

# Australian Orthopaedic Association National Joint Replacement Registry

2024 SUPPLEMENTARY REPORT

## Demographics and Outcome of Ankle Arthroplasty



AOA  
AUSTRALIAN  
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Australian  
Orthopaedic  
Association  
National  
Joint  
Replacement  
Registry

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Registry**

**Demographics and Outcome of Ankle  
Arthroplasty**

2024 Supplementary Report

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The Registry greatly appreciates the participation of all joint replacement patients throughout Australia. Their contribution allows ongoing improvements in arthroplasty outcomes to be achieved.

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# Introduction

This Ankle Arthroplasty Supplementary Report is based on the analysis of 5,361 ankle procedures with a procedure date from 2006 up to and including 31 December 2023.

This Report is one of 14 supplementary reports to complete the AOANJRR Annual Report for 2024.

Information on the background, purpose, aims, benefits and governance of the Registry can be found in the Introductory chapter of the 2024 Hip, Knee and Shoulder Arthroplasty Annual Report.

The Registry data quality processes including data collection, validation and outcomes assessment, are provided in detail in the Data Quality section of the introductory chapter of the 2024 Hip, Knee and Shoulder Arthroplasty Annual Report:

<https://aoanjrr.sahmri.com/annual-reports-2024>.

# Ankle Replacement

## CATEGORIES OF ANKLE REPLACEMENT

Ankle replacements are grouped into two broad categories: primary total and revision ankle replacement.

A primary total ankle replacement is the initial procedure involving replacing both the tibial and talar articular surfaces of the ankle joint with tibial and talar prostheses and an intervening insert which may or may not be attached to the tibial component.

Revision procedures are subsequent operations of previous ankle replacements where one or more of the prosthetic components are replaced, removed, or another component is added. Revisions include subsequent operations of primary total or previous revision procedures.

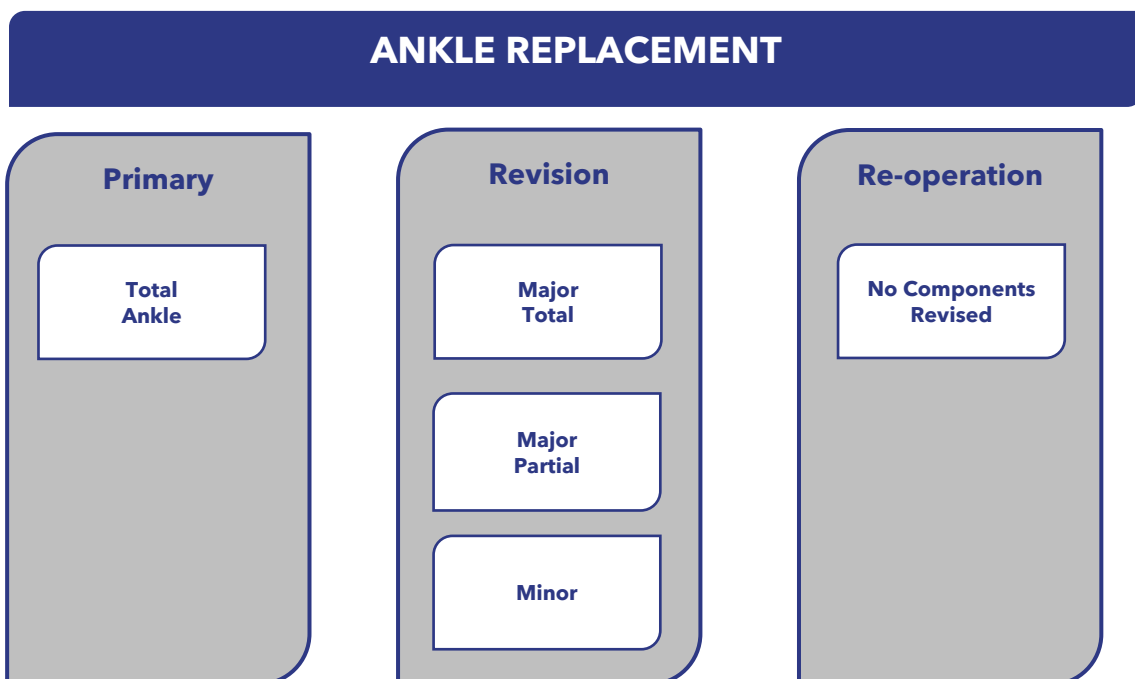
Ankle revisions are subcategorised into three classes: major total, major partial and minor revisions. Major total involves replacing both the tibial and talar components. Major partial involves revising either the tibial or talar component, and a minor revision procedure retains the original tibial and talar components and most often involves a revision of the insert only.

There is a third category of ankle replacement procedure data that the AOANJRR collects. This is information on re-operation after ankle replacement but without revision of any of the components. Surgeons have reported a small number of these procedures and the future aim of the AOANJRR is to increase reporting of these operations.

## DEMOGRAPHICS OF ANKLE REPLACEMENT

This report is an analysis of 5,361 ankle replacement procedures (4,613 primaries (86%) and 748 revisions (14%). This excludes 2 primary partial resurfacing ankle replacements from 2008.

Ankle replacement is more frequently undertaken in males (61.9%). The overall mean age is 67.4 years and the most common age group for both male and female patients is 65-74 years (Table A1 to Table A3 and Figure A1).



**Table A1 Number of Ankle Replacements by Gender**

Ankle Replacement	Male		Female		TOTAL	
	N	Row%	N	Row%	N	Row%
Primary Total	2852	61.8	1761	38.2	4613	100.0
Revision	468	62.6	280	37.4	748	100.0
<b>TOTAL</b>	<b>3320</b>	<b>61.9</b>	<b>2041</b>	<b>38.1</b>	<b>5361</b>	<b>100.0</b>

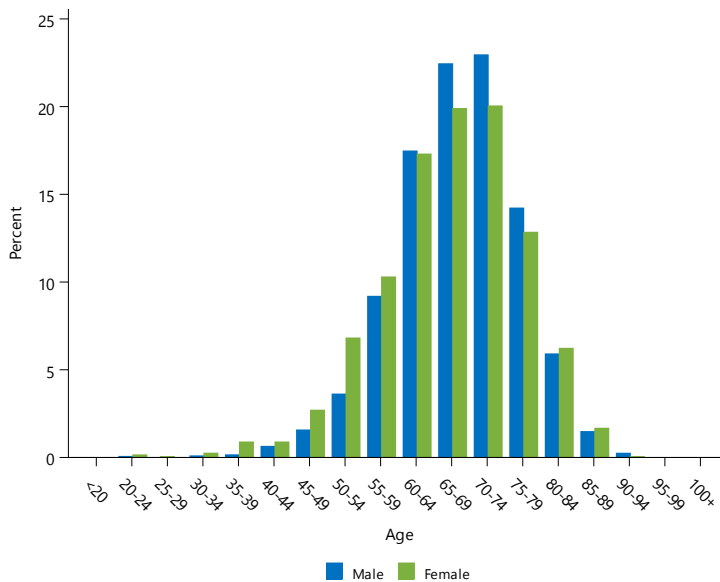
**Table A2 Number of Ankle Replacements by Age**

Ankle Replacement	<55		55-64		65-74		75-84		≥85		TOTAL	
	N	Row%	N	Row%	N	Row%	N	Row%	N	Row%	N	Row%
Primary Total	373	8.1	1294	28.1	1973	42.8	893	19.4	80	1.7	4613	100.0
Revision	69	9.2	154	20.6	349	46.7	164	21.9	12	1.6	748	100.0
<b>TOTAL</b>	<b>442</b>	<b>8.2</b>	<b>1448</b>	<b>27.0</b>	<b>2322</b>	<b>43.3</b>	<b>1057</b>	<b>19.7</b>	<b>92</b>	<b>1.7</b>	<b>5361</b>	<b>100.0</b>

**Table A3 Age and Gender of Primary and Revision Ankle Replacement**

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	2041	38.1%	20	90	67	66.4	9.9
Male	3320	61.9%	23	94	68	67.9	8.6
<b>TOTAL</b>	<b>5361</b>	<b>100.0%</b>	<b>20</b>	<b>94</b>	<b>68</b>	<b>67.4</b>	<b>9.1</b>

**Figure A1 Ankle Replacement by Age and Gender**





# Primary Total Ankle Replacement

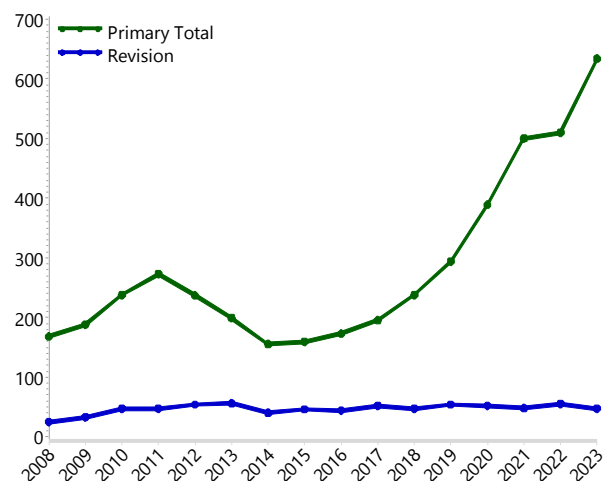
## DEMOGRAPHICS

There have been 4,613 primary total ankle replacements reported to the Registry. This is an additional 665 procedures since the last report.

For further information on the **closure of the database** please see the [Glossary](#) of the **Hip, Knee & Shoulder Arthroplasty Annual Report**.

The use of total ankle replacement was lowest in 2014 and is currently at its highest recorded usage of 634 procedures in 2023. There has been a 309% increase in the use of ankle replacement since 2014. In 2023, there was a 24.3% increase in the number of total ankle replacements compared to 2022 (Figure A2). The principal primary diagnosis is osteoarthritis (94.1%) (Table A4).

