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# Choice of Bearings Influences the Implant Survival of Total Hip Arthroplasty in Patients Who Have Osteoarthritis Aged 55 Years or More: Results of 158,044 Patients From the Nordic Arthroplasty Register Association From 2005 to 2017

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ABSTRACT

*Background:* The aim of our study was to compare implant survival rates of different total hip arthroplasty (THA) bearings in the Nordic Arthroplasty Register Association.

*Methods:* All conventional primary THAs performed between 2005 and 2017 in patients aged more than 55 years who had primary osteoarthritis were studied. Metal-on-highly cross-linked polyethylene (MoXLP), ceramic-on-highly cross-linked polyethylene (CoXLP), ceramic-on-ceramic (CoC), and metal-on-metal (MoM) bearings were included. The outcome was a revision. Kaplan-Meier (KM) estimates were calculated at 5 and 10 years. The risk for revision was analyzed using a flexible parametric survival model adjusted for nation, age, sex, femoral head size, and femoral fixation.

*Results:* A total of 158,044 THAs were included. The 5-year KM estimates were 95.9% (95% confidence interval [CI] 95.8 to 96.1) in MoXLP, 95.8% (95% CI 95.6 to 96.1) in CoXLP, 96.7% (95% CI 96.4 to 97.0) in CoC, and 93.9% (95% CI 93.5 to 94.4) in MoM. The 10-years KM estimates were 94.2% (94.0 to 94.5) in MoXLP, 94.3% (93.9 to 94.8) in CoXLP, 95.4% (95.0 to 95.9) in CoC, and 85.5% (84.9 to 86.2) in MoM. Compared with MoXLP, the adjusted risk for revision was lower in CoC (hazard ratio [HR] 0.6, CI 0.5 to 0.6), similar in CoXLP (HR 1.0, CI 0.9 to 1.0), and higher in MoM (HR 1.3, CI 1.2 to 1.4).

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*Conclusions:* We found that MoXLP, CoXLP, and CoC bearings evinced comparably high implant survival rates up to 10 years, and they can all be regarded as safe options in this patient group. The MoM bearings were associated with clearly lower survivorship. The CoC bearings had the highest implant survival and a lower adjusted risk for revision compared with highly cross-linked polyethylene bearings.



Long-term problems after primary total hip arthroplasty (THA) have historically been wear-related, and the mode of component failure differs between different bearings. In the 2000s, conventional polyethylene components that are prone to wear and aseptic loosening have more or less been completely replaced by highly cross-linked polyethylene (XLP) liners or cups used with either a metallic head (metal-on-highly cross-linked polyethylene [MoXLP]) or a ceramic head (ceramic-on-highly cross-linked polyethylene [CoXLP]) [1,2]. Early ceramic-on-ceramic (CoC) bearings were associated with a risk of ceramic fracture, a problem that has been substantially reduced by continuous improvement of the material and the introduction of fourth-generation CoC bearings [3,4]. Large metal-on-metal (MoM) bearings have shown high revision rates, mainly because of problems related to adverse reactions to metal debris [5].

Currently, MoXLP, CoXLP, and CoC are the most popular THA bearing options, since all of them have been associated with high implant survival rates [1]. The use of more expensive CoC bearings has been justified with a lower risk of implant wear compared with XLP bearings [6]; however, in large national registries, the results are contradictory with little evidence of improved long-term implant survival [7–9]. The Nordic Arthroplasty Register Association (NARA) combines the national arthroplasty register data from 4 Nordic countries [10]. Recently, the survivorship in the NARA data was found to be comparable among MoXLP, CoXLP, and CoC bearings in patients aged less than 55 years [7]. However, a similar comparison from the NARA data has not been made for older patients, who constitute the majority of the THA patients.

The aim of this study was to compare the survival rate of MoXLP, CoXLP, CoC, and MoM bearings used in patients aged 55 years or more who had a THA for primary osteoarthritis (OA) in the period from 2005 to 2017, based on the data from NARA. We hypothesized that MoXLP, CoXLP, and CoC bearings would have comparably high implant survivorship, while MoM bearings would perform inferiorly.

## Methods

A population-based cohort study was conducted using prospectively collected NARA data from each of the national registries in Denmark, Norway, Sweden, and Finland. These Nordic countries include a total of more than 27 million citizens, and they have similar publicly funded healthcare systems [11]. Registration completeness ranges from 90 to 98% for primary surgery and 81 to 94% for revision surgery when compared with the national patient registers in the respective countries. Data are regularly validated within the national registers, ensuring high data quality [10].

