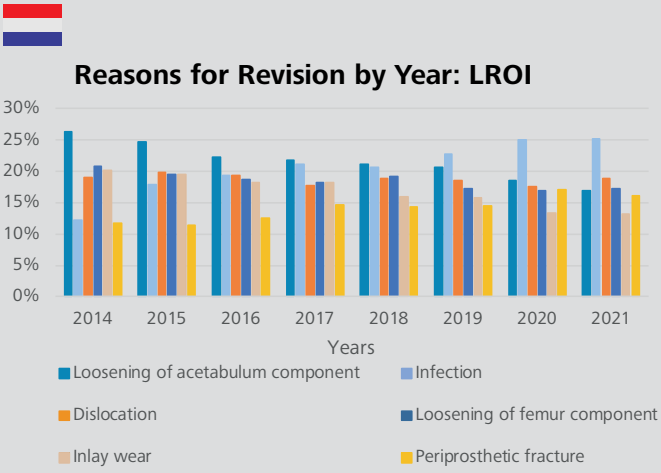
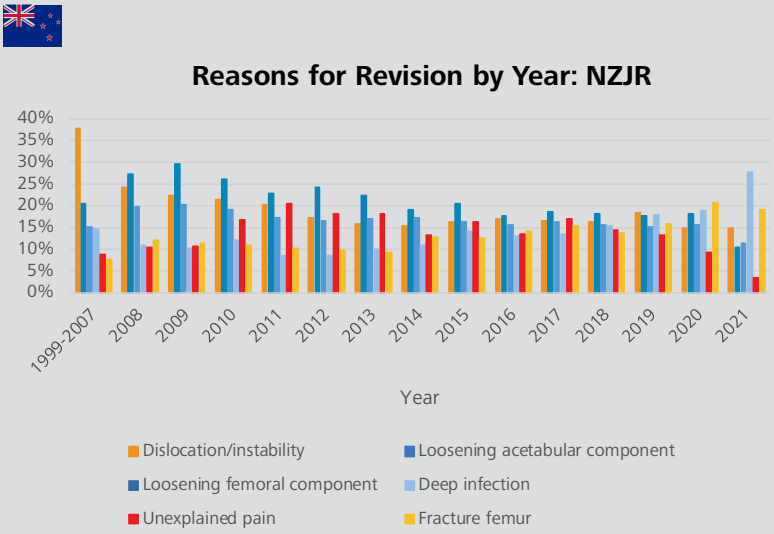
*Figure 14: Reasons for revision by year in the Netherlands.*




Evaluation of the data by CeramTec is based on LROI Annual Reports 2022 Page 30[7].

*Figure 15: Reasons for revision by year in New Zealand.*




Evaluation of the data by CeramTec is based NZJR Annual Report 2022 Page 22 Figure[5].



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## Revision Rates

### NJR

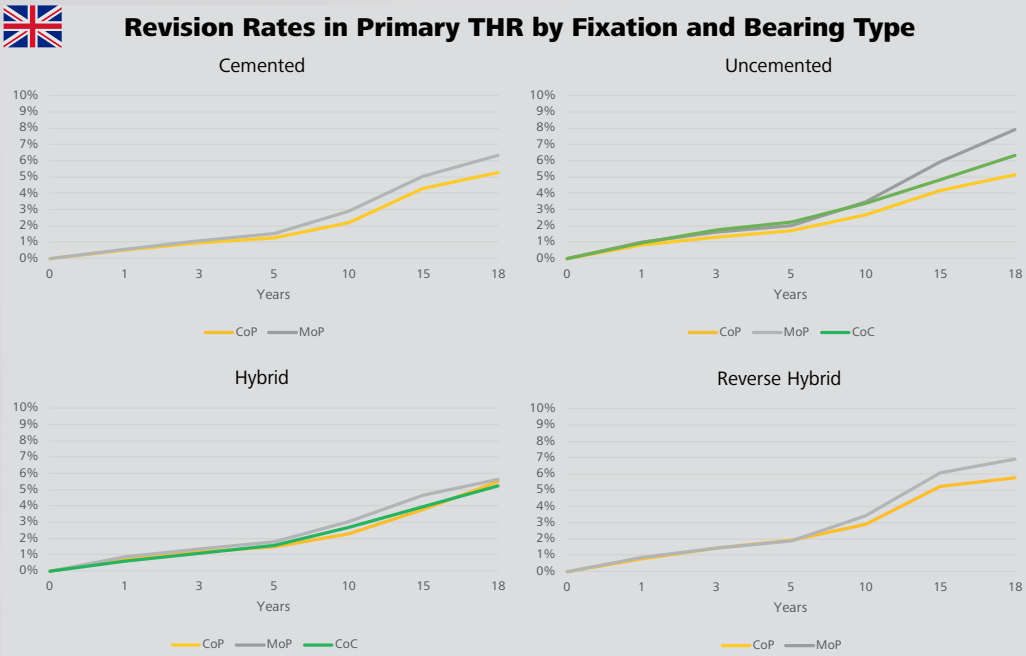
According to the NJR, the revision rates for CoP bearings remain consistently low or similar to those of other bearings in all fixation options up to fifteen years. The NJR also confirms that at ten years or more, CoP bearings outperform MoP in revision rates for cemented, uncemented, and hybrid hips. The excellent results encourage the wider use of CoP bearings.

