Supplementary Material

Appendix 1	PRISMA checklist
Appendix 2	MOOSE checklist
Appendix 3	Data sources and search strategy, eligibility criteria, and data extraction and quality assessment methods
Appendix 4	Literature search strategy
Appendix 5	Statistical analyses
Appendix 6	Reference list of 149 included articles
Appendix 7	Characteristics of studies included in review
Appendix 8	Cochrane risk of bias assessment for randomised controlled trials
Appendix 9	Incidence rate of dislocation across 112 relevant studies
Appendix 10	Incidence of dislocation following primary total hip replacement at specific average follow-up periods
Appendix 11	Risk of dislocation comparing males to females
Appendix 12	Risk of dislocation comparing males to females, grouped according to study level characteristics
Appendix 13	Risk of dislocation for BMI comparisons
Appendix 14	Risk of dislocation comparing individuals with a BMI ≥30 versus <30 kg/m^2, grouped according to several study characteristics
Appendix 15	Risk of dislocation comparing patients with neurological disease versus no neurological disease
Appendix 16	Risk of dislocation comparing a surgical indication of avascular necrosis versus osteoarthritis
Appendix 17	Risk of dislocation comparing a surgical indication of rheumatoid arthritis versus osteoarthritis
Appendix 18	Risk of dislocation comparing a surgical indication of avascular necrosis versus osteoarthritis, grouped according to study level characteristics
Appendix 19	Risk of dislocation comparing a posterior with an anterolateral approach
Appendix 20	Risk of dislocation comparing a direct anterior with a posterior approach
Appendix 21	Risk of dislocation comparing a posterior with an anterolateral approach, grouped according to study level characteristics
Appendix 22	Summary associations of surgery-related factors and risk of dislocation
Appendix 23	Risk of dislocation comparing a posterior short external rotator and capsule repair versus none
Appendix 24	Risk of dislocation comparing a posterior short external rotator and capsule repair versus none, grouped according to study level characteristics
Appendix 25	Summary associations of implant-related factors and risk of dislocation
Appendix 26	Risk of dislocation comparing femoral head diameter 28mm versus 32mm
Appendix 27	Risk of dislocation comparing femoral head diameter 28mm versus 32mm, grouped according to study level characteristics
Appendix 28	Summary associations of hospital-related factors and risk of dislocation
Appendix 29	Hospital-related factors and risk of dislocation
Appendix 30	Assessment of small study effects by funnel plots and Egger's regression symmetry tests

Appendix 1. PRISMA checklist

Section/topic	Item No	Checklist item	Reported on page No
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both	1
Abstract			
Structured summary	2	Provide a structured summary including, as applicable, background, objectives, data sources, study eligibility criteria, participants, interventions, study appraisal and synthesis methods, results, limitations, conclusions and implications of key findings, systematic review registration number	2
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known	Introduction
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS)	Introduction
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (such as web address), and, if available, provide registration information including registration number	Methods
Eligibility criteria	6	Specify study characteristics (such as PICOS, length of follow-up) and report characteristics (such as years considered, language, publication status) used as criteria for eligibility, giving rationale	Methods
Information sources	7	Describe all information sources (such as databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched	Methods
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated	Appendix 4
Study selection	9	State the process for selecting studies (that is, screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis)	Methods
Data collection process	10	Describe method of data extraction from reports (such as piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators	Methods
Data items	11	List and define all variables for which data were sought (such as PICOS, funding sources) and any assumptions and simplifications made	Methods
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis	Methods
Summary measures	13	State the principal summary measures (such as risk ratio, difference in means).	Methods
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (such as I^2 statistic) for each meta-analysis	Methods
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (such as publication bias, selective reporting within studies)	Methods
Additional analyses	16	Describe methods of additional analyses (such as sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified	Methods
Results			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram	Results, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (such as study size, PICOS, follow-up period) and provide the citations	Results, Table 1, Appendices 6-7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see item 12).	Results, Appendices 7-8
Results of individual studies	20	For all outcomes considered (benefits or harms), present for each study (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot	Results, Figures 2-4
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency	Results, Figures 2-4; Appendices 9-30
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see item 15)	Appendices 12, 14, 18, 21, 24, 27, 30
Additional analysis	23	Give results of additional analyses, if done (such as sensitivity or subgroup analyses, meta-regression) (see item 16)	Results, Figure 1, Appendices 12, 14, 18, 21, 24, 27, 30
Discussion			
Summary of evidence	24	Summarise the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (such as health care providers, users, and policy makers)	Discussion
Limitations	25	Discuss limitations at study and outcome level (such as risk of bias), and at review level (such as incomplete retrieval of identified research, reporting bias)	Discussion
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research	Discussion
Funding			
Funding	27	Describe sources of funding for the systematic review and other support (such as supply of data) and role of funders for the systematic review	Acknowledgements

Appendix 2. MOOSE checklist

Risk factors for dislocation after primary total hip replacement: meta-analysis of 125 studies involving approximately five million hip replacements