**Figure A2 Numbers of Ankle Replacement**



**Table A4 Primary Total Ankle Replacement by Primary Diagnosis**

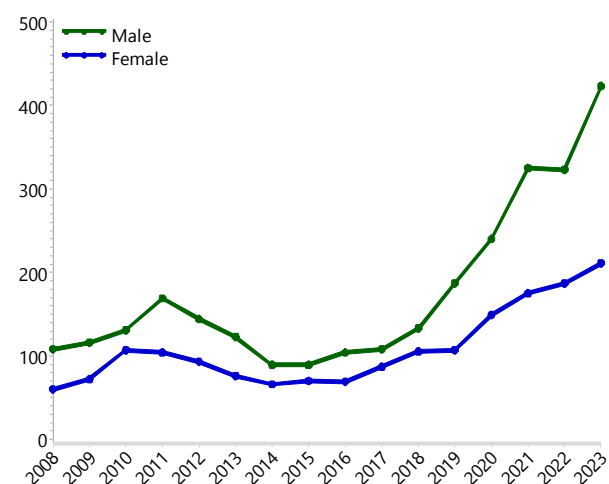
Primary Diagnosis	Number	Percent
Osteoarthritis	4343	94.1
Rheumatoid Arthritis	180	3.9
Other Inflammatory Arthritis	30	0.7
Instability	24	0.5
Fracture/Dislocation	12	0.3
Osteonecrosis	9	0.2
Tumour	2	0.0
Other	13	0.3
<b>TOTAL</b>	<b>4613</b>	<b>100.0</b>

**Table A5 Age and Gender of Primary Total Ankle Replacement**

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	1761	38.2%	20	90	67	66.4	9.8
Male	2852	61.8%	23	94	68	67.7	8.6
<b>TOTAL</b>	<b>4613</b>	<b>100.0%</b>	<b>20</b>	<b>94</b>	<b>68</b>	<b>67.2</b>	<b>9.1</b>

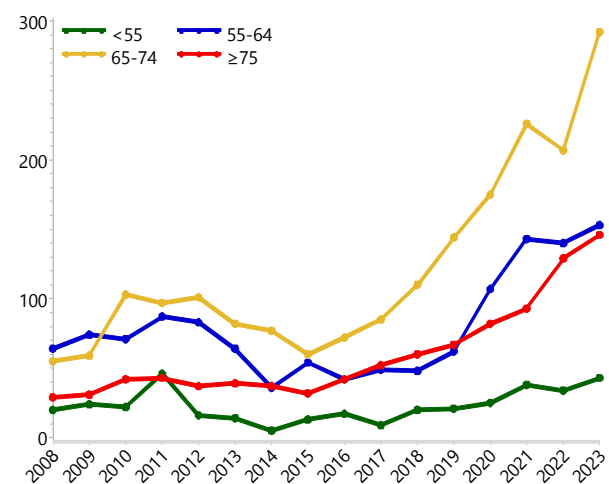
Overall, 61.8% of primary ankle procedures are performed on males. The use of primary ankle replacement in males has increased in recent years (Table A5 and Figure A3).

**Figure A3 Number of Primary Total Ankle Replacement by Gender**



The median age is 68 years with males and females having a similar median age. The most common age group is 65-74 years. All age groups have larger numbers in 2023 compared to both 2021 and 2022 (Figure A4).

**Figure A4 Number of Primary Total Ankle Replacement by Age**



## ASA AND BMI

ASA scores are an indication of comorbidity and have been collected since 2012. The Registry has ASA data on 3,330 primary total ankle replacement procedures. Total ankle replacement is most commonly performed in patients with ASA score 2 (Table A6).

BMI data have been collected since 2015. There are BMI data on 2,915 primary total ankle replacement procedures. Total ankle replacement is more common in patients who are pre-obese or obese class 1 (Table A7).

## BILATERAL PROCEDURES

The Registry has recorded 303 bilateral ankle replacements, 15.2% of which were performed

within 6 months of the initial procedure (Table A8).

## PROSTHESIS USE

Information on the changing use of tibial and talar prostheses in recent years compared to 2008, is provided in Table A9 and Table A10.

**Table A6 ASA Score for Primary Total Ankle Replacement**

ASA Score	Number	Percent
ASA 1	312	9.4
ASA 2	1830	55.0
ASA 3	1157	34.7
ASA 4	31	0.9
<b>TOTAL</b>	<b>3330</b>	<b>100.0</b>

**Table A7 BMI Category for Primary Total Ankle Replacement**

BMI Category	Number	Percent
Underweight (<18.50)	10	0.3
Normal (18.50-24.99)	451	15.5
Pre Obese (25.00-29.99)	1180	40.5
Obese Class 1 (30.00-34.99)	894	30.7
Obese Class 2 (35.00-39.99)	269	9.2
Obese Class 3 (≥40.00)	111	3.8
<b>TOTAL</b>	<b>2915</b>	<b>100.0</b>

Note: BMI has not been presented for patients aged ≤19 years

**Table A8 Time between Procedures for Bilateral Primary Ankle Replacement**

Bilateral Procedures	Same Day		1day-6months		≥6months		TOTAL	
	N	Total%	N	Total%	N	Total%	N	Total%
Both - Total Ankle	5	1.7	41	13.5	257	84.8	303	100.0
<b>TOTAL</b>	<b>5</b>	<b>1.7</b>	<b>41</b>	<b>13.5</b>	<b>257</b>	<b>84.8</b>	<b>303</b>	<b>100.0</b>

**Table A9 Most Used Tibial Prostheses in Primary Total Ankle Replacement**

2008		2019		2020		2021		2022		2023	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
98	Mobility	137	Infinity	200	Infinity	267	Infinity	312	Infinity	389	Infinity
34	Hintermann Series H3	52	Salto Talaris	81	Trabecular Metal	90	Trabecular Metal	74	Trabecular Metal	80	Trabecular Metal
18	Buechel-Pappas	41	Trabecular Metal	40	Inbone	47	Salto Talaris	60	Inbone	79	Inbone
11	Salto	26	Inbone	32	Salto Talaris	42	Inbone	27	Salto Talaris	65	Vantage
6	BOX	17	Vantage	20	Hintermann Series H3	24	Hintermann Series H3	21	Hintermann Series H3	20	Hintermann Series H3
1	Ankle Joint (Eska)	13	Hintermann Series H3	15	Vantage	23	Vantage	16	Vantage	1	Salto Talaris
		4	Salto	1	Salto	4	Zenith				
		4	Zenith			2	Invision				
						1	Salto				
<b>10 Most Used</b>											
168	(6) 100.0%	294	(8) 100.0%	389	(7) 100.0%	500	(9) 100.0%	510	(6) 100.0%	634	(6) 100.0%
<b>Remainder</b>											
0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%
<b>TOTAL</b>											
168	(6) 100.0%	294	(8) 100.0%	389	(7) 100.0%	500	(9) 100.0%	510	(6) 100.0%	634	(6) 100.0%

**Table A10 Most Used Talar Prostheses in Primary Total Ankle Replacement**

2008		2019		2020		2021		2022		2023	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
98	Mobility	107	Infinity	129	Infinity	200	Infinity	258	Infinity	338	Infinity
34	Hintermann Series H3	54	Inbone	108	Inbone	109	Inbone	110	Inbone	127	Inbone
18	Buechel-Pappas	52	Salto Talaris	81	Trabecular Metal	90	Trabecular Metal	74	Trabecular Metal	80	Trabecular Metal
11	Salto	41	Trabecular Metal	32	Salto Talaris	47	Salto Talaris	27	Salto Talaris	65	Vantage
6	BOX	17	Vantage	20	Hintermann Series H3	24	Hintermann Series H3	21	Hintermann Series H3	20	Hintermann Series H3
1	Ankle Joint (Eska)	13	Hintermann Series H3	15	Vantage	23	Vantage	16	Vantage	2	Invision
		4	Salto	3	Invision	4	Zenith	4	Invision	1	Custom Made (Osseoint)
		4	Zenith	1	Salto	2	Invision			1	Salto Talaris
		2	Invision			1	Salto				
<b>10 Most Used</b>											
168	(6) 100.0%	294	(9) 100.0%	389	(8) 100.0%	500	(9) 100.0%	510	(7) 100.0%	634	(8) 100.0%
<b>Remainder</b>											
0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%
<b>TOTAL</b>											
168	(6) 100.0%	294	(9) 100.0%	389	(8) 100.0%	500	(9) 100.0%	510	(7) 100.0%	634	(8) 100.0%

## **OUTCOME FOR ALL DIAGNOSES**

### **PRIMARY DIAGNOSIS**

The cumulative percent revision for osteoarthritis at 10 years is 14.2%. There has only been a small number of procedures for rheumatoid arthritis and, when adjusted for age and gender, there is no difference in the revision rate when compared to osteoarthritis (Table A11 and Figure A5).

### **REASON FOR REVISION**

Loosening is the most common reason for revision of primary total ankle replacement. This accounts for 32% of all revisions, followed by infection, implant breakage, instability and lysis (Table A12). The cumulative incidence of the five most common reasons for revision is presented in Figure A6.

### **TYPE OF REVISION**

The most common type of revision is an insert only revision (46.1%) (Table A13).

### **CHANGE IN OUTCOME OVER TIME**

There has been an improvement in primary total ankle replacement outcomes over time.

Comparing procedures undertaken prior to 2015 to those undertaken since 2015, the 5 year cumulative percent revision has declined from 10.7% to 5.2% (Table A14 and Figure A7).

### **RE-OPERATION**

There have been 49 procedures where a re-operation without component revision was performed on a primary total ankle replacement. These procedures are not included in the revision analysis.

### **PROSTHESIS TYPES**

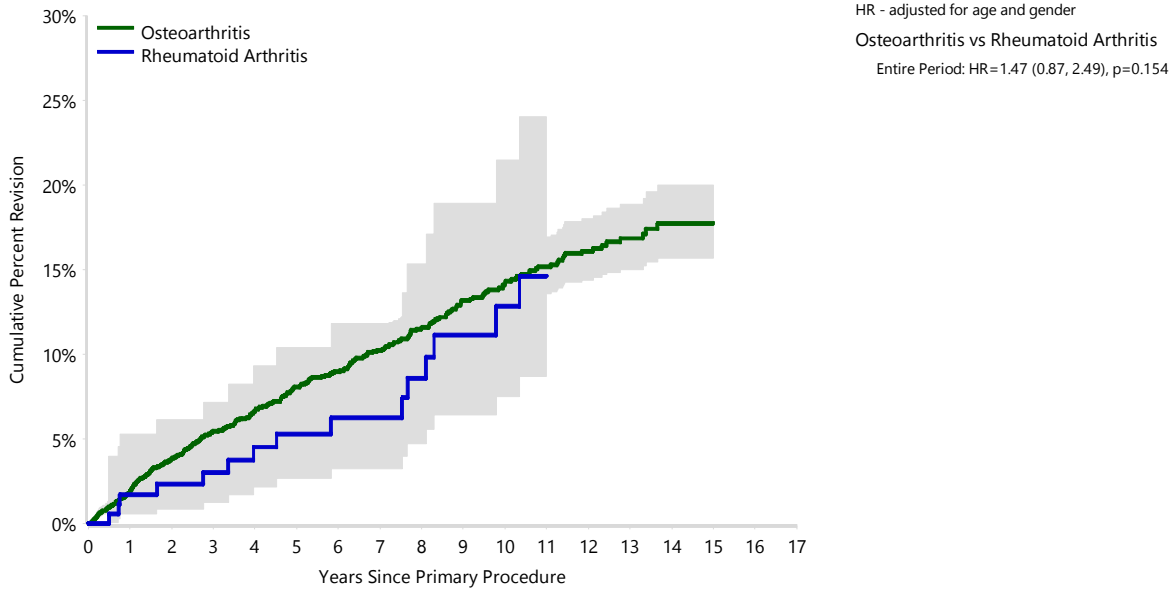
The outcomes of different prosthesis types are listed in Table A15.