As the number of cases recorded by the NJR increases, the confidence intervals narrow and statistical significance is reached for both genders, in all age groups, and up to 18 years after implantation. This year the results obtained in younger patients with CoC, and CoP are statistically better than those obtained by MoP; the NJR 2022 Annual Report states that these results are "striking".

In the cemented fixation group, CoP bearings with 36mm heads had higher revision rates than those with 28mm and 32mm heads. Correspondingly, in the uncemented and hybrid fixation groups, CoP bearings with 32mm and 36mm heads had lower revision rates.

In the uncemented fixation group, there is an association correlation between the revision rates of CoC bearings and head size: the larger the head, the lower the revision rate of the construct (except for 44mm heads after six years). In the hybrid fixation group, the revision rate of CoC bearings with 36mm heads was higher than that of 32mm and 28mm heads (P=0.002).[1]

*Figure 16: Cumulative revision rates in primary hip replacement with MoP, CoP, and CoC bearings in combination with different fixation methods in England, Wales, Northern Ireland, the Isle of Man and Guernsey.*




Evaluation of the data by CeramTec is based on the NJR Annual Report 2022 Page 63 Table 3.H5[1].



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### AOA NJRR

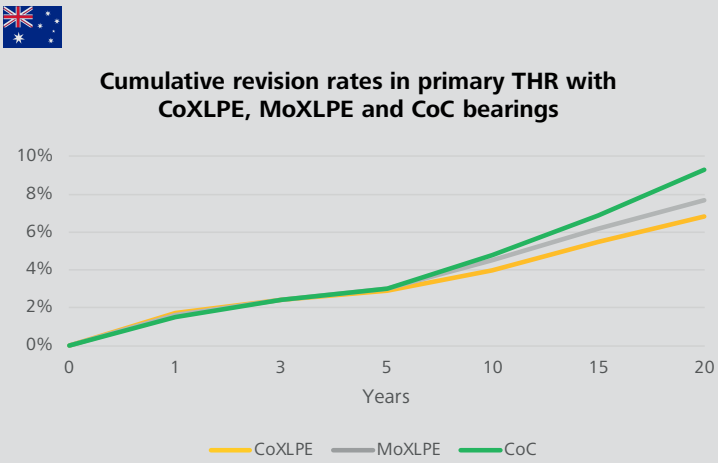
In Australia, CoXLPE significantly shows a lower rate of revision than MoXLPE after 1.5 years (HR=0.79 (0.74,0.84), p<0.001). According to the Australian registry analysis, the revision rate of CoC is not statistically different from MoXLPE (HR=1.00 (0.96,1.04), p=0.978) (Figure 17).

