Supplementary data

Table 1. Protocol

Screening and selection
1. Construction of search terms with university librarian.
2. Literature search PubMed, Embase, Scopus, and Web of Science in line with Prisma guidelines.
3. Blinded review with 2 authors utilizing Covidence systematic software and resolution of conflicts.

Exclusion criteria
- ROI was not defined.
- BMD was not measured using CT.
- CT was performed prior to THA.
- Conference proceedings.
- Non-English language.
- Cohort had a significant medical pathology affecting bone quality (metabolic, neoplastic, endocrine, or infectious).

Inclusion criteria
- Any study that used CT to measure peri-acetabular BMD following primary THA.

Data extraction
- Year of publication.
- Sample size.
- Sex.
- Implant details.
- CT parameters.
- Region of interests.
- Results of density measurements including SD and range [a].

Analysis
- Group into early and late follow-up.
- Group by ROI.
- Group by fixation type.
- Meta-analysis via OpenMeta and Revman software.
- Meta-regression via metafor package R statistic.
- Bias assessment modified Newcastle–Ottawa scale as defined in Tables 3 and 6 in Supplementary data.

[a] Attempt to contact corresponding author then extract with WebPlotDigitizer if required. Conversions to ash density to allow comparison.

Table 2. Example of PubMed search

Hip replacement	"Arthroplasty, Replacement, Hip"[mh] OR hip arthroplasty[tiab] OR hip replacement[tiab]
CT	"Tomography, x-ray computed"[mh] OR CT[tiab] OR computed tomography[tiab]
Acetabular	acetabular component[tiab] OR cup[tiab] OR acetabul*[tiab] "pelvic bones"[mh]
Density	"Bone density"[mh] OR density[tiab]

Table 3. Bias assessment was performed using the modification of the Newcastle–Ottawa scale for assessing bias in cohort studies

Selection
Representativeness of the exposed cohort (osteoarthritic degenerative disease associated with age)
- 1 star awarded for mean age 67.8 ±10 (mean age of total hip arthroplasty 67.8, 2021 AOAJRR report).

Ascertainment of exposure
- 1 star awarded if surgical record including components implanted discussed.

Demonstration that outcome of interest was not present at start of study
- 1 star awarded if baseline CT performed.

Selection of non-exposed cohort NA.

Comparability
Sex
- 1 star awarded if 40–60% of cohort women or cohort all 1 sex.

BMI
- 1 star awarded if average BMI < 30 (majority of THR in AOAJRR in normal or pre-obese category).

Diagnosis
- 1 star awarded if osteoarthritis patients only or 1 star awarded if attempts at excluding metabolic disease or medications.

Outcome
Assessment of outcome
- 1 star awarded if blinded assessment, independent reviewers, or reproducibility assessment performed.

Assessment of outcome
- 1 star if phantom used.

Follow-up long enough for outcome to occur
- 1 star awarded if follow-up greater than 1 year.

Adequacy of follow up
- 1 star awarded if greater than 80% follow-up achieved. No star if not mentioned or only 1 timeframe measured.

NA = Not applicable

Table 4. Characteristics of studies included in review

Study, first author	Acetabular component	Sample size	Mean age (range)/(SD)	No of females	CT scanner	kVp	mAs
Stepniewski 2008 (28)	Duraloc 100, Pinnacle 100, and AML Trispike (DePuy Raynham, MA, USA)	5	71 (62–81)	1	SomatomPlus 4, Siemens, Erlangen, Germany	140	220
Wodzislawski 2009 (29)	NS cemented or uncemented	19	> 40	9	Siemens CT scanner	NS	NS
Boomsma 2016 (30)	MOM, ReCap (Biomet, Warsaw, USA)	317	62 (SD 7.8)	161	Philips Brilliance 40CT scanner or Philips Brilliance 64CT scanner	140	175
Müller 2003 (31)	Cerafit (Ceraver, Roissy, France)	24	54 (31–70)	12	NS	140	206
Zingler 2011 (12)	Cerafit (Ceraver, Roissy, France) or TOP pressfit, Chirulen	54	(36–65)	35	SomatomPlus 4, Siemens, Erlangen, Germany	140	206
Meneghini 2010 (32)	Elliptical and Hedrocel cups (Implex Corp, Allendale, NJ, USA)	17	64 (46–76)	4	Sensation 64 CT scanner, NS Siemens Medical Solutions, Forchheim, Germany	NS	
Schmidt 2002 (33)	Cerafit (Ceraver, Roissy, France)	12	54 (31–70)	6	NS	140	206
Mueller 2006 (34)	Cerafit (Ceraver, Roissy, France)	26	58 (39–65)	11	Somatom Plus 4; Siemens	140	206
Mussmann 2018 (20)	NS 12 cemented and 12 uncemented	12	67 (62–70)	0	GE Discovery CT750 HD 64-channel scanner	80–140	630
Mueller 2007 (6)	Cerafit (Ceraver, Roissy, France)	24	58 (39–65)	9	SomatomPlus 4, Siemens, Erlangen, Germany	140	206
Kress 2011 (35)	Cerafit (Ceraver, Roissy, France)	24	58 (39–65)	9	SomatomPlus 4, Siemens, Erlangen, Germany	140	206
Schmidt 2012 (36)	T.O.P. pressfit (Waldemar Link, Hamburg, Germany)	38	59 (36–78)	32	SomatomPlus 4, Siemens, Erlangen, Germany	140	206
Mueller 2009 (37)	ZCA (Zimmer Inc, Warsaw, IN, USA)	44	(52–89)	18	SomatomPlus 4, Siemens	140	206
Pitto 2008 (11)	Trilogy (Zimmer Inc, Warsaw, IN, USA)	20	66 (40–78)	12	Siemens SomatomPlus, Erlangen, Germany	140	206
Pakvis 2016 (38)	RM pressfit (Mathys AG, Bettlach, Switzerland)	25	64 (56–71)	18	Toshiba RXL Aquilion 32	135	200
Wright 2001 (21)	Trilogy (Zimmer Inc, Warsaw, IN, USA)	26	68 (45–79)	13	General Electric Medical Systems, Milwaukee, Wisconsin; manufactured in 1995	NS	NS
Schmidt 2005 (22)	Trilogy (Zimmer Inc, Warsaw, IN, USA)	40	(39–90)	20	SomatomPlus 4, Siemens, Erlangen, Germany	140	206
Mueller 2007 (4)	ZCA (Zimmer Inc, Warsaw, IN, USA)	15	75 (69–79)	11	SomatomPlus 4, Siemens, Erlangen, Germany	140	206
Barbu-McInnis 2004 (39)	NS	3	NS	NS	GE CTi, Milwaukee, Wisconsin	NS	NS