**Table A11 Cumulative Percent Revision of Primary Total Ankle Replacement by Primary Diagnosis**

Primary Diagnosis	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Osteoarthritis	362	4343	1.9 (1.6, 2.4)	5.5 (4.7, 6.3)	8.1 (7.1, 9.1)	10.2 (9.1, 11.5)	14.2 (12.7, 15.9)	17.8 (15.7, 20.0)
Rheumatoid Arthritis	15	180	1.7 (0.6, 5.3)	3.0 (1.3, 7.2)	5.3 (2.7, 10.4)	6.3 (3.3, 11.8)	12.8 (7.5, 21.5)	
Other Inflammatory Arthritis	2	30	0.0 (0.0, 0.0)	8.7 (2.2, 30.5)	8.7 (2.2, 30.5)	8.7 (2.2, 30.5)	8.7 (2.2, 30.5)	
Instability	3	24	4.2 (0.6, 26.1)	4.2 (0.6, 26.1)	4.2 (0.6, 26.1)	17.9 (3.9, 62.1)		
Other	1	13	0.0 (0.0, 0.0)	10.0 (1.5, 52.7)	10.0 (1.5, 52.7)	10.0 (1.5, 52.7)		
Fracture/Dislocation	0	12	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)			
Other (2)	1	11	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	
<b>TOTAL</b>	<b>384</b>	<b>4613</b>						

Note: Only primary diagnoses with over 10 procedures have been listed

**Figure A5 Cumulative Percent Revision of Primary Total Ankle Replacement by Primary Diagnosis**



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Osteoarthritis	4343	3631	2546	1828	1370	870	212
Rheumatoid Arthritis	180	167	138	111	84	51	14

Note: Only primary diagnoses with over 50 procedures have been listed

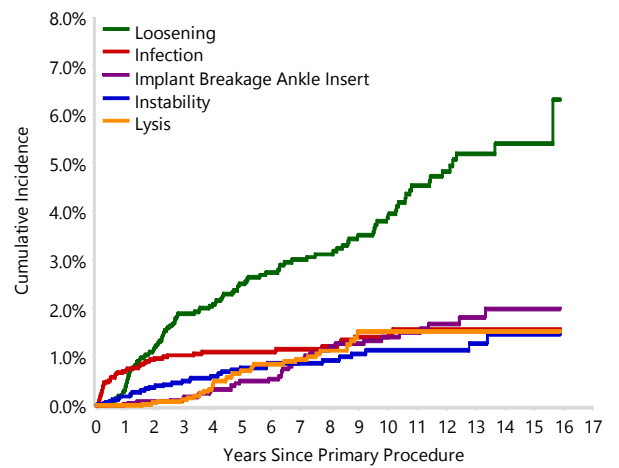
**Table A12 Reason for Revision of Primary Total Ankle Replacement**

Revision Diagnosis	Number	Percent
Loosening	123	32.0
Infection	52	13.5
Implant Breakage Ankle Insert	35	9.1
Instability	34	8.9
Lysis	33	8.6
Pain	22	5.7
Impingement	20	5.2
Fracture	16	4.2
Prosthesis Dissociation	9	2.3
Arthrofibrosis	7	1.8
Malalignment	7	1.8
Wear Ankle Insert	6	1.6
Heterotopic Bone	5	1.3
Synovitis	3	0.8
Incorrect Sizing	2	0.5
Implant Breakage Tibial	2	0.5
Metal Related Pathology	1	0.3
Tumour	1	0.3
Osteonecrosis	1	0.3
Progression Of Disease	1	0.3
Other	4	1.0
<b>TOTAL</b>	<b>384</b>	<b>100.0</b>

**Table A13 Type of Revision of Primary Total Ankle Replacement**

Type of Revision	Number	Percent
Insert Only	177	46.1
Tibial/Talar	70	18.2
Arthrodesis	46	12.0
Tibial Only	37	9.6
Talar Only	25	6.5
Cement Spacer	18	4.7
Minor Components	6	1.6
Removal of Prostheses	5	1.3
<b>TOTAL</b>	<b>384</b>	<b>100.0</b>

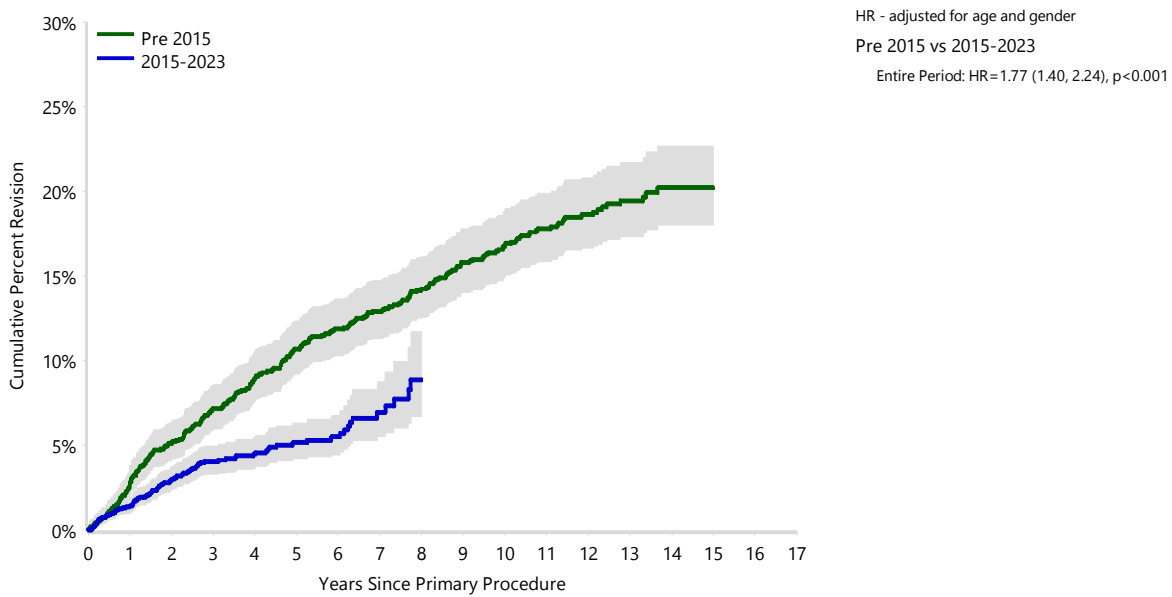
**Figure A6 Cumulative Incidence Revision Diagnosis of Primary Total Ankle Replacement**



**Table A14 Cumulative Percent Revision of Primary Total Ankle Replacement by Period**

Period	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
2015-2023	116	3092	1.4 (1.0, 1.9)	4.1 (3.3, 5.0)	5.2 (4.2, 6.3)	7.0 (5.5, 8.8)		
Pre 2015	268	1521	2.8 (2.1, 3.7)	7.2 (6.0, 8.6)	10.7 (9.2, 12.4)	12.9 (11.3, 14.7)	16.8 (15.0, 18.9)	20.2 (18.0, 22.7)
<b>TOTAL</b>	<b>384</b>	<b>4613</b>						

**Figure A7 Cumulative Percent Revision of Primary Total Ankle Replacement by Period**



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Pre 2015	1521	1467	1376	1289	1208	937	230
2015-2022	3092	2407	1354	686	276	0	0

**Table A15 Cumulative Percent Revision of Primary Total Ankle Replacement by Prosthesis Combination**

Tibia	Talar	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
BOX	BOX*	17	114	1.8 (0.4, 6.8)	5.4 (2.4, 11.6)	10.1 (5.7, 17.5)	10.1 (5.7, 17.5)	14.8 (9.1, 23.4)	
Buechel-Pappas	Buechel-Pappas*	10	63	1.6 (0.2, 10.7)	8.0 (3.4, 18.1)	9.6 (4.4, 20.1)	11.2 (5.5, 22.2)	16.6 (9.3, 28.8)	16.6 (9.3, 28.8)
Hintermann Series H3	Hintermann Series H3 <sup>1</sup>	99	558	4.0 (2.7, 6.0)	8.4 (6.3, 11.1)	11.4 (9.0, 14.6)	15.9 (12.9, 19.6)	20.4 (16.9, 24.6)	25.4 (20.6, 31.1)
Inbone	Inbone	8	274	2.1 (0.9, 5.0)	4.0 (2.0, 7.9)				
Infinity	Inbone	11	287	1.1 (0.4, 3.5)	4.8 (2.6, 8.9)				
	Infinity	20	1104	1.2 (0.6, 2.1)	2.7 (1.7, 4.3)	2.7 (1.7, 4.3)			
Mobility	Mobility*	90	568	2.3 (1.3, 3.9)	7.1 (5.2, 9.5)	10.2 (7.9, 13.0)	11.1 (8.8, 14.0)	14.7 (12.0, 17.9)	17.5 (14.3, 21.3)
S.T.A.R	S.T.A.R*	13	49	4.1 (1.0, 15.5)	12.6 (5.8, 25.8)	14.7 (7.3, 28.4)	21.4 (12.1, 36.1)	28.1 (16.6, 45.0)	
Salto	Salto*	65	421	2.2 (1.1, 4.1)	5.5 (3.7, 8.2)	9.0 (6.6, 12.2)	11.9 (9.1, 15.5)	16.0 (12.6, 20.2)	
Salto Talaris	Salto Talaris	25	507	1.2 (0.5, 2.6)	4.0 (2.6, 6.2)	4.8 (3.2, 7.2)	5.5 (3.7, 8.1)		
Trabecular Metal	Trabecular Metal	6	420	1.0 (0.4, 2.7)	1.8 (0.8, 4.1)	1.8 (0.8, 4.1)			
Vantage	Vantage	5	136	1.0 (0.1, 7.0)					
Zenith	Zenith*	13	87	3.4 (1.1, 10.3)	7.0 (3.2, 14.8)	14.7 (8.6, 24.5)	14.7 (8.6, 24.5)	17.3 (10.1, 28.6)	
Other (9)		2	25	0.0 (0.0, 0.0)	10.4 (2.7, 35.7)	10.4 (2.7, 35.7)	10.4 (2.7, 35.7)	10.4 (2.7, 35.7)	
<b>TOTAL</b>		<b>384</b>	<b>4613</b>						

Note: Only prostheses with over 15 procedures have been listed

\*denotes prosthesis combinations that have not had any reported use in primary total ankle procedures in 2023

<sup>1</sup> The Hinterman Series H3 combination has been identified as having a higher than anticipated rate of revision (HTARR) in the 2024 Annual Report:

See the Hinterman Series H3 combination in the [HTARR Chapter](#)

Corresponding prosthesis investigation of this combination is available [here](#)

HTARR methodology is available [here](#)



## OUTCOME FOR OSTEOARTHRITIS

### DEMOGRAPHICS

#### Age and Gender

Age is a risk factor for revision. Patients aged  $\geq 75$  years have a lower rate of revision compared to patients aged 65-74 years from 3 months, patients 55-64 years from 3-9 months and from 2.5 years, and when compared to patients aged  $< 55$  years for the entire period (Table A16 and Figure A8).