The lowest rate of revision is shown by ceramicised metal heads coupled with XLPE liners, which is statistically different from MoXLPE (after 3 months: HR=0.71 (0.65,0.77), p<0.001). However, the registry urges caution in the interpretation of this result, as in the previous reports, since *"This bearing is a single company product, used with a small number of femoral stem and acetabular component combinations. This may have a confounding effect on the outcome, making it unclear if the lower rate of revision is an effect of the bearing surface or reflects the limited combinations of femoral and acetabular prostheses."*

As far as the head size is concerned, the 32mm XLPE is associated with a lower rate of revision in comparison with the smaller and larger heads (XLPE <32mm vs XLPE 32mm after nine months: HR=1.18 (1.10,1.27), p<0.001; XLPE >32mm vs XLPE 32mm after one month: HR=1.13 (1.07,1.19), p<0.001) (Figure 18).

In contrast, for CoC bearings with mixed ceramic, there is no significant difference in the rate of revision between 36-38mm and 32mm head sizes (HR=1.01 (0.87,1.16), p=0.923). Additionally, the revision rates of 36-38mm and ≥40mm head sizes are also not statistically different over the entire period (HR=0.95 (0.77,1.17), p=0.633). However, the ≤28mm head sizes are associated with a higher revision rate within the first three months (HR=2.58 (1.50,4.43), p<0.001) compared to 32mm head sizes (Figure 19).[2]

*Figure 17: Cumulative revision rates in primary THR with CoXLPE, MoXLPE and CoC bearings (Primary Diagnosis OA) in Australia.*




Evaluation of the data by CeramTec is based on the AOA NJRR Annual Report 2022 Page 97 Table HT42[2].



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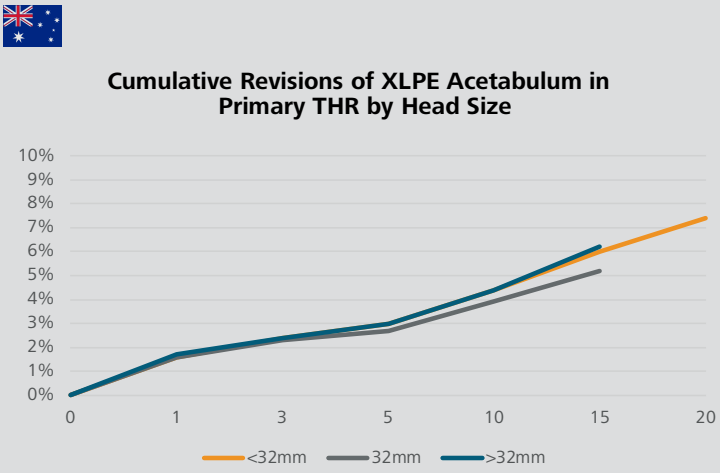
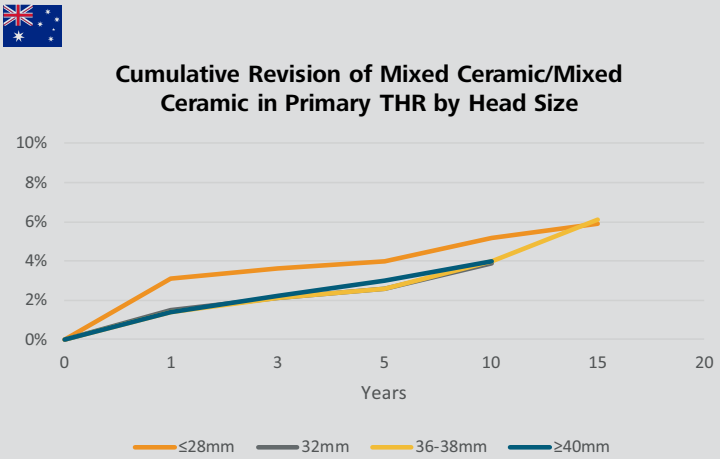
*Figure 18: Cumulative revision rates of XLPE acetabulum in primary THR by head size in Australia (Primary Diagnosis OA, restricted to modern prostheses).*




Evaluation of the data by CeramTec is based on the AOA NJRR Annual Report 2022 Page 100 Table HT43[2].

*Figure 19: Cumulative revision of mixed ceramic/mixed ceramic bearings (Primary Diagnosis OA, restricted to modern prostheses) by head size in Australia.*




Evaluation of the data by CeramTec is based on AOA NJRR Annual Report 2022 Page 109 Table HT46[2].