### *Inclusion Criteria*

Patients aged 55 years or more who underwent a primary THA for primary OA between January 1, 2005 and December 31, 2017 were included. The follow-up ended with the first hip revision, death, or December 31, 2018, whichever came first. The exposure was to the primary THA bearings, including MoXLP, CoXLP, CoC, and MoM bearings. The study period was selected to start in 2005 because the fourth-generation ceramic bearings were introduced in 2004, according to the manufacturer (CeramTec, Plochingen, Germany). In the NARA dataset, the different generations of ceramic bearings are not separated, so we decided to start the study period when fourth-generation bearings were commonly used. However, the third-generation ceramic bearings could not be reliably excluded from the data. We also included bilateral THAs because previous studies have shown that the effect of departing from the independence assumption in the study of hip prosthesis survival is negligible [12].

### *Exclusion Criteria*

We excluded patients who had received a conventional polyethylene bearing, a cemented cup, a dual-mobility cup, or a <28-mm femoral head because these implants were not routinely used in conventional primary THAs in most NARA countries, although cemented cups are popular in Sweden [13]. Furthermore, including cemented cups would have introduced an additional source of bias to the analyses, as they are only available with polyethylene-bearing surfaces. We also excluded patients who had surgery for other reasons than primary OA to have a more homogeneous population. To minimize the possible effect of the learning curve, we excluded patients who received a cup and/or femoral component used in less than 50 cases for each country (Figure 1).

### *Data Analyses*

Descriptive statistics were used for the presentation of demographic data. Follow-up time and age were presented as medians and interquartile ranges due to skewness. The main end point was the first revision for any reason. We also reported the distribution of the main reasons for revision as classified in the NARA dataset: aseptic loosening (cup and/or stem, also including wear and osteolysis), periprosthetic joint infection (PJI), periprosthetic femoral fracture, dislocation, pain only, and other reasons. For survival analyses, the MoXLP group was chosen as the reference group because it was the most common bearing in NARA data. The Kaplan-Meier (KM) survival estimates for the first revision with 95% confidence intervals (CIs) were calculated for all bearings at 5 and 10 years. Adjusted survival was first assessed with a multivariable Cox regression model, yet the proportional hazards assumption was not met and was not fixable with time-dependent coefficients due to the massive amount of data. Thus, we decided to use a flexible parametric survival model (FPSM), which is not affected by the proportional hazard assumption bias [14]. The FPSM estimates for revision were adjusted for age (as a continuous variable), sex, nation, femoral head size, and stem fixation. The adjusted covariates were chosen using the directed acyclic graphs (Supplementary 1) [15]. The results of the FPSM were reported as hazard ratios (HRs) with 95% CIs, and they can be interpreted similarly to the Cox regression model. An exponential distribution was used in the model. The distribution was selected by comparing the distributions with the survival curves and selecting the most