There is no difference in the rate of revision between males and females (Table A17 and Figure A9).

#### ASA and BMI

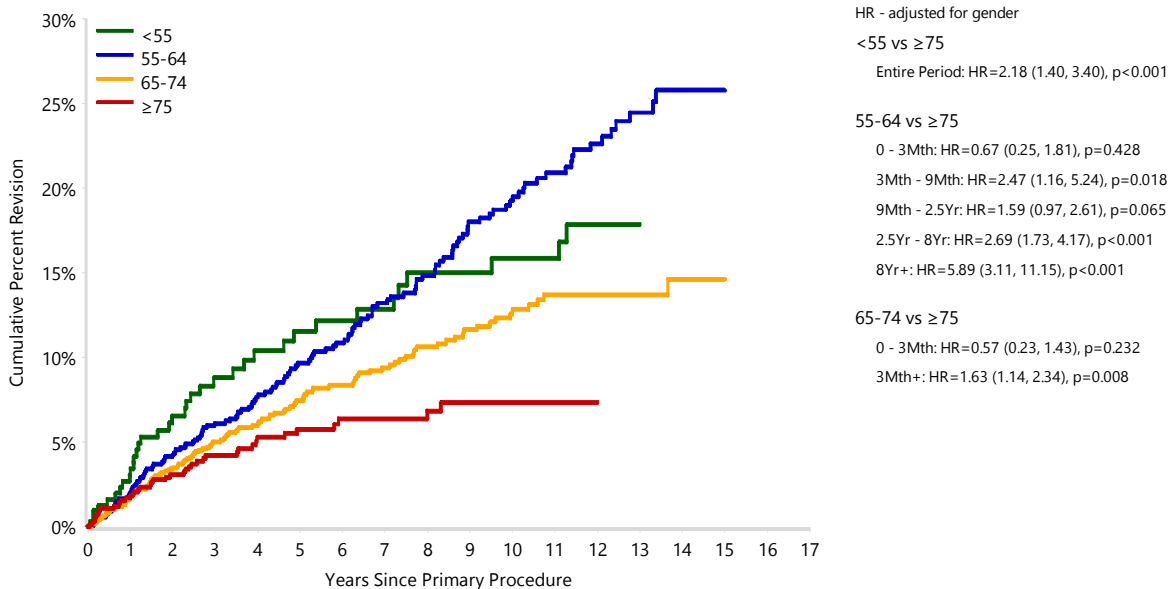
ASA is not a risk factor for revision (Table A18 and Figure A10).

As the number of procedures in each BMI category is relatively small, an analysis of combined BMI  $< 30 \text{ kg/m}^2$  (underweight, normal and pre-obese) compared to BMI of  $\geq 30 \text{ kg/m}^2$  (obese classes 1-3) was undertaken. There is no difference in the rate of revision comparing obese and non-obese patients (Table A19 and Figure A11).

**Table A16 Cumulative Percent Revision of Primary Total Ankle Replacement by Age (Primary Diagnosis OA)**

Age	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
<55	36	314	3.4 (1.9, 6.3)	8.8 (5.9, 13.0)	11.5 (8.1, 16.4)	12.8 (9.1, 18.0)	15.8 (11.4, 21.8)	
55-64	150	1211	1.9 (1.3, 2.9)	6.1 (4.8, 7.8)	9.7 (7.8, 11.9)	13.2 (11.0, 15.9)	19.2 (16.3, 22.7)	25.8 (21.8, 30.4)
65-74	133	1874	1.7 (1.2, 2.5)	5.0 (4.0, 6.3)	7.4 (6.1, 9.1)	9.4 (7.8, 11.3)	12.8 (10.7, 15.4)	14.6 (11.8, 18.0)
$\geq 75$	43	944	1.8 (1.1, 3.0)	4.2 (3.0, 6.0)	5.8 (4.2, 7.9)	6.4 (4.6, 8.7)	7.4 (5.3, 10.2)	
<b>TOTAL</b>	<b>362</b>	<b>4343</b>						

**Figure A8 Cumulative Percent Revision of Primary Total Ankle Replacement by Age (Primary Diagnosis OA)**

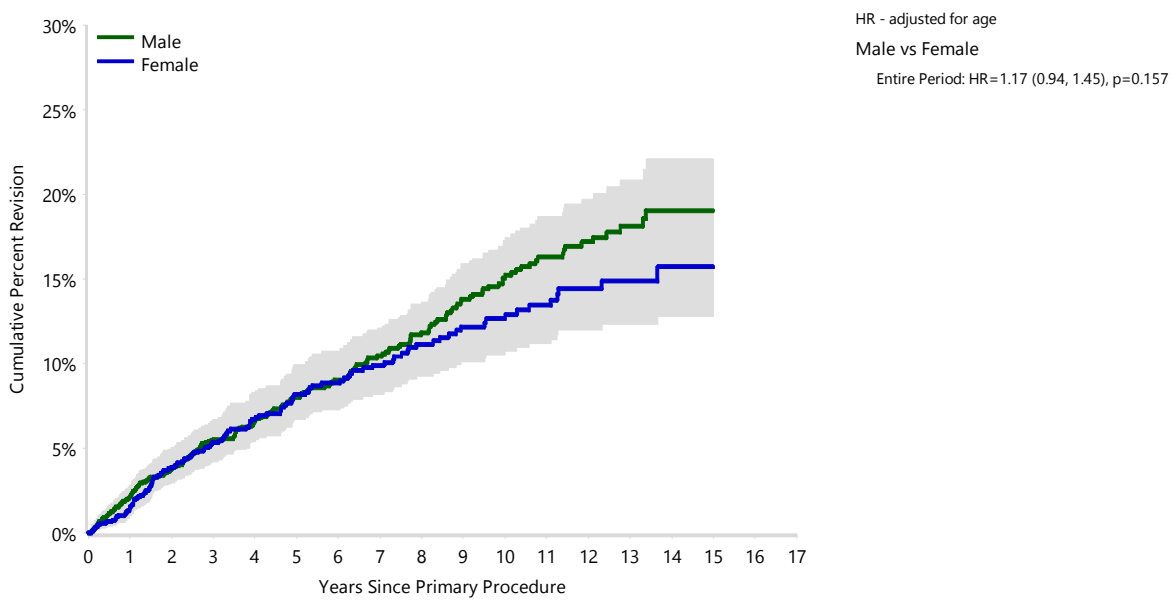


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
<55	314	263	189	148	124	98	33
55-64	1211	1042	741	557	452	310	89
65-74	1874	1557	1084	757	555	342	69
$\geq 75$	944	769	532	366	239	120	21

**Table A17 Cumulative Percent Revision of Primary Total Ankle Replacement by Gender (Primary Diagnosis OA)**

Gender	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Male	234	2752	2.2 (1.7, 2.8)	5.5 (4.6, 6.6)	8.0 (6.8, 9.3)	10.5 (9.0, 12.1)	15.2 (13.2, 17.5)	19.0 (16.4, 22.1)
Female	128	1591	1.6 (1.0, 2.3)	5.3 (4.2, 6.7)	8.2 (6.7, 10.0)	9.9 (8.2, 12.0)	12.7 (10.5, 15.2)	15.7 (12.8, 19.3)
<b>TOTAL</b>	<b>362</b>	<b>4343</b>						

**Figure A9 Cumulative Percent Revision of Primary Total Ankle Replacement by Gender (Primary Diagnosis OA)**

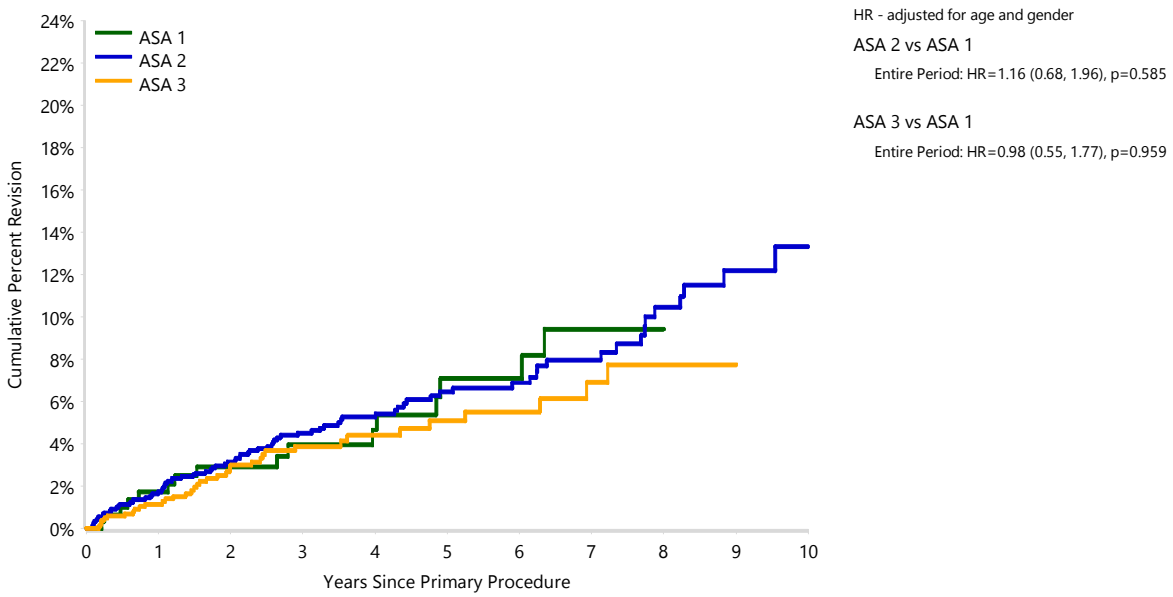


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Male	2752	2273	1569	1110	830	524	131
Female	1591	1358	977	718	540	346	81