## EPRD

According to the EPRD, among all bearing surfaces, CoC bearing couples show the lowest failure rates in the short-, mid- term. The revision rate of MohXLPE bearings is higher than that of CoC, CohXLPE and CohXLPE+Antiox in both the cemented and uncemented stem fixation groups (Figure 20).

Comparing the revision rates between the different fixation groups, the results showed no great difference between the cemented and uncemented fixation groups, which is not in line with results observed from other registry reports (Figure 21).

In both the cemented stem fixation group and the uncemented stem fixation group, the 36mm head size show a lower cumulative revision rate over seven years (Figure 22).[3]



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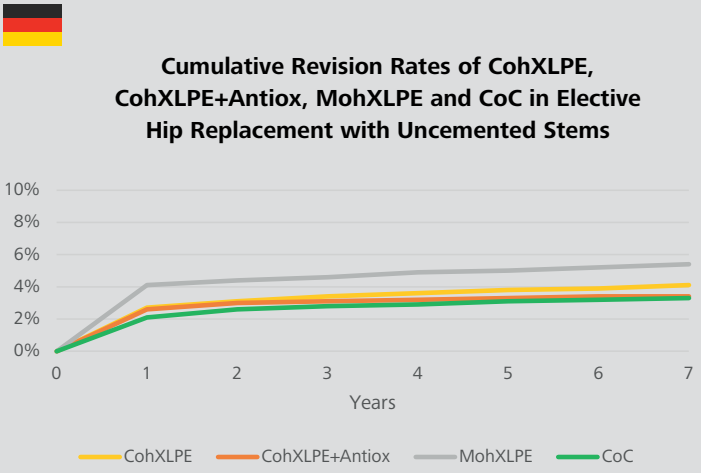
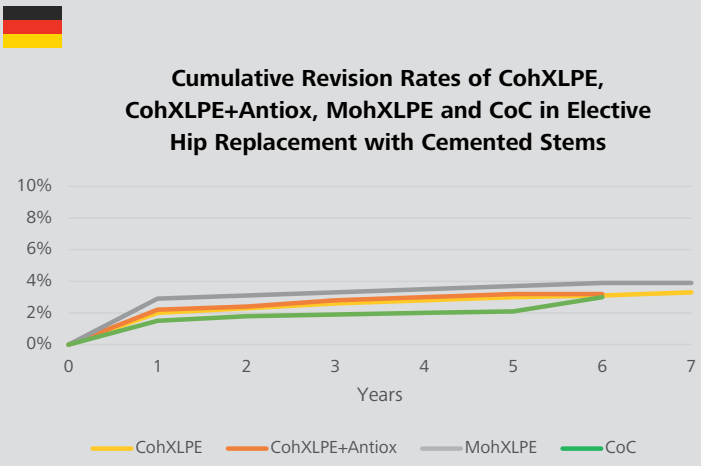
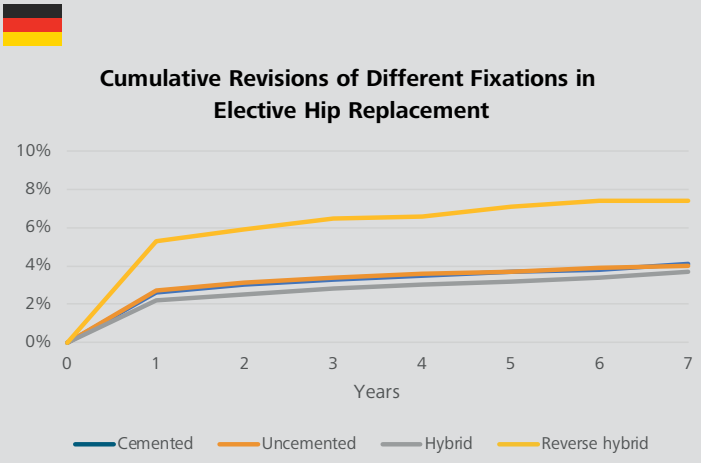
*Figure 20: Cumulative revision rates of CohXLPE, CohXLPE+Antiox, MohXLPE and CoC in elective hip replacement by stem fixation in Germany.*




Evaluation of the data by CeramTec is based on EPRD Annual Report 2022 Page 50 Table 38[3].