Criteria		Brief description of how the criteria were handled in the review
Reporting of background		
√	Problem definition	Factors influencing dislocation following primary total hip replacement (THR) are not well understood. We conducted a systematic review and meta-analysis to assess the associations of patient-, surgery-, implant-, and hospital-related factors with dislocation risk following primary THR
√	Hypothesis statement	Several patient-, surgery-, implant-, and hospital-related factors influence the risk of dislocation following primary THR
√	Description of study outcomes	Dislocation
√	Type of exposure	Patient-, surgery-, implant-, and hospital-related factors
√	Type of study designs used	Longitudinal studies (prospective or retrospective case control, prospective cohort, retrospective cohort, case-cohort, nested-case control, or clinical trials)
√	Study population	Patients followed for dislocation following primary THR
Reporting of search strategy should include		
√	Qualifications of searchers	
√	Search strategy, including time period included in the synthesis and keywords	Time period: from inception to March 8, 2019 The detailed search strategy can be found in Appendix 3
√	Databases and registries searched	MEDLINE, EMBASE, Web of Science, and Cochrane databases
√	Search software used, name and version, including special features	OvidSP was used to search EMBASE and MEDLINE EndNote used to manage references
√	Use of hand searching	We searched bibliographies of retrieved papers
√	List of citations located and those excluded, including justifications	Details of the literature search process are outlined in the flow chart. The citation list for excluded studies are available on request.
√	Method of addressing articles published in languages other than English	Not applicable
√	Method of handling abstracts and unpublished studies	Abstracts with no full text publications were not included.
√	Description of any contact with authors	We contacted authors of studies that did not provide adequate data in their studies
Reporting of methods should include		
√	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	Detailed inclusion and exclusion criteria are described in the Methods section.
√	Rationale for the selection and coding of data	Data extracted from each of the studies were relevant to the population characteristics, study design, exposure, and outcome.
√	Assessment of confounding	We assessed confounding by ranking individual studies on the basis of different adjustment levels and performed sub-group analyses to evaluate differences in the overall estimates according to levels of adjustment.
√	Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	Study quality was assessed based on the nine-star Newcastle–Ottawa Scale using pre-defined criteria namely: population representativeness, comparability (adjustment of confounders), ascertainment of outcome. Sensitivity analyses by several quality indicators such as study size, duration of follow-up, and adjustment factors. Cochrane risk of bias for clinical trials
√	Assessment of heterogeneity	Heterogeneity of the studies was quantified with I^2 statistic that provides the relative amount of variance of the summary effect due to the between-study heterogeneity and explored using meta-regression and stratified analyses
√	Description of statistical methods in sufficient detail to be replicated	Description of methods of meta-analyses, sensitivity analyses, meta-regression and assessment of publication bias are detailed in the methods. We performed random effects meta-analysis with Stata 15.
√	Provision of appropriate tables and graphics	Table 1; Figures 1-4; Appendices 9-30
Reporting of results should include		
√	Graph summarizing individual study estimates and overall estimate	Figures 1-4; Appendices 9-30
√	Table giving descriptive information for each study included	Appendix 7

√	Results of sensitivity testing	Sensitivity analysis was conducted to assess the influence of some large studies and low quality studies on the pooled estimate.
√	Indication of statistical uncertainty of findings	95% confidence intervals were presented with all summary estimates, I^2 values and results of sensitivity analyses
Reporting of discussion should include		
√	Quantitative assessment of bias	Sensitivity analyses indicate heterogeneity in strengths of the association due to most common biases in observational studies. The systematic review is limited in scope, as it involves published data. Individual participant data is needed. Limitations have been discussed.
√	Justification for exclusion	All studies were excluded based on the pre-defined inclusion criteria in methods section.
√	Assessment of quality of included studies	Brief discussion included in 'Methods' section
Reporting of conclusions should include		
√	Consideration of alternative explanations for observed results	Discussion
√	Generalization of the conclusions	Discussed in the context of the results.
√	Guidelines for future research	We recommend analyses of individual participant data
√	Disclosure of funding source	In "Acknowledgement" section

Appendix 3. Data sources and search strategy, eligibility criteria, and data extraction and quality assessment methods

Data sources and search strategy

We systematically conducted an electronic search of MEDLINE, Embase, Web of Science and The Cochrane library from inception of these databases to March 8, 2019. The search strategy was constructed by combining MeSH search terms and key words related to the population (e.g., "primary total hip replacement"), exposures (e.g., "age", "sex", "risk factor"), and outcome (e.g., "dislocation", "instability"). The search was restricted to human studies with no limits on language. The full details of the MEDLINE search strategy are reported in appendix pp 7-8**.** All titles and abstracts of studies retrieved from the databases were screened by one reviewer (SKK) to assess their suitability for inclusion, after which full texts of potentially eligible papers were acquired. Full text evaluation was then conducted by two independent reviewers (SKK and MCB) based on the eligibility criteria. Disagreements regarding eligibility of articles were discussed and the opinion of a third reviewer (MRW) was sought when necessary to achieve consensus. The "cited by" function in Web of Science and the reference lists of relevant studies and review articles were assessed to identify any additional papers.

Eligibility criteria

Papers were eligible if they were longitudinal studies (prospective or retrospective cohorts, case-cohorts, nested-case controls, or clinical trials) that recruited patients who had undergone primary THR and reported on the associations of any patient-, surgery-, implant- or hospital-related factor (assessed at baseline or at time of surgery) with the risk of dislocation. Since more than 50% of dislocations occur in the first three months following THR[1,2] and about a third manifest as late dislocations more than 5 years postoperatively,[3] no restrictions were placed on the duration of follow-up. We excluded studies: (i) restricted to selected populations or patients with prevalent comorbidities (e.g. diabetes) and had no comparison or control groups; (ii) of revision THRs; (iii) that exclusively assessed risk factors for recurrent dislocation; (iv) that evaluated exposures (conditions) that developed post-surgery; (v) that involved only particular indications for THR such as hip fracture; and (vi) that included only hemiarthroplasty or hip resurfacing.