**Table A18 Cumulative Percent Revision of Primary Total Ankle Replacement by ASA Score (Primary Diagnosis OA)**

ASA Score	N Revised	N Total	1 Yr	2 Yrs	3 Yrs	5 Yrs	7 Yrs	9 Yrs
ASA 1	17	304	1.7 (0.7, 4.1)	2.9 (1.5, 5.8)	4.0 (2.1, 7.3)	7.1 (4.1, 12.1)	9.4 (5.6, 15.8)	
ASA 2	89	1762	1.7 (1.2, 2.5)	3.1 (2.3, 4.2)	4.5 (3.5, 5.8)	6.4 (5.1, 8.2)	8.0 (6.2, 10.2)	12.2 (9.3, 16.0)
ASA 3	39	1058	1.2 (0.6, 2.1)	3.0 (2.0, 4.5)	3.9 (2.7, 5.6)	5.1 (3.5, 7.3)	6.9 (4.6, 10.3)	7.8 (5.1, 11.7)
ASA 4	0	29	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	
<b>TOTAL</b>	<b>145</b>	<b>3153</b>						

**Figure A10 Cumulative Percent Revision of Primary Total Ankle Replacement by ASA Score (Primary Diagnosis OA)**



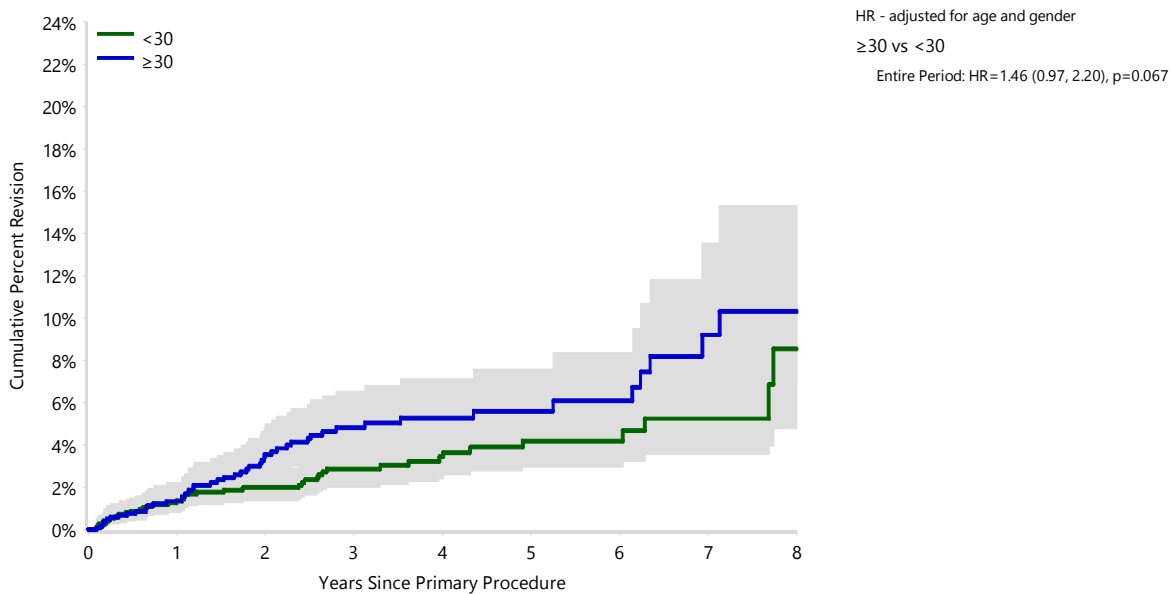
Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	7 Yrs	9 Yrs
ASA 1	304	260	224	175	104	57	23
ASA 2	1762	1389	1094	836	486	271	115
ASA 3	1058	816	628	457	241	118	47

**Table A19 Cumulative Percent Revision of Primary Total Ankle Replacement by BMI Category (Primary Diagnosis OA)**

BMI Category	N Revised	N Total	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
Underweight (<18.50)	0	6	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
Normal (18.50-24.99)	13	415	1.3 (0.6, 3.2)	2.4 (1.2, 4.7)	3.3 (1.8, 6.2)	4.0 (2.2, 7.4)	4.8 (2.6, 8.8)	4.8 (2.6, 8.8)
Pre Obese (25.00-29.99)	30	1122	1.4 (0.8, 2.3)	1.9 (1.2, 3.0)	2.7 (1.8, 4.1)	3.3 (2.1, 4.9)	4.0 (2.6, 6.1)	4.0 (2.6, 6.1)
Obese Class 1 (30.00-34.99)	35	855	1.5 (0.9, 2.6)	3.2 (2.1, 4.8)	4.5 (3.1, 6.5)	4.8 (3.3, 6.9)	4.8 (3.3, 6.9)	5.4 (3.6, 8.1)
Obese Class 2 (35.00-39.99)	11	263	0.4 (0.1, 3.0)	4.3 (2.0, 8.8)	5.7 (3.0, 10.8)	6.9 (3.7, 12.8)	6.9 (3.7, 12.8)	
Obese Class 3 (≥40.00)	5	99	2.5 (0.6, 9.8)	5.5 (2.1, 14.1)	5.5 (2.1, 14.1)	5.5 (2.1, 14.1)	11.1 (3.8, 30.2)	
<b>TOTAL</b>	<b>94</b>	<b>2760</b>						

Note: BMI has not been presented for patients aged ≤19 years

**Figure A11 Cumulative Percent Revision of Primary Total Ankle Replacement by BMI Category (Primary Diagnosis OA)**



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
<30	1543	1181	913	653	450	312	199
≥30	1217	930	695	484	339	226	152

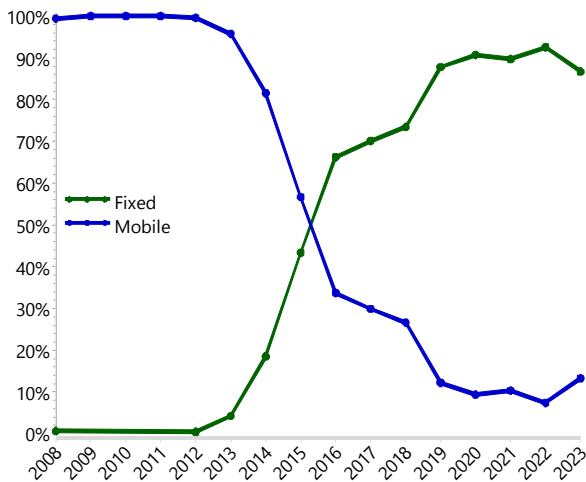
Note: BMI has not been presented for patients aged ≤19 years

## PROSTHESIS CHARACTERISTICS

### Insert Mobility

Inserts used in primary ankle replacement may be either fixed or mobile. There has been a major change in the type of insert chosen during the last decade. Fixed inserts are now more common for primary total ankle replacements (Figure A12).

**Figure A12 Primary Total Ankle Replacement by Mobility (Primary Diagnosis OA)**



Fixed inserts are used in the majority of primary total ankle replacements (57.1%). Total ankle replacements with fixed inserts have a lower rate of revision compared to mobile inserts (Table A20 and Figure A13).

### Fixation

It is not possible to assess the comparative revision rate of cement and cementless fixation as almost all procedures (98%) use cementless fixation for both the tibial and talar components (Table A21).

Approximately 50% of cementless prostheses have an HA coating. Prostheses with an HA coating have a higher rate of revision compared to prostheses without HA (Table A22 and Figure A14). However, there is no difference in revision rate for either fixed or mobile bearing prostheses when those with and without HA coating are compared (Table A23 and Figure A15).

### Image Derived Instrumentation (IDI)

IDI has been used in 1,362 primary total ankle replacement procedures since 2015 (Figure A16). There is no difference in the rate of revision when primary total ankle replacement procedures using IDI are compared to procedures without IDI use (Table A24 and Figure A17). However, the results should be interpreted with caution as IDI is used with a limited number of primary total ankle prostheses.

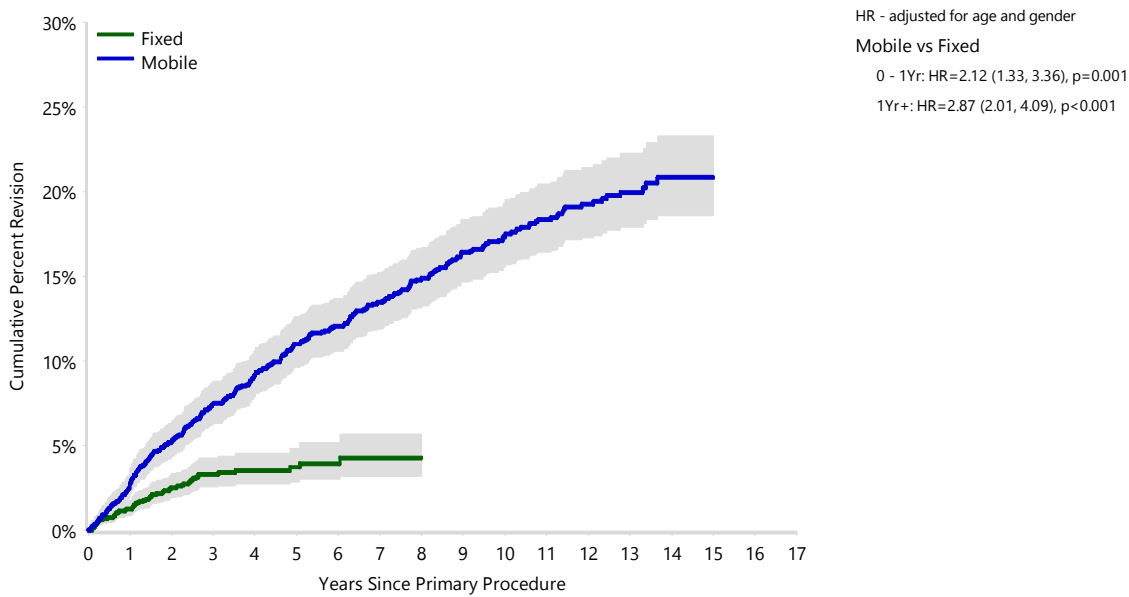
### Surgeon Variation

There is some surgeon-related variability in the revision rate of total ankle replacement. The proportions of revisions for surgeons who have undertaken at least 15 ankle procedures since 2015 are shown in Figure A18. The proportions of revisions for surgeons using fixed mobility who have undertaken at least 15 ankle procedures since 2015 are shown in Figure A19.