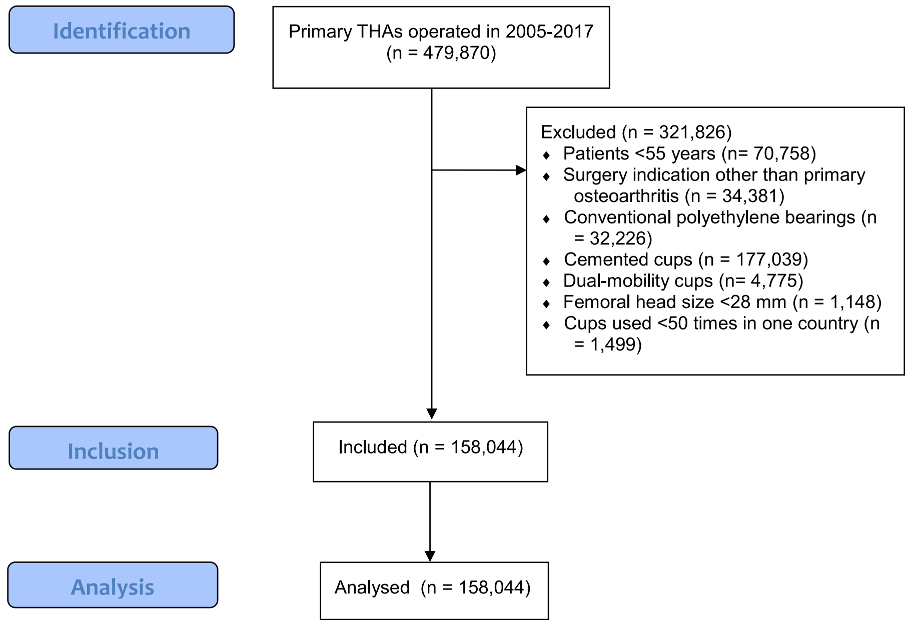


**Fig. 1.** Flowchart of the study population.

similar pattern. The KM estimates and FPSM estimates for all 4 bearings were also reported separately within specific age groups: 55 to 64 years, 65 to 74 years, and 75+ years. We also compared the 5-year mortality risk between study groups by calculating HRs for death using FPSM adjusted for age and sex.

This study was reported according to the Reporting of Studies Conducted using Observational Routine-Collected Health Data Guidelines [16]. The ethical approval for the NARA dataset was approved by the appointed authorities in each country: the Swedish Ethical Review Authority (Dnr: 1184-18/2019-00812), the Finnish National Institute of Health and Welfare (Dnro THL/1743/5.05.00/2014), the Norwegian Data Inspectorate (ref 24.1.2017: 16/01622-3/CDG), and the Danish Data Protection Agency [1-16-02-54-17].

The final data included 158,044 THAs (Figure 1). The most common bearing was MoXLP (63.9%), followed by CoXLP (18.7%), CoC (9.1%), and MoM (8.3%). The use of MoXLP and CoXLP bearings increased steadily during the whole study period, whereas the use of CoC bearings peaked in 2012 and decreased after that. The use of MoM bearings started to decrease after 2008, and very few MoM THAs were performed after 2012 (Figure 2). Therefore, the median follow-up was shortest in the CoXLP and MoXLP groups (median 3.0 and 3.6 years, respectively) and longest in the MoM group (median 9.3 years) (Table 1).

The median age of patients varied from 65 years in the CoC group to 70 years in the MoXLP group. Uncemented THA was the most common fixation type in all groups; however, the proportion of hybrid THAs varied from 23.6% in the MoXLP group to 2.5% in MoM and 1.8% in CoC groups. In the MoXLP and CoXLP groups, the most common reasons for revision were dislocation (1.0% prevalence in both groups) and PJI (1.0 and 0.9%, respectively). In the CoC and MoM groups, a large part of revisions (1.1% in the CoC group and 9.1% in the MoM group) was classified as "other reasons," followed by dislocation (0.7%) in the CoC group and aseptic loosening (1.4%) in the MoM group (Table 2).

## Results

The KM estimates were highest in the CoC group (96.7% at 5 years and 95.4% at 10 years), slightly lower in the MoXLP group (95.9 and 94.2%) and in the CoXLP group (95.8 and 94.3%), and clearly lowest in the MoM group (93.9 and 85.5%) (Table 3 and Figure 3). The survival estimates for the age groups (55 to 64, 65 to 74, and 75+ years) are presented in Supplementary 2.

Compared with the MoXLP group, the adjusted risk for revision was lower in the CoC group (HR 0.6, CI 0.5 to 0.6), similar in the CoXLP group (HR 1.0, CI 0.9 to 1.0), and higher in the MoM group (HR 1.3, CI 1.2 to 1.4). When stratified by age, the survival of CoC bearings remained superior compared with other bearings in all 3 age groups, while the risk of revision between the CoXLP and MoXLP groups was comparable (Table 4). The MoM bearings performed clearly worse in patients aged 55 to 64 and 65 to 74 years compared with MoXLP; however, the risk of revision was slightly lower in MoM compared with MoXLP in patients aged 75+ years.