Data extraction and quality assessment

One reviewer (SKK) independently extracted qualitative and quantitative information into a standardised data collection spreadsheet. Data was extracted on study design, patient characteristics, type of exposures, and outcomes. A second reviewer (MCB) then independently checked the extracted data with that in the original papers. Any disagreements on extracted information between the two reviewers (SKK and MCB) were discussed and a third reviewer (MRW) was involved to achieve consensus. Authors were contacted to provide additional information if there was insufficient data (e.g. data for estimating a risk

ratio) reported. When the same study was described in multiple publications, the paper with the most comprehensive information was used. Methodological quality of each eligible study was assessed using the nine-star Newcastle-Ottawa Scale (NOS).[4] NOS measures the quality of evidence from a score of zero to nine, based on three pre-defined domains including: (i) selection of participants; (ii) comparability; and (iii) ascertainment of outcomes of interest. The Cochrane Collaboration's risk of bias tool was used to assess the quality of randomised conrolled trials (RCTs).[5]

References

1. Woo RY, Morrey BF. Dislocations after total hip arthroplasty. *J Bone Joint Surg Am* 1982; **64**(9): 1295-306.

2. Tamaki T, Oinuma K, Miura Y, Higashi H, Kaneyama R, Shiratsuchi H. Epidemiology of Dislocation Following Direct Anterior Total Hip Arthroplasty: A Minimum 5-Year Follow-Up Study. *J Arthroplasty* 2016; **31**(12): 2886-8.

3. von Knoch M, Berry DJ, Harmsen WS, Morrey BF. Late dislocation after total hip arthroplasty. *J Bone Joint Surg Am* 2002; **84**(11): 1949-53.

4. Wells GA, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2011. www.ohri.ca/programs/clinical_epidemiology/oxford.asp. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp (accessed 20 August.

5. Higgins JP, Altman DG, Gotzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011; **343**: d5928.

Appendix 4. Literature search strategy

Relevant studies, published from inception to March 8, 2019 (date last searched), were identified through electronic searches using MEDLINE, Embase, Web of Science, and Cochrane databases with no limits on language. Electronic searches were supplemented by scanning reference lists of articles identified for all relevant studies (including review articles), by hand searching of relevant journals and by correspondence with study investigators.

1 exp Arthroplasty, Replacement, Hip/ (24261)
2 primary.mp. (1433430)
3 exp Risk Factors/ (757067)
4 predictor.mp. (165039)
5 exp Risk Assessment/ (241419)
6 age.mp. (8254398)
7 exp Sex/ (7618)
8 gender.mp. (289037)
9 exp Body Mass Index/ (115624)
10 exp Body Weight/ (434494)
11 exp Obesity/ (194257)
12 exp Femur Head/ (9055)
13 femoral head.mp. (13361)
14 exp Femur/ (52415)
15 bearing.mp. (163097)
16 exp Bone Transplantation/ (30285)
17 bone-grafting.mp. (9443)
18 exp Osteotomy/ (33222)
19 cup inclination.mp. (280)
20 cup anteversion.mp. (187)
21 rim liner.mp. (13)
22 constrained liner.mp. (72)
23 exp Joint Instability/ (18869)
24 history of instability.mp. (53)
25 abductor.mp. (4811)
26 instability.mp. (113768)
27 exp Osteonecrosis/ (14700)
28 acetabul*.mp. (19874)
29 abduction.mp. (11448)
30 exp Smoking/ (139466)
31 exp Tobacco/ (29292)
32 alcohol.mp. (276997)
33 exp Socioeconomic Factors/ (422282)
34 socioeconomic.mp. (196851)
35 Diabetes Mellitus/ (111170)
36 diabetes.mp. (559194)
37 exp Hypertension/ (243676)
38 exp Heart Failure/ (111781)
39 exp Cardiovascular Diseases/ (2252580)
40 exp Coronary Artery Disease/ (56252)
41 exp Myocardial Infarction/ (167360)
42 exp Neoplasms/ (3140515)
43 malignancy.mp. (126587)

44 cancer.mp. (1525619)
45 exp Comorbidity/ (98296)
46 Charlson comorbidity index.mp. (4236)
47 exp Arthritis, Rheumatoid/ (107717)
48 exp Osteoarthritis/ (57822)
49 exp Lupus Erythematosus, Systemic/ (56771)
50 exp Respiratory Tract Diseases/ (1271873)
51 exp Respiratory Tract Infections/ (341882)
52 respiratory disease.mp. (15697)
53 renal disease.mp. (54706)
54 exp Kidney Failure, Chronic/ (89527)
55 exp Kidney Diseases/ (486724)
56 urinary disease.mp. (107)
57 exp Urinary Tract Infections/ (44487)
58 neurologic disease.mp. (3351)
59 lumbar stenosis.mp. (708)
60 exp Spinal Fusion/ (23190)
61 exp Spinal Stenosis/ (5598)
62 exp Diskectomy/ (5017)
63 discectomy.mp. (5671)
64 exp Scoliosis/ (16867)
65 exp Parkinson Disease/ (60940)
66 exp Dementia/ (152129)
67 exp Depression/ (106981)
68 anterior approach.mp. (3581)
69 posterior approach.mp. (4150)
70 lateral approach.mp. (2388)
71 anterolateral approach.mp. (599)
72 posterolateral approach.mp. (640)
73 exp Hip Dislocation/ (6014)
74 dislocation.mp. (50116)
75 instability.mp. (113768)
76 exp Joint Instability/ (18869)
77 luxation.mp. (4415)
78 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 (13318407)
79 73 or 74 or 75 or 76 or 77 (160210)
80 1 and 2 and 78 and 79 (1058)
81 limit 80 to humans (1050)
****