**Table A20 Cumulative Percent Revision of Primary Total Ankle Replacement by Mobility (Primary Diagnosis OA)**

Mobility	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	66	2480	1.2 (0.9, 1.8)	3.3 (2.6, 4.3)	3.7 (2.9, 4.9)	4.3 (3.2, 5.7)		
Mobile	296	1860	2.8 (2.1, 3.6)	7.5 (6.3, 8.8)	11.0 (9.6, 12.6)	13.5 (11.9, 15.2)	17.4 (15.6, 19.4)	20.8 (18.6, 23.3)
<b>TOTAL</b>	<b>362</b>	<b>4340</b>						

**Figure A13 Cumulative Percent Revision of Primary Total Ankle Replacement by Mobility (Primary Diagnosis OA)**



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	2480	1913	1014	455	175	7	2
Mobile	1860	1718	1532	1373	1195	863	210

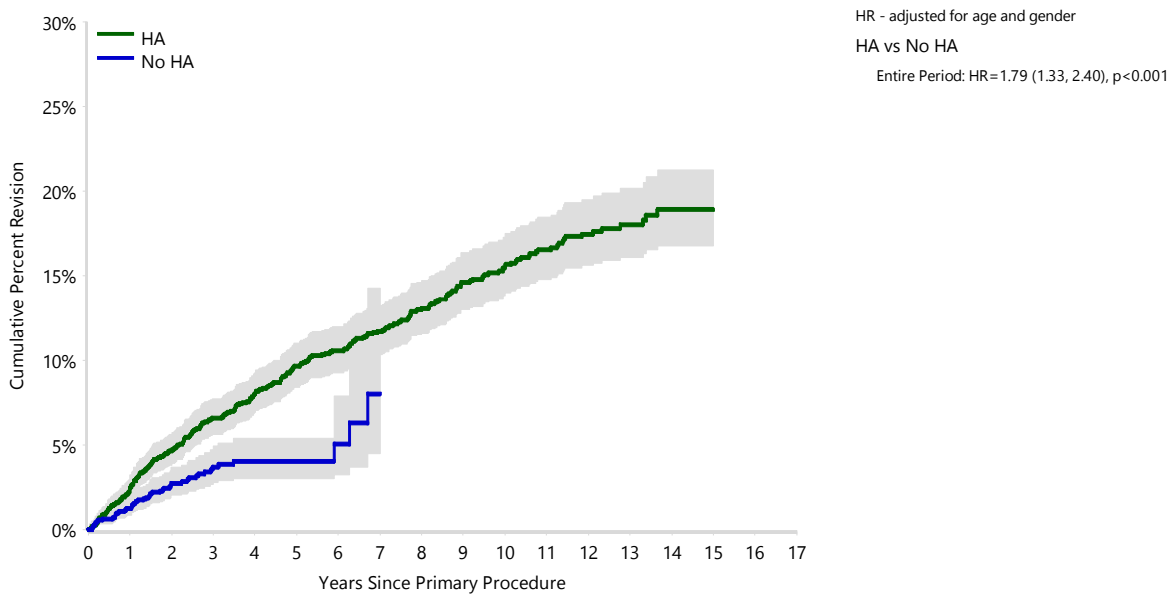
**Table A21 Cumulative Percent Revision of Primary Total Ankle Replacement by Fixation (Primary Diagnosis OA)**

Fixation	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Cemented	1	26	3.8 (0.6, 24.3)	3.8 (0.6, 24.3)	3.8 (0.6, 24.3)	3.8 (0.6, 24.3)	3.8 (0.6, 24.3)	
Cementless	357	4266	1.9 (1.5, 2.4)	5.5 (4.7, 6.3)	8.1 (7.2, 9.2)	10.3 (9.1, 11.5)	14.3 (12.8, 15.9)	17.8 (15.8, 20.1)
Hybrid (Tibial Cemented)	1	21	4.8 (0.7, 29.3)	4.8 (0.7, 29.3)				
Hybrid (Talus Cemented)	3	30	0.0 (0.0, 0.0)	7.8 (2.0, 27.8)	7.8 (2.0, 27.8)	20.9 (5.8, 60.5)		
<b>TOTAL</b>	<b>362</b>	<b>4343</b>						

**Table A22 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Surface Coating (Primary Diagnosis OA)**

Coating	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
HA	298	2126	2.5 (1.9, 3.2)	6.6 (5.6, 7.8)	9.7 (8.4, 11.0)	11.7 (10.3, 13.2)	15.6 (13.9, 17.4)	18.9 (16.8, 21.3)
No HA	59	2137	1.3 (0.9, 1.9)	3.7 (2.8, 4.9)	4.1 (3.0, 5.4)	8.0 (4.5, 14.3)		
<b>TOTAL</b>	<b>357</b>	<b>4265</b>						

**Figure A14 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Surface Coating (Primary Diagnosis OA)**

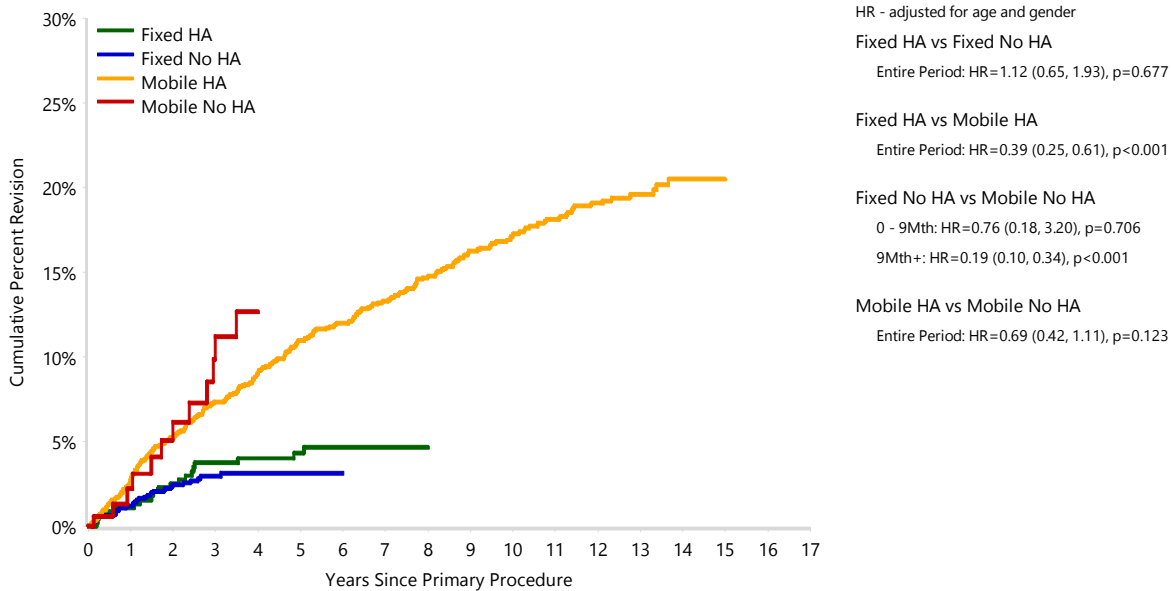


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
HA	2128	2039	1825	1622	1309	850	209
No HA	2137	1522	671	183	44	12	0

**Table A23 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Mobility and Surface Coating (Primary Diagnosis OA)**

Mobility	Coating	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	HA	20	450	1.1 (0.5, 2.7)	3.7 (2.3, 6.0)	4.3 (2.7, 6.8)	4.7 (3.0, 7.2)		
	No HA	41	1963	1.2 (0.8, 1.8)	2.9 (2.1, 4.1)	3.1 (2.3, 4.3)			
Mobile	HA	278	1676	2.8 (2.1, 3.8)	7.4 (6.2, 8.7)	11.0 (9.5, 12.6)	13.3 (11.7, 15.1)	17.2 (15.3, 19.3)	20.5 (18.2, 23.0)
	No HA	18	174	2.2 (0.7, 6.8)	11.2 (6.2, 19.6)				
<b>TOTAL</b>		<b>357</b>	<b>4263</b>						

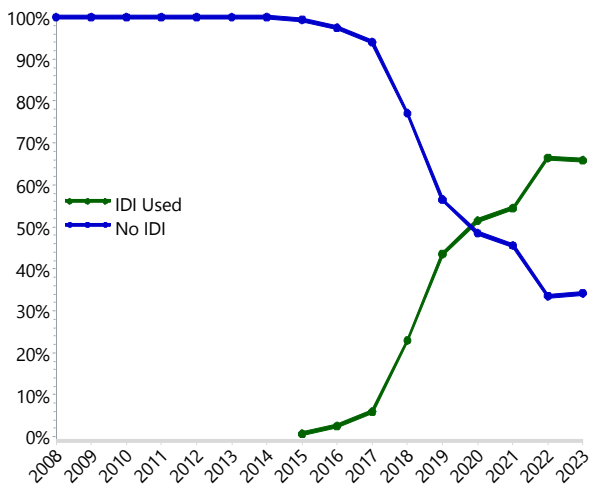
**Figure A15 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Mobility and Surface Coating (Primary Diagnosis OA)**



Number at Risk		0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	HA	450	439	369	295	154	6	1
	No HA	1963	1413	604	146	12	0	0
Mobile	HA	1676	1600	1456	1327	1155	844	208
	No HA	174	109	67	37	32	12	0