NS = not specified.

Table 5. Data collection detailed description on ROI taken, conversion, and extraction of data

Study, first author	ROI taken	Units	Conversion used	Standard deviation reported	Standard deviation calculated	WebPlot-Digitizer
Wodzislawski 2009 (29)	As per text all 10–15 mm above acetabulum	HU	–0.9 + 0.7 × (HU)			No
Müller 2003 (31)	As per text ROI 5mm above acetabular component and 15 mm below	mgCaHA/mL	0.8772 × (mgCaHA/mL) + 0.0789	No	Mean SD	No
Zingler 2011 (12)	2 mm slices at 10 mm intervals cranial to the cup	mgCaHA/mL	0.8772 × (mgCaHA/mL) + 0.0789	Yes	NA	No
Mueller 2006 (34)	As per text 3 above level and 3 below starting 30 mm above the cup	mgCaHA/ mL	0.8772 × (mgCaHA/mL) + 0.0789	Yes	NA	No
Mussmann 2018 (20)	As per text split into quadrants. Estimated as 26 mm radius due to mean reported cup size 56 mm. Split into superior, inferior, anterior, and posterior	K_2HPO_4/cm^3	1.06 × (K_2HPO_4/cm^3) + 0.0389	No	Mean SD	No
Mueller 2007 (6)	As per text 6 scans starting 20 mm above the cup with 3 above and 3 below	mgCaHA/ mL	0.8772 × (mgCaHA/mL) + 0.0789	Yes	NA	No
Kress 2011 (35)	As per text 6 scans starting 20 mm above the cup with 3 above and 3 below	mgCaHA/ mL	0.8772 × (mgCaHA/mL) + 0.0789	No	Mean SD	No
Schmidt 2012 (36)	As per text 6 scans 3 above the level of the component and 3 below	mgCaHA/ mL	0.8772 × (mgCaHA/mL) + 0.0789	Yes	N/A	No
Mueller 2009 (37)	As per text 5 scans above the level of the component starting at 25 mm above, 5 scans below	mgCaHA/ mL	0.8772 × (mgCaHA/mL) + 0.0789	Yes	N/A	No
Pakvis 2016 (38)	ROI taken as 6 axial scans starting 10 mm above the acetabular component	mg/cm^3	N/A	No	Range/4	Yes
Wright 2001 (21)	ROI taken as 5 axial scans starting 10mm above the acetabular component progressing in 2.5 mm intervals	mg/cm^3	N/A	No	95% CI [a]	Yes
Schmidt 2005 (22)	As per text 1 ROI 10 mm proximal to cup and 1 below	HU	–0.9 + 0.7*(HU)	No	Mean SD	No
Mueller 2007 (4)	As per text 5 axial scans above and 5 below starting 25 mm above cup	mgCaHA/mL	0.8772 x (mgCaHA/mL) + 0.0789	Yes	NA	No

NA = Not available
[a] assuming sampling distribution is t(26)) i.e. sqrt(26) * CI/(3.92)

Table 6. Bias assessment results

Study, first author	Selection	Comparability	Outcome	Total
Stepniewski 2008 (28)	2	0	2	4
Wodzislawki 2009 (29)	3	1	0	4
Boomsma 2016 (30)	2	1	2	5
Müller 2003 (31)	2	1	2	5
Zingler 2011 (12)	3	2	2	7
Meneghini 2010 (32)	2	0	3	5
Schmidt 2002 (33)	2	1	2	5
Mueller 2006 (34)	3	2	3	8
Mussman 2018 (20)	2	2	3	7
Mueller 2007 (6)	3	1	3	7
Kress 2011 (35)	3	1	3	7
Schmidt 2012 (36)	3	1	3	7
Mueller 2009 (37)	3	1	3	7
Pitto 2008 (11)	3	1	3	7
Pakvis 2016 (38)	3	2	3	8
Wright 2001 (21)	3	2	3	8
Schmidt 2005 (22)	2	2	2	6
Mueller 2007 (4)	2	1	2	5
Barbu-McInnis 2004 (39)	0	0	0	0