Each part was specifically translated for searching the other databases (EMBASE, Web of Science, and Cochrane databases)

Appendix 5. Statistical analyses

We pooled the incidence rate for dislocation (estimated from the number of dislocations within average follow-up period/total number of participants or procedures as reported) with 95% confidence intervals (CIs). Given that we employed binary data with low dislocation rates, the Freeman-Tukey variance stabilising double arcsine transformation was used.[1] Temporal trends in dislocation rates were evaluated using the median year of data collection/surgery reported by studies, as previously reported.[2] Relative risks (RRs) with 95% confidence intervals (CIs) were used as summary measures of associations between the different exposures and risk of dislocation. Fully-adjusted risk estimates were used for pooling when reported, otherwise crude RRs were calculated from the raw counts extracted from studies. For studies with zero events in one of the arms (exposure or control), the RR was calculated with the 'opposite-arm' continuity correction.[3] Due to the variety of BMI cut-offs employed by the included studies, we used the following risk comparisons based on the data available: ≥25 vs. <25; ≥30 vs. <30; ≥35 vs. <35; ≥50 vs. <50 kg/m^2 and per unit increase in BMI, to ensure consistency in the pooling approach and enhance comparability and interpretation of findings as previously reported.[4,5] Random-effects models were used to combine RRs to minimize the effect of heterogeneity.[6] In the absence of substantial heterogeneity, fixed-effect models were employed. Heterogeneity was assessed using the Cochrane χ^2 statistic and the I^2 statistic.[7] Several pre-defined study-level characteristics which may explain heterogeneity were explored using subgroup analyses and random effects meta-regression.[8] Funnel plots and Egger's regression symmetry tests were used to assess for publication bias or small study effects[9] in pooled analysis involving 10 or more studies. The statistical analyses employed Stata MP 16 (Stata Corp, College Station, Texas, USA).

References

1. Freeman MF, Tukey JW. Transformations Related to the Angular and the Square Root. *Ann Math Statist* 1950: 607-11.
2. Berstock JR, Beswick AD, Lopez-Lopez JA, Whitehouse MR, Blom AW. Mortality After Total Knee Arthroplasty: A Systematic Review of Incidence, Temporal Trends, and Risk Factors. *J Bone Joint Surg Am* 2018; **100**(12): 1064-70.
3. Sweeting MJ, Sutton AJ, Lambert PC. What to add to nothing? Use and avoidance of continuity corrections in meta-analysis of sparse data. *Stat Med* 2004; **23**(9): 1351-75.
4. Kunutsor SK, Whitehouse MR, Blom AW, Beswick AD, INFORM team. Patient-related risk factors for periprosthetic joint infection after total joint arthroplasty: A systematic review and meta-analysis. *PloS one* 2016; **11**(3): e0150866.
5. Barrett MC, Whitehouse MR, Blom AW, Kunutsor SK. Host-related factors for venous thromboembolism following total joint replacement: A meta-analysis of 89 observational studies involving over 14 million hip and knee replacements. *J Orthop Sci* 2019.
6. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials* 1986; **7**(3): 177-88.
7. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003; **327**(7414): 557-60.
8. Thompson SG, Sharp SJ. Explaining heterogeneity in meta-analysis: a comparison of methods. *Stat Med* 1999; **18**(20): 2693-708.

9. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997; **315**(7109): 629-34.

Appendix 6. Reference list of 149 included articles

1. Angerame MR, Fehring TK, Masonis JL, Mason JB, Odum SM, Springer BD. Early Failure of Primary Total Hip Arthroplasty: Is Surgical Approach a Risk Factor? *The Journal of arthroplasty.* 2018;33(6):1780-1785.

2. Giardina F, Castagnini F, Stea S, Bordini B, Montalti M, Toni A. Short Stems Versus Conventional Stems in Cementless Total Hip Arthroplasty: A Long-Term Registry Study. *The Journal of arthroplasty.* 2018;33(6):1794-1799.

3. Ponzio DY, Poultsides LA, Salvatore A, Lee Y-Y, Memtsoudis SG, Alexiades MM. In-Hospital Morbidity and Postoperative Revisions After Direct Anterior vs Posterior Total Hip Arthroplasty. *The Journal of arthroplasty.* 2018;33(5):1421-1425.e1421.

4. Hwang J-H, Kim S-M, Oh K-J, Kim Y. Dislocations after use of dual-mobility cups in cementless primary total hip arthroplasty: prospective multicentre series. *International orthopaedics.* 2018;42(4):761-767.