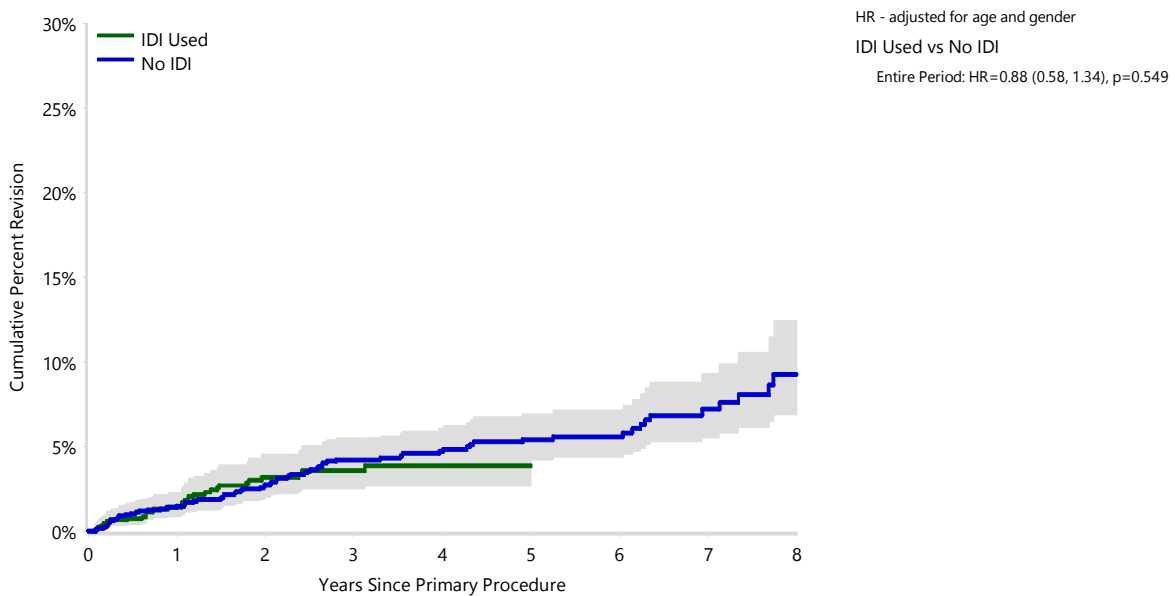
**Figure A16 Primary Total Ankle Replacement by IDI Usage (Primary Diagnosis OA)**



**Table A24 Cumulative Percent Revision of Primary Total Ankle Replacement Since 2015 by IDI Usage (Primary Diagnosis OA)**

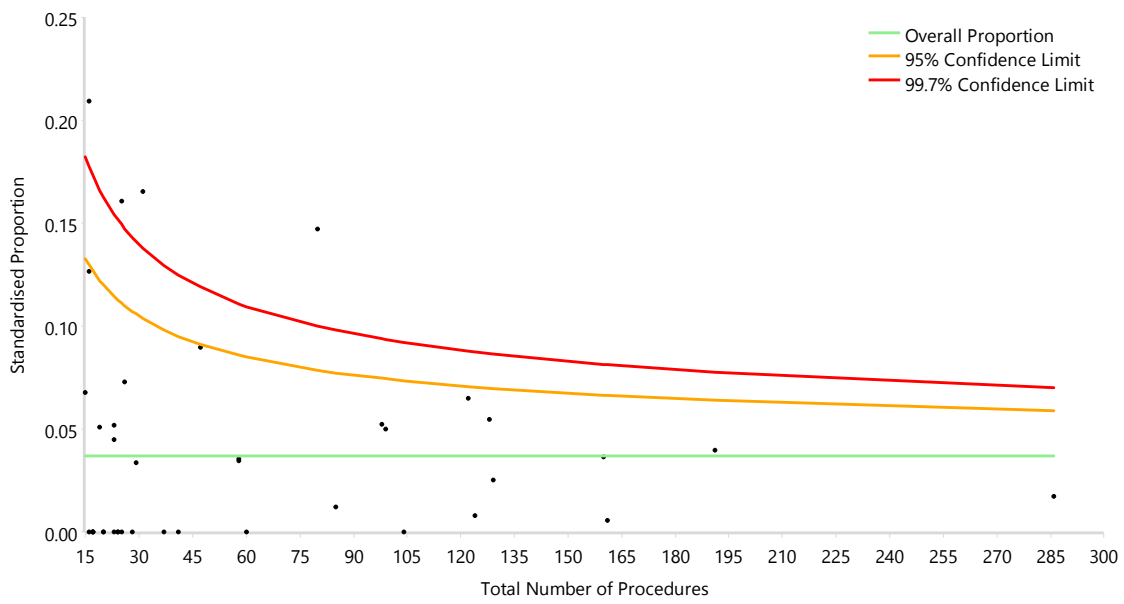
IDI Usage	N Revised	N Total	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
IDI Used	34	1362	1.4 (0.9, 2.3)	3.2 (2.2, 4.5)	3.6 (2.5, 5.1)	3.9 (2.7, 5.5)	3.9 (2.7, 5.5)	
No IDI	75	1569	1.5 (1.0, 2.3)	2.8 (2.0, 3.8)	4.2 (3.3, 5.5)	4.7 (3.6, 6.1)	5.4 (4.2, 7.0)	5.6 (4.4, 7.2)
<b>TOTAL</b>	<b>109</b>	<b>2931</b>						

**Figure A17 Cumulative Percent Revision of Primary Total Ankle Replacement Since 2015 by IDI Usage (Primary Diagnosis OA)**

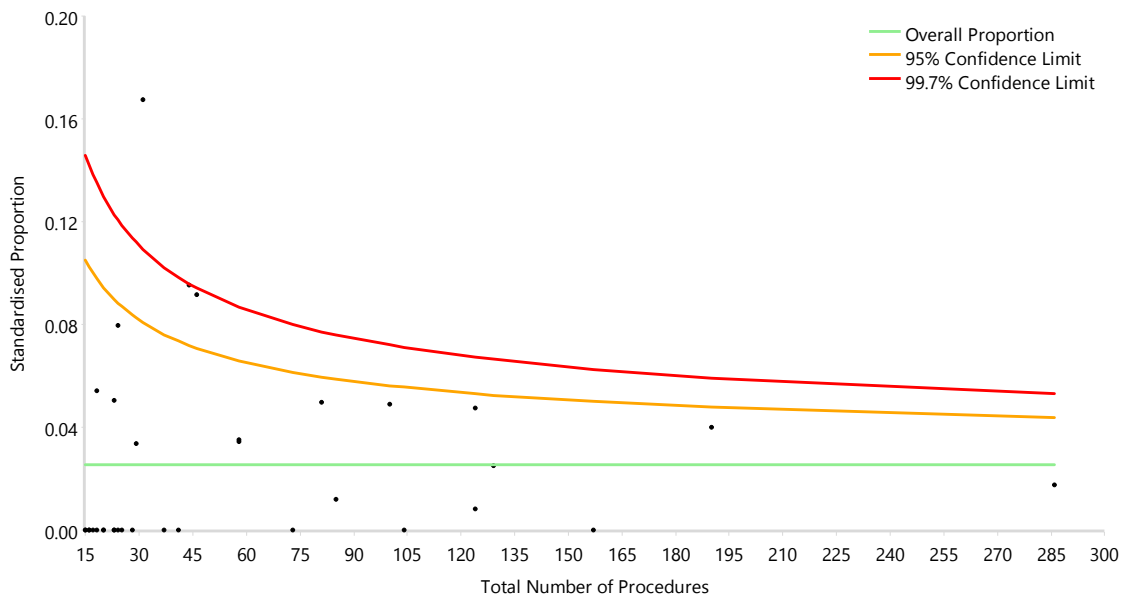


Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
IDI Used	1362	938	605	354	172	62	14
No IDI	1569	1331	1147	918	732	576	421

**Figure A18 Funnel Plot of Revision of Primary Total Ankle Replacement Since 2015 by Surgeon (Primary Diagnosis OA)**



**Figure A19 Funnel Plot of Primary Total Ankle Replacement Since 2015 with Fixed Mobility by Surgeon (Primary Diagnosis OA)**



## DEMOGRAPHICS OF ALL REVISIONS

This report analyses 748 revisions of ankle replacements with a procedure date up to and including 31 December 2023. This is an additional 50 procedures compared to the previous report.

### TYPE OF REVISION

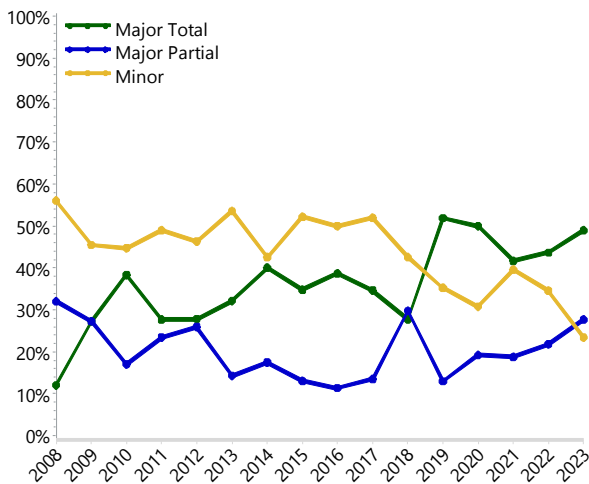
The majority of all revisions recorded by the Registry are major revisions (56.8%) (Table A25).

The proportion of revisions that are major total, major partial and minor revisions has changed since 2008. In 2008, 32.0% of ankle revisions performed were major partial revisions, and this has decreased to 27.7%. The proportion of minor revisions has also decreased over this time. The proportion of major total revisions has increased, from 12.0% of revisions performed in 2008 to 48.9% of revisions performed in 2023 (Figure A20).

### REASON FOR REVISION

Overall, the most common reasons for revision are loosening (33.6%), infection (13.1%), implant breakage of the ankle insert (11.0%), and lysis (8.4%) (Table A26).

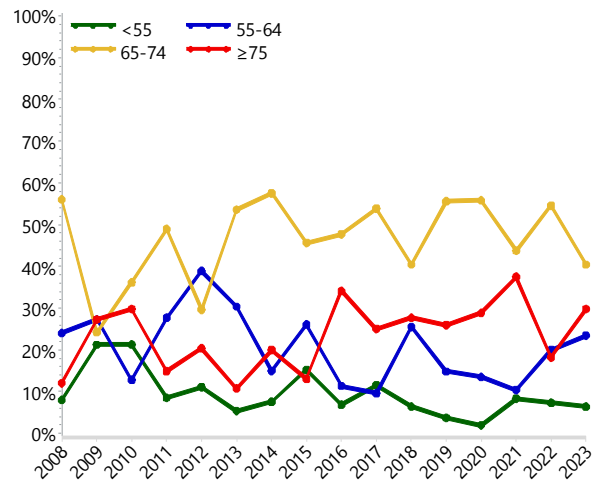
**Figure A20 Revision Ankle Replacement by Class**



### AGE AND GENDER

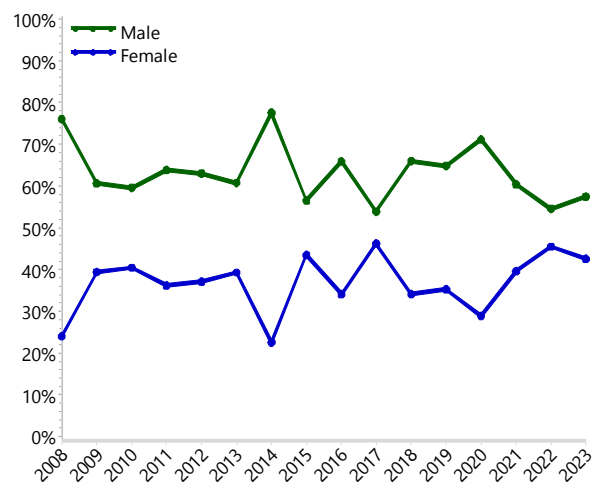
Compared to 2008, 2023 has seen an increase in the proportion of revision procedures in patients aged  $\geq 75$  years and a decrease in the proportion of procedures in patients aged 65-74 years (Figure A21).