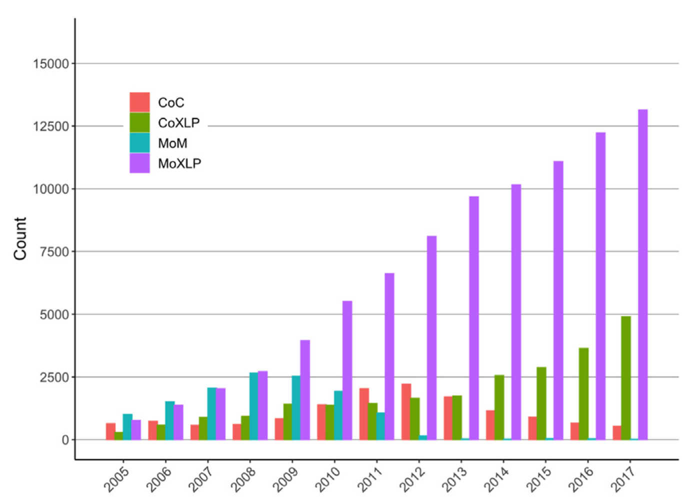


**Fig. 2.** Bar chart of the used bearings in NARA data from 2005 to 2017. NARA, Nordic Arthroplasty Register Association; CoC, ceramic-on-ceramic; CoXLP, ceramic-on-highly cross-linked polyethylene; MoM, metal-on-metal; MoXLP, metal-on-highly cross-linked polyethylene.

**Table 1**
Patient Demographics of Primary THA Patients Operated for Osteoarthritis in 2005 to 2017.

| Bearing | MoXLP | CoXLP | CoC | MoM |
|---|---|---|---|---|
| Total, n | 101,004 | 29,664 | 14,320 | 13,056 |
| Follow-up years, median (IQR) | 3.6 (1.6 to 6.1) | 3.0 (1.2 to 6.1) | 6.6 (4.3 to 8.3) | 9.3 (7.6 to 10.9) |
| Age, median (IQR) in y | 70 (64 to 75) | 66 (61 to 71) | 65 (61 to 70) | 66 (61 to 71) |
| Women, n (%) | 55,986 (55.4) | 16,186 (54.6) | 8,243 (57.6) | 6,022 (46.1) |
| Nation, n (%) | | | | |
| Sweden | 19,515 (19.3) | 4,635 (15.6) | 245 (1.7) | 120 (0.9) |
| Denmark | 48,556 (48.1) | 4,783 (16.1) | 2,191 (15.3) | 1,255 (9.6) |
| Norway | 8,247 (8.2) | 7,766 (26.2) | 2,303 (16.1) | 209 (1.6) |
| Finland | 24,686 (24.4) | 12,480 (42.1) | 9,581 (66.9) | 11,472 (87.9) |
| Fixation type, n (%) | | | | |
| Uncemented | 77,120 (76.4) | 25,094 (84.6) | 14,056 (98.2) | 12,728 (97.5) |
| Hybrid | 23,884 (23.6) | 4,570 (15.4) | 264 (1.8) | 328 (2.5) |
| Femoral head size, n (%) | | | | |
| 28 mm | 4,874 (4.8) | 2,660 (9.0) | 798 (5.6) | 348 (2.7) |
| 32 mm | 35,201 (34.9) | 12,562 (42.3) | 4,527 (31.6) | 144 (1.1) |
| 36 mm | 59,612 (59.0) | 14,313 (48.3) | 8,109 (56.6) | 2,420 (18.5) |
| >36 mm | 1,317 (1.3) | 129 (0.4) | 886 (6.2) | 10,144 (77.7) |

THA, total hip arthroplasty; MoXLP, metal-on-highly cross-linked polyethylene; CoXLP, ceramic-on-highly cross-linked polyethylene; CoC, ceramic-on-ceramic; MoM, metal-on-metal; IQR, interquartile range.

Notably, the number of patients aged 75+ years with a CoC or MoM bearing was low (Supplementary 3).

In a sensitivity analysis that included only uncemented THAs performed in the years 2010 or later and excluded revisions for PJI, the risk of revision was still lower in the CoC group compared with the MoXLP group (HR 0.8, CI 0.7 to 0.9), while the risk of revision was slightly higher in the CoXLP group compared with the MoXLP group (HR 1.2, CI 1.0 to 1.3).

Compared with the MoXLP group, the adjusted 5-year risk of death was similar in the MoM group (HR 1.0, CI 0.9 to 1.1), but lower in the CoXLP group (HR 0.8, CI 0.7 to 0.9) and in the CoC group (HR 0.8, CI 0.7 to 0.8).

## Discussion

We showed that in THA patients aged 55 years or more operated for primary OA, MoXLP, CoXLP, and CoC bearings implanted during 2005 to 2017 had comparable survival rates at 5 and 10 years, while MoM bearings had the lowest survival rate. The risk for revision adjusted for nation, age, sex, femoral head size, and femoral fixation was lowest in CoC bearings, comparable between MoXLP and CoXLP bearings, and highest in MoM bearings.