5. Salib CG, Reina N, Perry KI, Taunton MJ, Berry DJ, Abdel MP. Lumbar fusion involving the sacrum increases dislocation risk in primary total hip arthroplasty. *The bone & joint journal.* 2019;101-B(2):198-206.

6. Gausden EB, Parhar HS, Popper JE, Sculco PK, Rush BNM. Risk Factors for Early Dislocation Following Primary Elective Total Hip Arthroplasty. *The Journal of arthroplasty.* 2018;33(5):1567-1571.e1562.

7. Rondon AJ, Tan TL, Schlitt PK, Greenky MR, Phillips JL, Purtill JJ. Total Joint Arthroplasty in Patients With Parkinson's Disease: Survivorship, Outcomes, and Reasons for Failure. *The Journal of arthroplasty.* 2018;33(4):1028-1032.

8. Li M, Xu C, Xie J, Hu Y, Liu H. Comparison of collum femoris-preserving stems and ribbed stems in primary total hip arthroplasty. *Journal of orthopaedic surgery and research.* 2018;13(1):271.

9. Malkani AL, Garber AT, Ong KL, et al. Total Hip Arthroplasty in Patients With Previous Lumbar Fusion Surgery: Are There More Dislocations and Revisions? *The Journal of arthroplasty.* 2018;33(4):1189-1193.

10. Hailer NP, Weiss RJ, Stark A, Karrholm J. The risk of revision due to dislocation after total hip arthroplasty depends on surgical approach, femoral head size, sex, and primary diagnosis. An analysis of 78,098 operations in the Swedish Hip Arthroplasty Register. *Acta orthopaedica.* 2012;83(5):442-448.

11. Seagrave KG, Troelsen A, Madsen BG, Husted H, Kallemose T, Gromov K. Can Surgeons Reduce the Risk for Dislocation After Primary Total Hip Arthroplasty Performed Using the Posterolateral Approach? *The Journal of arthroplasty.* 2017;32(10):3141-3146.

12. Rowan FE, Salvatore AJ, Lange JK, Westrich GH. Dual-Mobility vs Fixed-Bearing Total Hip Arthroplasty in Patients Under 55 Years of Age: A Single-Institution, Matched-Cohort Analysis. *The Journal of arthroplasty.* 2017;32(10):3076-3081.

13. Graves SE, de Steiger R, Davidson D, et al. The use of femoral stems with exchangeable necks in primary total hip arthroplasty increases the rate of revision. *The bone & joint journal.* 2017;99-B(6):766-773.

14. Utsunomiya T, Motomura G, Ikemura S, Hamai S, Fukushi J-I, Nakashima Y. The Results of Total Hip Arthroplasty After Sugioka Transtrochanteric Anterior Rotational Osteotomy for Osteonecrosis. *The Journal of arthroplasty.* 2017;32(9):2768-2773.

15. Shah SM, Walter WL, Tai SM, Lorimer MF, de Steiger RN. Late Dislocations After Total Hip Arthroplasty: Is the Bearing a Factor? *The Journal of arthroplasty.* 2017;32(9):2852-2856.

16. Mjaaland KE, Svenningsen S, Fenstad AM, Havelin LI, Furnes O, Nordsletten L. Implant Survival After Minimally Invasive Anterior or Anterolateral Vs. Conventional Posterior or Direct Lateral Approach: An

Analysis of 21,860 Total Hip Arthroplasties from the Norwegian Arthroplasty Register (2008 to 2013). *The Journal of bone and joint surgery American volume.* 2017;99(10):840-847.

17. Abdel MP, Chalmers BP, Trousdale RT, Hanssen AD, Pagnano MW. Randomized Clinical Trial of 2-Incision vs Mini-Posterior Total Hip Arthroplasty: Differences Persist at 10 Years. *The Journal of arthroplasty.* 2017;32(9):2744-2747.

18. Gofton WT, Illical EM, Feibel RJ, Kim PR, Beaule PE. A Single-Center Experience With a Titanium Modular Neck Total Hip Arthroplasty. *The Journal of arthroplasty.* 2017;32(8):2450-2456.

19. Buckland AJ, Puvanesarajah V, Vigdorchik J, et al. Dislocation of a primary total hip arthroplasty is more common in patients with a lumbar spinal fusion. *The bone & joint journal.* 2017;99-B(5):585-591.

20. Zijlstra WP, De Hartog B, Van Steenbergen LN, Scheurs BW, Nelissen RGHH. Effect of femoral head size and surgical approach on risk of revision for dislocation after total hip arthroplasty. *Acta orthopaedica.* 2017;88(4):395-401.

21. Meneghini RM, Elston AS, Chen AF, Kheir MM, Fehring TK, Springer BD. Direct Anterior Approach: Risk Factor for Early Femoral Failure of Cementless Total Hip Arthroplasty: A Multicenter Study. *The Journal of bone and joint surgery American volume.* 2017;99(2):99-105.

22. Tarasevicius S, Smailys A, Grigaitis K, Robertsson O, Stucinskas J. Short-term outcome after total hip arthroplasty using dual-mobility cup: report from Lithuanian Arthroplasty Register. *International orthopaedics.* 2017;41(3):595-598.

23. Prudhon JL, Verdier R, Caton JH. Low friction arthroplasty and dual mobility cup: a new gold standard. *International orthopaedics.* 2017;41(3):563-571.