*Figure 21: Cumulative revision rates of different fixations in elective hip replacement in Germany.*




Evaluation of the data by CeramTec is based on EPRD Annual Report 2022 Page 50 Table 38[3].



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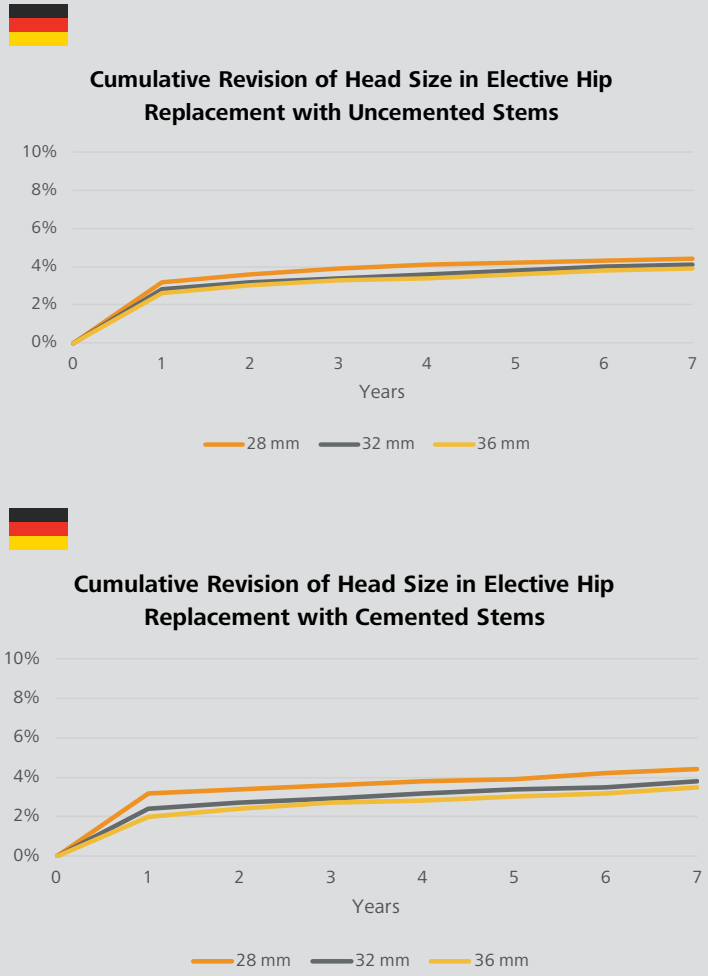
*Figure 22: Cumulative revision rates of head size in elective hip replacement with different fixations in Germany.*




Evaluation of the data by CeramTec is based on EPRD Annual Report 2022 Page 50 Table 38[3].

## AJRR

In the USA, 9.2% of all THR procedures were revisions. There was a steep decline of this number from 20% in 2012 to 10% in 2016, however since 2017, it has remained relatively stable. For male patients over 65 years old, cemented stem fixations show a higher cumulative revision rate than that of uncemented stem fixations. The opposite is true for female patients over 65 years old.[4]



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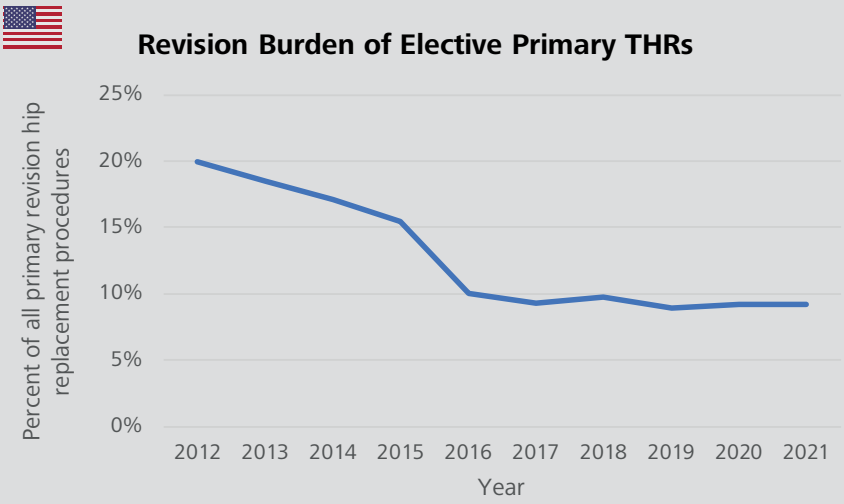
*Figure 23: Revision burden of elective primary THRs in the United States.*