Our findings of the comparable survival rate up to 10 years in MoXLP, CoXLP, and CoC bearings and lower revision risk in CoC bearings compared with XLP bearings differ from the results of the Australian registry, where the CoC bearings have had a higher cumulative 20-year revision percentage (9.3, CI 8.8 to 9.8) compared with MoXLP (7.7, CI 7.2 to 8.2) and CoXLP (6.8, CI 6.0 to 7.6) [8]. It is likely that the Australian registry includes a larger proportion of third-generation CoC bearings than our data because the follow-up is longer than that in our study, which included only THAs from 2005 to 2017. This may, at least partially, explain the discrepancy. In the National Joint Registry (NJR) of England, Wales, Northern Ireland, and the Isle of Man, XLP liners are not separated from conventional polyethylene. Their 15-year cumulative revision percentage estimates for metal-on-polyethylene bearings used in uncemented THAs (5.9, CI 5.7 to 6.2) were slightly higher compared with ceramic-on-polyethylene (4.2, CI 3.9 to 4.5) and CoC (4.8, CI 4.6 to 5.1) [9]. Similar results were found in the 15-year estimates for hybrid THAs (metal-on-polyethylene: 4.7, CI 4.4 to 4.9; ceramic-on-polyethylene: 3.8, CI 3.3 to 4.3; CoC: 3.9, CI 3.6 to 4.3). Notably, all the 15-year revision estimates in the NJR were lower compared with our results, which may be explained by the lower revision completeness of reporting in the early years in the NJR data [17]. In a recent NARA study of patients aged less than 55 years, no difference was found after 13 years of follow-up on these 3 bearings [7].

The 5-year mortality risk in our study was lower in CoC and CoXLP bearings compared with MoXLP, while it was similar between MoM and MoXLP. This could indicate that the MoXLP group was more fragile on average compared with the ceramic groups. Furthermore, only 0.4% of CoC bearings were revised for PJI, compared with 1.0% in MoXLP and CoXLP bearings. Previous studies showed that ceramic bearings have been associated with a lower infection revision rate, but the authors suggested that ceramic bearings may have been favored in younger and healthier patients;

**Table 2**
Main Reason for the First Revision.

| Revision Cause, n (Prevalence %) | MoXLP | CoXLP | CoC | MoM |
|---|---|---|---|---|
| Aseptic loosening | 531 (0.5) | 136 (0.5) | 74 (0.5) | 188 (1.4) |
| Prosthetic joint infection | 1,008 (1.0) | 309 (1.0) | 60 (0.4) | 114 (0.9) |
| Periprosthetic femoral fracture | 721 (0.7) | 162 (0.5) | 90 (0.6) | 108 (0.8) |
| Dislocation | 987 (1.0) | 276 (0.9) | 106 (0.7) | 63 (0.5) |
| Pain only | 105 (0.1) | 59 (0.2) | 19 (0.1) | 18 (0.1) |
| Others | 378 (0.4) | 131 (0.4) | 163 (1.1) | 1,183 (9.1) |
| Main reason for revision not defined | 43 (0.04) | 22 (0.07) | 16 (0.1) | 72 (0.6) |
| Total revised | 3,773 (3.7) | 1,095 (3.7) | 528 (3.7) | 1,746 (13.4) |
| Not revised during follow-up | 97,231 (96.3) | 28,569 (96.3) | 13,792 (96.3) | 11,310 (86.6) |

MoXLP, metal-on-highly cross-linked polyethylene; CoXLP, ceramic-on-highly cross-linked polyethylene; CoC, ceramic-on-ceramic; MoM, metal-on-metal.