**Figure A21 Revision Ankle Replacement by Age**



Revision ankle replacement is more common in males (62.69%). There has been a decrease in the proportion of males undergoing revisions since 2008 (Figure A22).

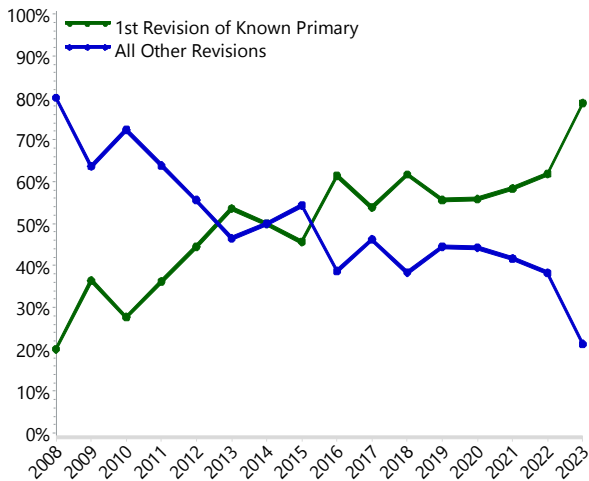
**Figure A22 Revision Ankle Replacement by Gender**



## DEMOGRAPHICS OF 1<sup>ST</sup> REVISIONS OF KNOWN PRIMARY PROCEDURES

There have been 384 1<sup>st</sup> revision procedures where the primary procedure has been recorded by the Registry. This includes revisions of all primary total ankle replacements (Figure A23).

**Figure A23 Ankle Replacement by Revision**



There are a higher proportion of minor revisions in the 1<sup>st</sup> revisions of known primary procedures group (47.7%) compared to the all revisions group (43.2%) (Table A25).

### REASON FOR REVISION

There are differences in the reasons for revision between the 1<sup>st</sup> revisions of known primary procedures group and the all revisions group. Loosening is the most common reason for revision in both groups, but the proportion is lower in the 1<sup>st</sup> revisions of known primary procedures group (32.0% compared to 33.6%). There is a smaller proportion of implant breakage ankle insert in the 1<sup>st</sup> revisions group (9.1%) compared to the all revisions group (11.0%). Other diagnoses such as infection, lysis, instability and pain are slightly higher in the 1<sup>st</sup> revisions of known primary procedures group (Table A26).

### TYPE OF REVISION

The '1<sup>st</sup> revisions of known primary procedures' group and the 'all revisions' group differ in the types of revisions recorded.

The 1<sup>st</sup> revisions of known primary procedures group has a slightly smaller proportion of major revisions (52.3%) compared to the all revisions group (56.8%). There are less arthrodesis, tibial/talar and, but more tibial only and insert only revisions (Table A25).

**Table A25 Revision Ankle Replacement by Type of Revision**

Type of Revision	All Revisions		1st Revision of Known Primary	
	Number	Percent	Number	Percent
Tibial/Talar	150	20.1	70	18.2
Arthrodesis	127	17.0	46	12.0
<b>N Major Total</b>	<b>277</b>	<b>37.0</b>	<b>116</b>	<b>30.2</b>
Tibial Only	47	6.3	37	9.6
Talar Only	48	6.4	25	6.5
Cement Spacer	36	4.8	18	4.7
Removal of Prostheses	17	2.3	5	1.3
<b>N Major Partial</b>	<b>148</b>	<b>19.8</b>	<b>85</b>	<b>22.1</b>
Insert Only	315	42.1	177	46.1
Minor Components	8	1.1	6	1.6
<b>N Minor</b>	<b>323</b>	<b>43.2</b>	<b>183</b>	<b>47.7</b>
<b>TOTAL</b>	<b>748</b>	<b>100.0</b>	<b>384</b>	<b>100.0</b>

**Table A26 Revision Ankle Replacement by Reason for Revision**

Reason for Revision	All Revisions		1st Revision of Known Primary	
	Number	Percent	Number	Percent
Loosening	251	33.6	123	32.0
Infection	98	13.1	52	13.5
Implant Breakage Ankle Insert	82	11.0	35	9.1
Instability	59	7.9	34	8.9
Lysis	63	8.4	33	8.6
Pain	39	5.2	22	5.7
Impingement	42	5.6	20	5.2
Fracture	22	2.9	16	4.2
Prosthesis Dissociation	18	2.4	9	2.3
Arthrofibrosis	12	1.6	7	1.8
Malalignment	11	1.5	7	1.8
Wear Ankle Insert	11	1.5	6	1.6
Heterotopic Bone	7	0.9	5	1.3
Synovitis	3	0.4	3	0.8
Implant Breakage Tibial	2	0.3	2	0.5
Incorrect Sizing	2	0.3	2	0.5
Metal Related Pathology	1	0.1	1	0.3
Osteonecrosis	3	0.4	1	0.3
Progression Of Disease	1	0.1	1	0.3
Tumour	2	0.3	1	0.3
Avascular Talus	1	0.1		
Cysts	1	0.1		
Fusion/Arthrodesis	1	0.1		
Malposition	1	0.1		
Prosthesis Dislocation	1	0.1		
Valgus Deformity	1	0.1		
Other	13	1.7	4	1.0
<b>TOTAL</b>	<b>748</b>	<b>100.0</b>	<b>384</b>	<b>100.0</b>

## OUTCOME OF 1<sup>ST</sup> REVISION OF KNOWN PRIMARY ANKLE REPLACEMENT

This analysis reports the outcome of the 1<sup>st</sup> revision of a known primary total ankle replacement.

There is no difference in the rate of 2<sup>nd</sup> revision when the classes of 1<sup>st</sup> revision are compared (Table A27 and Figure A24).

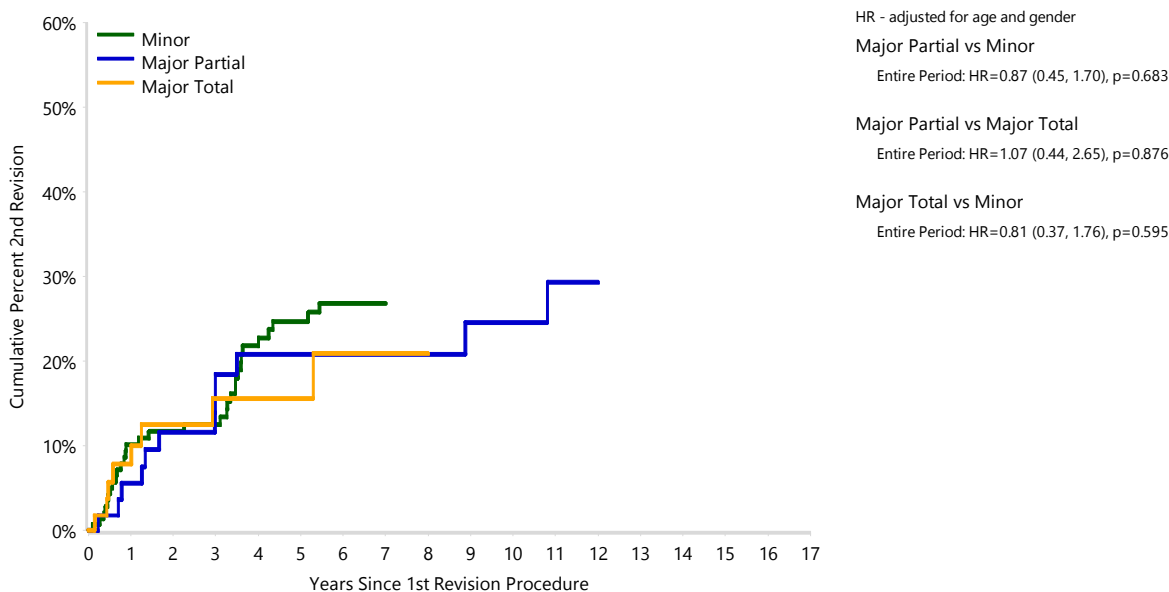
There are 258 1<sup>st</sup> revisions of primary total ankle replacements undertaken for osteoarthritis, excluding all procedures with a 1<sup>st</sup> revision for infection or where no tibial or talar components have been inserted.

**Table A27 Cumulative Percent 2<sup>nd</sup> Revision of Known Primary Total Ankle Replacement by Class of 1<sup>st</sup> Revision (Primary Diagnosis OA, Excluding 1<sup>st</sup> Revision for Infection)**

Class of 1st Revision	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Minor	32	144	10.2 (6.1, 16.6)	12.5 (8.0, 19.4)	24.7 (17.9, 33.6)	26.8 (19.7, 36.0)		
Major Partial	12	56	5.6 (1.8, 16.3)	18.4 (10.0, 32.6)	20.8 (11.7, 35.5)	20.8 (11.7, 35.5)	24.6 (14.1, 40.9)	
Major Total	8	58	7.8 (3.0, 19.5)	15.6 (7.6, 30.5)	15.6 (7.6, 30.5)	20.9 (10.3, 39.8)		
<b>TOTAL</b>	<b>52</b>	<b>258</b>						

Note: Excluding revisions where no minor or major tibial/talar components have been inserted

**Figure A24 Cumulative Percent 2<sup>nd</sup> Revision of Known Primary Total Ankle Replacement by Class of 1<sup>st</sup> Revision (Primary Diagnosis OA, Excluding 1<sup>st</sup> Revision for Infection)**



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Minor	144	120	97	72	49	18	2
Major Partial	56	48	36	32	24	18	2
Major Total	58	41	26	17	9	5	0

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