Evaluation of the data by CeramTec is based on AJRR Annual Report 2022 Page 55 Figure 2.39[4].

### NZJR

The New Zealand registry uses two very specific statistical terms for revision rates that are not found in the other registries:

**Observed component years:** the number of registered primary procedures multiplied by the number of years each component has been in place.

**Rate/100 component years:** equivalent to the yearly revision rate expressed as a percentage figure derived by dividing the number of prostheses revised, by the observed component years multiplied by 100.

Regardless of the fixation method, the NZJR shows that the revision rate for CoC bearings is lower than that for CoP and MoP. The revision rate for CoP is also lower than that of MoP.

When comparing the revision rate of bearings in different fixation groups, the CoC bearing has the lowest revision rate in the uncemented and the hybrid fixation group.

Regarding the head size group, in primary THR 32mm femoral heads show the lowest revision rates, followed by 36mm, then <=28mm heads.[5]



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*Table 2: Revision data by bearing type in New Zealand.*

| Bearing Surface | Number of Operations | Observed Component Years | Number Revised | Rate/100 Component Years | Exact 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| CoC | 15,634 | 133,906.2 | 636 | 0.47 | 0.44 | 0.51 |
| CoP | 46,900 | 291,411.6 | 1,631 | 0.56 | 0.53 | 0.59 |
| MoP | 89,777 | 745,939.1 | 4,716 | 0.63 | 0.61 | 0.65 |

Evaluation of the data by CeramTec is based on the NZJR Annual Report 2022 Page 31[5].

*Table 3: Revision data by bearing type in New Zealand when adjusted to fixation.*

| Fixation and Bearing | Number of Operations | Observed Component Years | Number Revised | Rate/100 Component Years | Exact 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| Cemented | | | | | | |
| CoP | 931 | 7,894.8 | 59 | 0.75 | 0.57 | 0.96 |
| MoP | 26,638 | 244,266 | 1,562 | 0.64 | 0.61 | 0.67 |
| Uncemented/Cementless | | | | | | |
| CoC | 12,179 | 105,853.5 | 523 | 0.49 | 0.45 | 0.54 |
| CoP | 31,080 | 189,323.8 | 1,058 | 0.56 | 0.53 | 0.59 |
| MoP | 18,190 | 145,282.7 | 1,002 | 0.69 | 0.65 | 0.73 |
| Hybrid | | | | | | |
| CoC | 3,453 | 28,051.8 | 113 | 0.40 | 0.33 | 0.48 |
| CoP | 14,889 | 94,193.1 | 514 | 0.55 | 0.50 | 0.59 |
| MoP | 44,949 | 356,390.4 | 2,152 | 0.60 | 0.58 | 0.63 |

Data extracted and compiled from CeramTec from the NZJR Annual Report 2022 Page 33[5].

### LROI

The LROI analyzed the cumulative revision rate of acetabulum and femur separately. With uncemented inlay materials, the Kaplan-Meier shows the cumulative acetabulum revision rate at 10-year of ceramics/oxidized zirconium (1.8 (1.6-2.0)) is lower than that of cross-linked PE (1.9 (1.8-2.0)). However, the cumulative revision rate at 13-year of ceramic (2.2 (1.9-2.6)) is a bit higher than that of cross-linked PE (2.1 (2.0-2.3)).