**Table 3**
The 5-Y and 10-Y Kaplan-Meier Survival Estimates for Revision.

| Bearing | Kaplan-Meier Survival Estimate % (95% CI) | |
|---|---|---|
| | At 5 Y | At 10 Y |
| MoXLP | 95.9 (95.8 to 96.1) | 94.2 (94.0 to 94.5) |
| CoXLP | 95.8 (95.6 to 96.1) | 94.3 (93.9 to 94.8) |
| CoC | 96.7 (96.4 to 97.0) | 95.4 (95.0 to 95.9) |
| MoM | 93.9 (93.5 to 94.4) | 85.5 (84.9 to 86.2) |

MoXLP, metal-on-highly cross-linked polyethylene; CoXLP, ceramic-on-highly cross-linked polyethylene; CoC, ceramic-on-ceramic; MoM, metal-on-metal; CI, confidence interval.

thus, the results could be explained by confounding by indication [18–20]. However, in the sensitivity analysis, where only uncemented THAs implanted after 2010 were included and revisions for PJI were excluded, the risk of revision remained lower in CoC compared with MoXLP and CoXLP.

The rate of aseptic loosening was similarly low in MoXLP, CoXLP, and CoC bearings. MoXLP bearings have a theoretically higher risk of liner wear compared to CoC bearings [6], but in previous studies, the results of MoXLP THAs showed a very low risk of aseptic loosening [2,21]. Interestingly, 1.4% of the CoC bearings were revised for "other reasons" compared with 0.4% in the MoXLP group and 0.5% in the CoXLP group. The causes for revision included in the group "other reasons" in the CoC group probably comprise fractures of the liner or femoral head, which is a problem specific to CoC bearings. However, a fracture of the ceramic head is more common in the third-generation bearings and smaller (28 mm) heads that only constitute 5.6% of this study population [3,4]. Squeaking is another problem with CoC implants, with a prevalence of 17 to 27% [22–24]. Salo et al. [22] and Varnum et al. [24] reported poorer patient-reported outcomes in patients with a noisy hip, while Blakeney et al. [23] reported that squeaking did not affect patient satisfaction. However, it is unlikely that a major proportion of CoC bearings in our data would have been revised primarily for squeaking.

The MoM bearings had the lowest survival rate and highest risk for revision in our data, and 9.1% of MoMs were revised for "other reasons." Most of these revision surgeries were probably performed because of adverse reactions to metal debris that led to a remarkable revision burden in the early 2010s [5,25–27]. The inferiority of

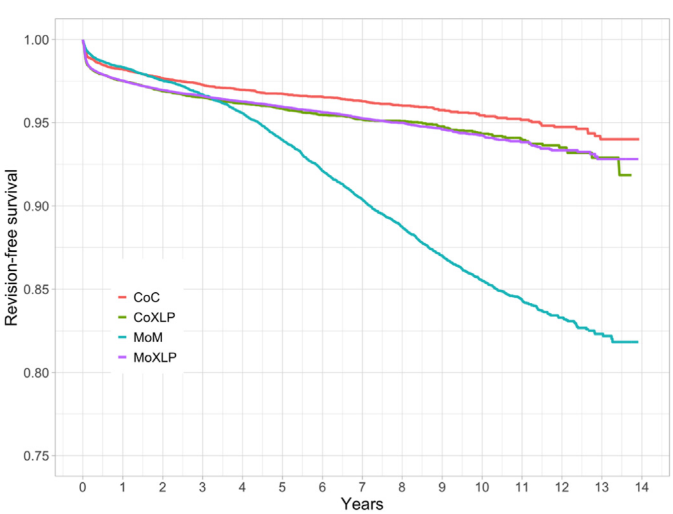


**Fig. 3.** The Kaplan-Meier revision-free survival estimates. CoC, ceramic-on-ceramic; CoXLP, ceramic-on-highly cross-linked polyethylene; MoM, metal-on-metal; MoXLP, metal-on-highly cross-linked polyethylene.

**Table 4**
The Flexible Parametric Survival Model for Revision Adjusted for Nation, Age, Sex, Femoral Head Size, and Femoral Fixation.

| Bearing | HR | 95% CI |
|---|---|---|
| All Patients | | |
| MoXLP | Reference | |
| CoXLP | 1.0 | 0.9 to 1.0 |
| CoC | 0.6 | 0.5 to 0.6 |
| MoM | 1.3 | 1.2 to 1.4 |
| Age 55 to 64 y | | |
| MoXLP | Reference | |
| CoXLP | 0.9 | 0.8 to 1.0 |
| CoC | 0.6 | 0.5 to 0.7 |
| MoM | 1.5 | 1.3 to 1.8 |
| Age 65 to 74 y | | |
| MoXLP | Reference | |
| CoXLP | 1.0 | 0.9 to 1.1 |
| CoC | 0.6 | 0.5 to 0.7 |
| MoM | 1.2 | 1.1 to 1.4 |
| Age 75+ y | | |
| MoXLP | Reference | |
| CoXLP | 1.1 | 0.9 to 1.3 |
| CoC | 0.6 | 0.4 to 0.8 |
| MoM | 0.8 | 0.6 to 1.0 |

HR, hazard ratio; CI, confidence interval; MoXLP, metal-on-highly cross-linked polyethylene; MoM, metal-on-metal; CoXLP, ceramic-on-highly cross-linked polyethylene; CoC, ceramic-on-ceramic.