24. Perfetti DC, Schwarzkopf R, Buckland AJ, Paulino CB, Vigdorchik JM. Prosthetic Dislocation and Revision After Primary Total Hip Arthroplasty in Lumbar Fusion Patients: A Propensity Score Matched-Pair Analysis. *The Journal of arthroplasty.* 2017;32(5):1635-1640.e1631.

25. Kurtz SM, Lau E, Baykal D, Springer BD. Outcomes of Ceramic Bearings After Primary Total Hip Arthroplasty in the Medicare Population. *The Journal of arthroplasty.* 2017;32(3):743-749.

26. Charles R, LaTulip S, Goulet JA, Pour AE. Previous arthroscopic repair of femoro-acetabular impingement does not affect outcomes of total hip arthroplasty. *International orthopaedics.* 2017;41(6):1125-1129.

27. Sadhu A, Nam D, Coobs BR, Barrack TN, Nunley RM, Barrack RL. Acetabular Component Position and the Risk of Dislocation Following Primary and Revision Total Hip Arthroplasty: A Matched Cohort Analysis. *The Journal of arthroplasty.* 2017;32(3):987-991.

28. Werner BC, Higgins MD, Pehlivan HC, Carothers JT, Browne JA. Super Obesity Is an Independent Risk Factor for Complications After Primary Total Hip Arthroplasty. *The Journal of arthroplasty.* 2017;32(2):402-406.

29. Cafri G, Paxton EW, Love R, Bini SA, Kurtz SM. Is There a Difference in Revision Risk Between Metal and Ceramic Heads on Highly Crosslinked Polyethylene Liners? *Clinical orthopaedics and related research.* 2017;475(5):1349-1355.

30. Ancelin D, Reina N, Cavaignac E, Delclaux S, Chiron P. Total hip arthroplasty survival in femoral head avascular necrosis versus primary hip osteoarthritis: Case-control study with a mean 10-year follow-up after anatomical cementless metal-on-metal 28-mm replacement. *Orthopaedics & traumatology, surgery & research : OTSR.* 2016;102(8):1029-1034.

31. Lee S-W, Kim W-Y, Kang M-S. Primary total hip arthroplasty using modified posterior approach through quadratus femoris flap osteotomy; comparison with conventional posterior approach. *Hip international : the journal of clinical and experimental research on hip pathology and therapy.* 2016;26(6):543-549.

32. Sing DC, Barry JJ, Aguilar TU, et al. Prior Lumbar Spinal Arthrodesis Increases Risk of Prosthetic-Related Complication in Total Hip Arthroplasty. *The Journal of arthroplasty.* 2016;31(9 Suppl):227-232.e221.

33. Blizzard DJ, Klement MR, Penrose CT, Sheets CZ, Bolognesi MP, Seyler TM. Cervical Myelopathy Doubles the Rate of Dislocation and Fracture After Total Hip Arthroplasty. *The Journal of arthroplasty.* 2016;31(9 Suppl):242-247.

34. Menendez ME, Ring D, Barnes CL. Inpatient Dislocation After Primary Total Hip Arthroplasty. *The Journal of arthroplasty.* 2016;31(12):2889-2893.

35. Malek IA, Royce G, Bhatti SU, et al. A comparison between the direct anterior and posterior approaches for total hip arthroplasty: the role of an 'Enhanced Recovery' pathway. *The bone & joint journal.* 2016;98-B(6):754-760.

36. Wagner ER, Kamath AF, Fruth KM, Harmsen WS, Berry DJ. Effect of Body Mass Index on Complications and Reoperations After Total Hip Arthroplasty. *The Journal of bone and joint surgery American volume.* 2016;98(3):169-179.

37. Opperer M, Lee Y-y, Nally F, Blanes Perez A, Goudarz-Mehdikhani K, Gonzalez Della Valle A. A critical analysis of radiographic factors in patients who develop dislocation after elective primary total hip arthroplasty. *International orthopaedics.* 2016;40(4):703-708.

38. Garcia-Rey E, Garcia-Cimbrelo E. Abductor Biomechanics Clinically Impact the Total Hip Arthroplasty Dislocation Rate: A Prospective Long-Term Study. *The Journal of arthroplasty.* 2016;31(2):484-490.

39. Haughom BD, Plummer DR, Moric M, Della Valle CJ. Is There a Benefit to Head Size Greater Than 36 mm in Total Hip Arthroplasty? *The Journal of arthroplasty.* 2016;31(1):152-155.

40. Fujishiro T, Hiranaka T, Hashimoto S, et al. The effect of acetabular and femoral component version on dislocation in primary total hip arthroplasty. *International orthopaedics.* 2016;40(4):697-702.

41. Abdel MP, von Roth P, Jennings MT, Hanssen AD, Pagnano MW. What Safe Zone? The Vast Majority of Dislocated THAs Are Within the Lewinnek Safe Zone for Acetabular Component Position. *Clinical orthopaedics and related research.* 2016;474(2):386-391.

42. Spaans EA, Spaans AJ, van den Hout JAAM, Bolder SBT. The result of transmuscular versus transosseous repair of the posterior capsule on early dislocations in primary hip arthroplasty. *Hip international : the journal of clinical and experimental research on hip pathology and therapy.* 2015;25(6):537-542.

43. Pitto RP, Garland M, Sedel L. Are ceramic-on-ceramic bearings in total hip arthroplasty associated with reduced revision risk for late dislocation? *Clinical orthopaedics and related research.* 2015;473(12):3790-3795.