As far as the head size is concerned, the 36mm femoral head (0.9 (0.7-1.0)) is associated with a lower rate of revision for dislocation at 13-years, in comparison with the 32mm (1.2 (1.1-1.2)) head and 22-28mm head (1.8 (1.7-1.9)) at 13-years.[7]



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## Patient-Reported Outcome Measures (PROMs)

**PROMs calculate the health gains after surgical treatment from a patient perspective. This can contribute to the analysis of revision rates, identifying patients with persistent pain or disability, as well as measuring patient satisfaction after surgery. Therefore, many registries and hospitals have started to record PROMs data. There is a growing demand for feasible methods and instruments to collect comprehensive PROMs and to enable data comparison between the registries. This is the first year that NJR and AOA NJRR began introducing PROMs in a separate section. Reporting PROMs at the implant brand level is a trend for the future.**

### NJR

As of this year, the NJR introduced PROMs in an additional section, focusing primarily on evaluating the integration of available PROMs data with the entire report and describing current ideas on reporting hip and knee PROMs at an implant brand level in future years.[1]

### AOA NJRR

In 2021, the Australian Registry started to form a new chapter to provide basic information on PROMs. The Australian Registry uses the EQ-VAS and EQ-5D-5L to measure quality of life and the Oxford Hip Score (OHS) to assess pain and function. In general, a large improvement in quality of life, joint-specified pain and function has been achieved for all classes of joint replacement.[2]

### AJRR

According to the AJRR, 401 sites out of 1,251 (32%) have submitted PROMs up to 31st December 2021, marking a 38% increase compared to the previous Annual Report. Results of the HOOS, JR. score demonstrates that 91% of the patients achieved a meaningful improvement after elective primary THR.[4]

### NZJR

The NZJR was one of the first joint registries to collect PROMs data. The validated Oxford Hip outcome questionnaires have been sent out on a random selection basis since July 2002 achieving an annual response rate of 20%. The Oxford-12 questionnaire includes 12 questions which can be scored from 4 to 0. The maximum score of 48 indicates normal function, 0 represents most severe disability.

According to the statistics recorded in the NZJR Annual Report 2022, the average scores are 40.36, 42.37, 41.94 and 41.37, 40.67 at six months, five years, ten years, fifteen years and twenty years, respectively, after surgery.[5]



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### LROI

The LROI uses NRS (rest), NRS (activity), EQ5D index score, EQ5D thermometer, HOOS-PS score, Oxford Hip score, Anchor question: Daily functioning to measure PROMs for patients underwent hip arthroplasty procedures. According to the LROI, the response rate of pre-operative PROMs was 63.1% in 2021. The response rate of all three pre-operative, 3 and 12 months postoperative in 2020 was 34.7%.[7]



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# Worth Knowing

## Pandemic Impact

There is still a significant influence due to the COVID-19 pandemic on the volume of hip replacements. However, the impact of pandemic in 2021 was less severe than in 2020. The Australian Registry reported 19,595 fewer joint replacement procedures than expected over the last two years (2020-2021). The NJR also confirmed that activity in 2020 was roughly half that of normal pre COVID-19, which has recovered to 70-85% in 2021. According to the Swedish Registry, the total number of reported THR decreased by 25% in 2020 compared to the number in 2019. In 2021, the impact of pandemic eased and increased 16% compared to the number of procedures performed in 2020. The AJRR also reported a 14% procedural volume growth compared to the 2020 in 2021.

## Dual Mobility

In all analyzed registries, the use of dual mobility bearings has steadily increased over the years.[1-5,7] The NJR confirms that the CoPoM dual mobility bearings show lower revision than the MoPoM combinations, but with no significant difference.[1]

## Hip Resurfacing

Metal resurfacing is still restricted to a carefully monitored patient selection. Women are mostly excluded from this procedure. Ceramic resurfacing procedures are recorded by the NJR and AOA NJRR.

According to the NJR, CoC and MoP resurfacings are now being implanted and in future annual reports these will be reported as a new category, although the numbers are likely to remain too small for meaningful analysis for a number of years yet.

298 CoC hip resurfacing procedures have been documented by the AOA NJRR with a cumulative revision rate of 0.3 (0.0, 2.5) at 1 year, which is a lower rate of revision compared to MoM resurfacing combinations at 1 year (AOA NJRR Annual Report 2022 Page 159 Table HT94).[2] According to the AOA NJRR Annual Report 2022, of all the revisions for total hip resurfacing procedures, the most common reasons were loosening, metal related pathology and (periprosthetic) fracture.