MoM was highlighted in the younger age groups (55 to 64 and 65 to 74 years). Younger age has been associated with an increased risk of revision in MoM bearings [28]. In patients aged 75+ years, MoM bearings actually had a slightly lower risk of revision compared with MoXLP. However, there were less than 2,000 patients who had a MoM bearing in the 75+ year age group, and no relevant conclusions can be drawn from this comparison. Overall, very few MoM bearings were used in the NARA countries after 2012.

### *Potential Limitations*

The follow-up varied between the study groups, and we could not present the survival estimates beyond 10 years because of the limited number of patients who had longer follow-up. We were not able to adjust the FPSM estimates for comorbidities. Therefore, the impact of residual confounding due to comorbidities must be considered in the interpretation of the results. Our main end point was revision for all causes, but the factors involved in the decision of revision surgery are not known in register-based data, and it is possible that they have differed between the bearings. Moreover, a major portion of revisions were performed due to other reasons than failure of the bearing material; for instance, PJI was a common reason for revisions. Furthermore, it is possible that the incidence of nonimplant-related complications has varied during the study period, which may have caused a bias in the survival rates because the bearings were not used evenly during the whole study period. For example, the incidence of PJI has doubled in the NARA data from 2004 to 2018 [29]. Therefore, we did the sensitivity analysis where revisions for PJI were excluded and only THAs implanted after 2010 were included. The third-generation and fourth-generation CoC bearings could not be separated from the data, and it is likely that there is a major proportion of third-generation bearings involved, although the follow-up started in 2005 [30]. Nevertheless, the CoC group had the highest survivorship and the lowest risk for revision in our data.

In conclusion, MoXLP, CoXLP, and CoC bearings had comparably high implant survival rates up to 10 years in the large NARA dataset, while MoM bearings were associated with clearly lower survivorship. The CoC bearings were associated with the highest implant survival and the lowest adjusted risk for revision, while the risk for revision was similar for MoXLP and CoXLP.

## CRediT authorship contribution statement

**Oskari Pakarinen:** Writing – review & editing, Writing – original draft, Methodology. **Ville Ponkilainen:** Writing – review & editing, Software, Methodology, Formal analysis. **Claus Varnum:** Writing – review & editing. **Alma B. Pedersen:** Writing – review & editing. **Søren Overgaard:** Writing – review & editing. **Johan Kärrholm:** Writing – review & editing. **Ola Rolfson:** Writing – review & editing. **Anne Marie Fenstad:** Writing – review & editing. **Ove Furnes:** Writing – review & editing. **Geir Hallan:** Writing – review & editing. **Keijo Mäkelä:** Writing – review & editing. **Antti Eskelinen:** Writing – review & editing, Supervision, Conceptualization.