44. Jamsen E, Peltola M, Puolakka T, Eskelinen A, Lehto MUK. Surgical outcomes of hip and knee arthroplasties for primary osteoarthritis in patients with Alzheimer's disease: a nationwide registry-based case-controlled study. *The bone & joint journal.* 2015;97-B(5):654-661.

45. Sheth D, Cafri G, Inacio MCS, Paxton EW, Namba RS. Anterior and Anterolateral Approaches for THA Are Associated With Lower Dislocation Risk Without Higher Revision Risk. *Clinical orthopaedics and related research.* 2015;473(11):3401-3408.

46. Maisongrosse P, Lepage B, Cavaignac E, et al. Obesity is no longer a risk factor for dislocation after total hip arthroplasty with a double-mobility cup. *International orthopaedics.* 2015;39(7):1251-1258.

47. Sanz-Reig J, Lizaur-Utrilla A, Miralles-Munoz F. [Risk factors for total hip arthroplasty dislocation and its functional outcomes]. *Factores de riesgo de luxacion de artroplastia total de cadera primaria y su resultado funcional.* 2015;59(1):19-25.

48. Delaunay C. Effect of hydroxyapatite coating on the radio-clinical results of a grit-blasted titanium alloy femoral taper. A case-control study of 198 cementless primary total hip arthroplasty with the AlloclassicTM system. *Orthopaedics & traumatology, surgery & research : OTSR.* 2014;100(7):739-744.

49. Insull PJ, Cobbett H, Frampton CM, Munro JT. The use of a lipped acetabular liner decreases the rate of revision for instability after total hip replacement: a study using data from the New Zealand Joint Registry. *The bone & joint journal.* 2014;96-B(7):884-888.

50. Kaneko T, Hirakawa K, Fushimi K. Relationship between peri-operative outcomes and hospital surgical volume of total hip arthroplasty in Japan. *Health policy (Amsterdam, Netherlands).* 2014;117(1):48-53.

51. Caton JH, Prudhon JL, Ferreira A, Aslanian T, Verdier R. A comparative and retrospective study of three hundred and twenty primary Charnley type hip replacements with a minimum follow up of ten years to assess whether a dual mobility cup has a decreased dislocation risk. *International orthopaedics.* 2014;38(6):1125-1129.

52. Jamsen E, Puolakka T, Peltola M, Eskelinen A, Lehto MUK. Surgical outcomes of primary hip and knee replacements in patients with Parkinson's disease: a nationwide registry-based case-controlled study. *The bone & joint journal.* 2014;96-B(4):486-491.

53. Gerhardt DMJM, Bisseling P, de Visser E, van Susante JLC. Modular necks in primary hip arthroplasty without anatomical deformity: no clear benefit on restoration of hip geometry and dislocation rate. An exploratory study. *The Journal of arthroplasty.* 2014;29(8):1553-1558.

54. Ravi B, Croxford R, Hollands S, et al. Increased risk of complications following total joint arthroplasty in patients with rheumatoid arthritis. *Arthritis & rheumatology (Hoboken, NJ).* 2014;66(2):254-263.

55. Jameson SS, Mason J, Baker P, et al. A comparison of surgical approaches for primary hip arthroplasty: a cohort study of patient reported outcome measures (PROMs) and early revision using linked national databases. *The Journal of arthroplasty.* 2014;29(6):1248-1255.e1241.

56. Bergh C, Fenstad AM, Furnes O, et al. Increased risk of revision in patients with non-traumatic femoral head necrosis. *Acta orthopaedica.* 2014;85(1):11-17.

57. Nakashima Y, Hirata M, Akiyama M, et al. Combined anteversion technique reduced the dislocation in cementless total hip arthroplasty. *International orthopaedics.* 2014;38(1):27-32.

58. Kostensalo I, Junnila M, Virolainen P, et al. Effect of femoral head size on risk of revision for dislocation after total hip arthroplasty: a population-based analysis of 42,379 primary procedures from the Finnish Arthroplasty Register. *Acta orthopaedica.* 2013;84(4):342-347.

59. Leichtle UG, Leichtle CI, Taslaci F, Reize P, Wunschel M. Dislocation after total hip arthroplasty: risk factors and treatment options. *Acta orthopaedica et traumatologica turcica.* 2013;47(2):96-103.

60. Lachiewicz PF, Soileau ES. Low early and late dislocation rates with 36- and 40-mm heads in patients at high risk for dislocation. *Clinical orthopaedics and related research.* 2013;471(2):439-443.

61. Lindgren V, Garellick G, Karrholm J, Wretenberg P. The type of surgical approach influences the risk of revision in total hip arthroplasty: a study from the Swedish Hip Arthroplasty Register of 90,662 total hipreplacements with 3 different cemented prostheses. *Acta orthopaedica.* 2012;83(6):559-565.

62. Howie DW, Holubowycz OT, Middleton R, Large Articulation Study G. Large femoral heads decrease the incidence of dislocation after total hip arthroplasty: a randomized controlled trial. *The Journal of bone and joint surgery American volume.* 2012;94(12):1095-1102.

63. Zhang Z-j, Zhao X-y, Kang Y, et al. The influence of body mass index on life quality and clinical improvement after total hip arthroplasty. *Journal of orthopaedic science : official journal of the Japanese Orthopaedic Association.* 2012;17(3):219-225.