The NZJR also provides information on resurfacing components. The use of MoM-resurfacing continuously increased from 70 procedures in 2016 to 122 procedures in 2020, however only 77 new resurfacing procedures were recorded in 2021.[5]



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# Abbreviations, Tables and Figures

**AJRR:** The American Joint Replacement Registry

**AOA NJRR:** The Australian Orthopaedic Association National Joint Replacement Registry

**CI:** Confidence Interval

**CMoP:** Ceramicised Metal-on-Polyethylene

**CoC:** Ceramic-on-Ceramic

**CoM:** Ceramic-on-Metal

**CoP:** Ceramic-on-Polyethylene (including both conventional polyethylene and cross-linked polyethylene)

**CoPoM:** Ceramic-on-Polyethylene-on-Metal (Dual Mobility - only used by the NJR)

**CoXLPE:** Ceramic-on-Cross-Linked Polyethylene

**CohXLPE:** Ceramic-on-Highly Cross-Linked Polyethylene (only used by the EPRD)

**DM:** Dual Mobility

**EPRD:** Endoprothesenregister Deutschland (The German Arthroplasty Registry)

**EQ-5D:** European Quality of Life 5 Dimensions

**EQ-5D-5L:** European Quality of Life 5 Dimensions 5 Level Version

**EQ VAS Health:** EuroQol-Visual Analogue Scales

**HOOS JR. Score:** Hip Disability and Osteoarthritis Outcome Score for Joint Replacement Score

**HR:** Hazard Ratio

**ISAR:** International Society of Arthroplasty Registries

**MoM:** Metal-on-Metal

**MoP:** Metal-on-Polyethylene (including both conventional polyethylene and cross-linked polyethylene)

**MoPoM:** Metal-on-Polyethylene-on-Metal (Dual Mobility - only used by the NJR)

**MoXLPE:** Metal-on-Cross-Linked Polyethylene

**MohXLPE:** Metal-on-Highly Cross-Linked Polyethylene (only used by the EPRD)

**NHS:** The National Health Service



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# Abbreviations, Tables and Figures

**NJR:** The National Joint Registry, which covers England, Wales, Northern Ireland, the Isle of Man and the States of Guernsey

**NZJR:** The New Zealand Joint Registry

**OA:** Osteoarthritis

**PROMs:** Patient-Reported Outcome Measures

**PROMIS-10:** Patient-Reported Outcomes Measurement Information System-10

**SAR:** The Swedish Arthroplasty Register (Merger of the Swedish Hip Arthroplasty Register and the Swedish Knee Arthroplasty Register)

**SD:** Standard Deviation

**THA:** Total Hip Arthroplasty

**THR:** Total Hip Replacement

**VR-12:** The Veterans RAND 12 Item Health Survey

**Figure 1a (left):** Distribution of fixation methods in primary THRs in 2021 (Annual Data): in Australia, Germany, Netherland as well as England, Wales, Northern Ireland, the Isle of Man and Guernsey.

**Figure 1b (right):** Distribution of femoral stem fixation methods in primary THR (2012-2021) in the United States.

**Figure 2:** Distribution of head sizes in primary THRs in 2021: in Germany, the United States and Netherlands.

**Figure 3:** Composition of femoral heads in primary THR by year in England, Wales, Northern Ireland, the Isle of Man and Guernsey.

**Figure 4:** Composition of femoral heads in primary THR by year in Germany.

**Figure 5:** Composition of femoral heads in primary THR by year (cumulative data) in the United States.

**Figure 6:** Composition of femoral heads in primary THR by year in the Netherlands.

**Figure 7:** Usage of CoP, MoP and CoC in primary THR by year in England, Wales, Northern Ireland, the Isle of Man and Guernsey.

**Figure 8:** Usage of CoP, MoP, CoC and CMoP in primary THR by year in Germany.

**Figure 9:** Usage of CoP, MoP and CMoP in primary THR by year in the United States.



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