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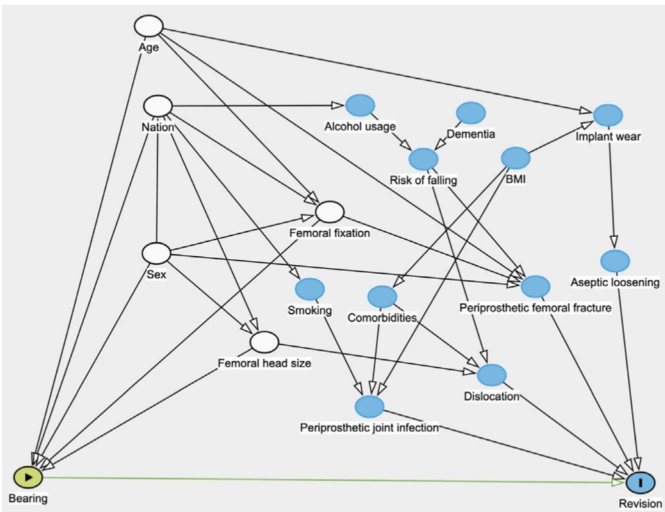
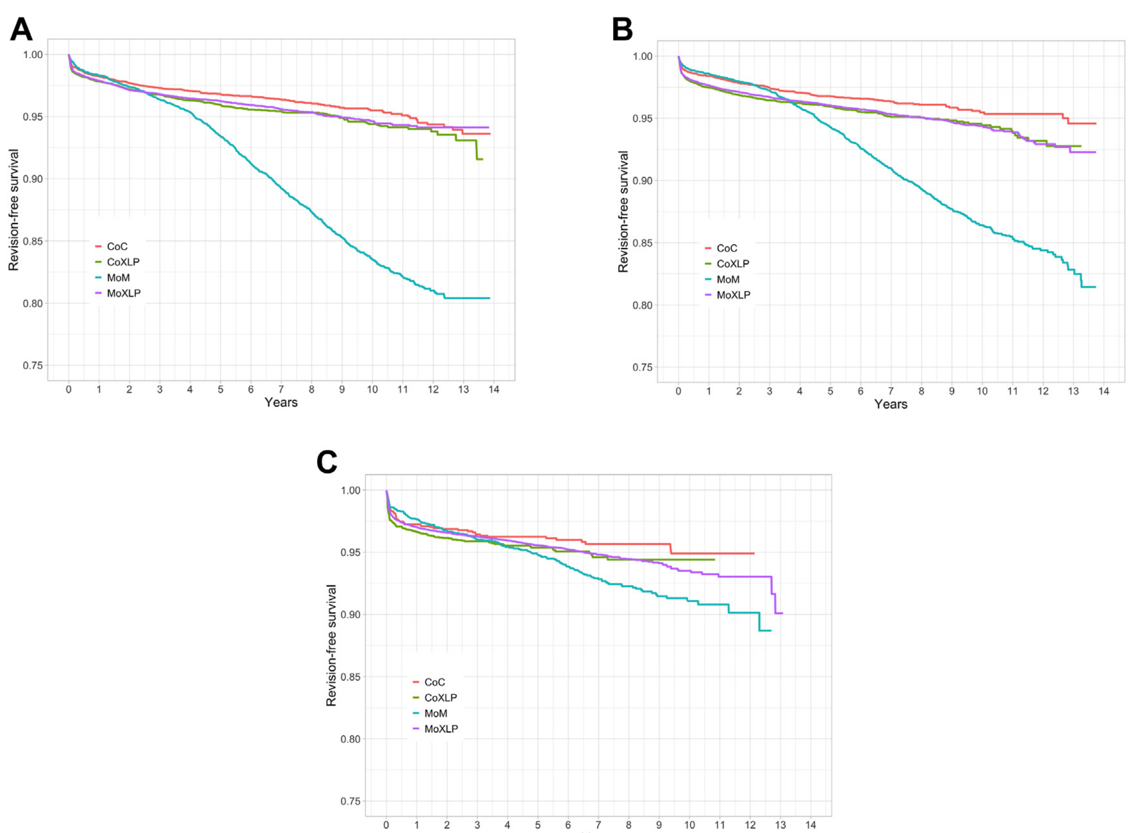
## Appendix




**Supplementary 1.** The directed acyclic graph. Adjusted variables are marked in white ellipse.




**Supplementary 2.** The Kaplan-Meier revision-free survival estimates for age groups (A) 55 to 64, (B) 65 to 74, and (C) 75+. CoC, ceramic-on-ceramic; CoXLP, ceramic-on-highly cross-linked polyethylene; MoM, metal-on-metal; MoXLP, metal-on-highly cross-linked polyethylene.

**Supplementary 3**
The Number of Patients in Bearings Stratified by Age Group.

| Bearing | Age 55 to 64 | Age 65 to 74 | Age 75+ |
|---|---|---|---|
| MoXLP | 26,502 | 45,521 | 28,974 |
| CoC | 6,866 | 6,065 | 1,389 |
| CoXLP | 13,297 | 12,187 | 4,180 |
| MoM | 5,782 | 5,472 | 1,802 |
| Total | 52,454 | 69,245 | 36,345 |

CoC, ceramic-on-ceramic; CoXLP, ceramic-on-highly cross-linked polyethylene; MoM, metal-on-metal; MoXLP, metal-on-highly cross-linked polyethylene.