64. Davis AM, Wood AM, Keenan ACM, Brenkel IJ, Ballantyne JA. Does body mass index affect clinical outcome post-operatively and at five years after primary unilateral total hip replacement performed for osteoarthritis? A multivariate analysis of prospective data. *The Journal of bone and joint surgery British volume.* 2011;93(9):1178-1182.

65. Lazarinis S, Karrholm J, Hailer NP. Effects of hydroxyapatite coating on survival of an uncemented femoral stem. A Swedish Hip Arthroplasty Register study on 4,772 hips. *Acta orthopaedica.* 2011;82(4):399-404.

66. Molli RG, Lombardi AV, Jr., Berend KR, Adams JB, Sneller MA. Metal-on-metal vs metal-on-improved polyethylene bearings in total hip arthroplasty. *The Journal of arthroplasty.* 2011;26(6 Suppl):8-13.

67. Edmunds CT, Boscainos PJ. Effect of surgical approach for total hip replacement on hip function using Harris Hip scores and Trendelenburg's test. A retrospective analysis. *The surgeon : journal of the Royal Colleges of Surgeons of Edinburgh and Ireland.* 2011;9(3):124-129.

68. Clement ND, Muzammil A, Macdonald D, Howie CR, Biant LC. Socioeconomic status affects the early outcome of total hip replacement. *The Journal of bone and joint surgery British volume.* 2011;93(4):464-469.

69. Peter R, Lubbeke A, Stern R, Hoffmeyer P. Cup size and risk of dislocation after primary total hip arthroplasty. *The Journal of arthroplasty.* 2011;26(8):1305-1309.

70. Bouchet R, Mercier N, Saragaglia D. Posterior approach and dislocation rate: a 213 total hip replacements case-control study comparing the dual mobility cup with a conventional 28-mm metal head/polyethylene prosthesis. *Orthopaedics & traumatology, surgery & research : OTSR.* 2011;97(1):2-7.

71. Makela KT, Hakkinen U, Peltola M, Linna M, Kroger H, Remes V. The effect of hospital volume on length of stay, re-admissions, and complications of total hip arthroplasty. *Acta orthopaedica.* 2011;82(1):20-26.

72. Dudda M, Gueleryuez A, Gautier E, Busato A, Roeder C. Risk factors for early dislocation after total hip arthroplasty: a matched case-control study. *Journal of orthopaedic surgery (Hong Kong).* 2010;18(2):179-183.

73. Krenzel BA, Berend ME, Malinzak RA, et al. High preoperative range of motion is a significant risk factor for dislocation in primary total hip arthroplasty. *The Journal of arthroplasty.* 2010;25(6 Suppl):31-35.

74. Amlie E, Hovik O, Reikeras O. Dislocation after total hip arthroplasty with 28 and 32-mm femoral head. *Journal of orthopaedics and traumatology : official journal of the Italian Society of Orthopaedics and Traumatology.* 2010;11(2):111-115.

75. Soohoo NF, Farng E, Lieberman JR, Chambers L, Zingmond DS. Factors that predict short-term complication rates after total hip arthroplasty. *Clinical orthopaedics and related research.* 2010;468(9):2363-2371.

76. Bozic KJ, Ong K, Lau E, et al. Risk of complication and revision total hip arthroplasty among Medicare patients with different bearing surfaces. *Clinical orthopaedics and related research.* 2010;468(9):2357-2362.

77. Kim Y-H, Choi Y, Kim J-S. Influence of patient-, design-, and surgery-related factors on rate of dislocation after primary cementless total hip arthroplasty. *The Journal of arthroplasty.* 2009;24(8):1258-1263.

78. Sexton SA, Walter WL, Jackson MP, De Steiger R, Stanford T. Ceramic-on-ceramic bearing surface and risk of revision due to dislocation after primary total hip replacement. *The Journal of bone and joint surgery British volume.* 2009;91(11):1448-1453.

79. Hooper GJ, Rothwell AG, Stringer M, Frampton C. Revision following cemented and uncemented primary total hip replacement: a seven-year analysis from the New Zealand Joint Registry. *The Journal of bone and joint surgery British volume.* 2009;91(4):451-458.

80. Lubbeke A, Suva D, Perneger T, Hoffmeyer P. Influence of preoperative patient education on the risk of dislocation after primary total hip arthroplasty. *Arthritis and rheumatism.* 2009;61(4):552-558.

81. Palan J, Beard DJ, Murray DW, Andrew JG, Nolan J. Which approach for total hip arthroplasty: anterolateral or posterior? *Clinical orthopaedics and related research.* 2009;467(2):473-477.

82. Blom AW, Rogers M, Taylor AH, Pattison G, Whitehouse S, Bannister GC. Dislocation following total hip replacement: the Avon Orthopaedic Centre experience. *Annals of the Royal College of Surgeons of England.* 2008;90(8):658-662.

83. Conroy JL, Whitehouse SL, Graves SE, Pratt NL, Ryan P, Crawford RW. Risk factors for revision for early dislocation in total hip arthroplasty. *The Journal of arthroplasty.* 2008;23(6):867-872.

84. Grant JA, Viens N, Bolognesi MP, Olson SA, Cook CE. Two-year outcomes in primary THA in obese male veterans administration medical center patients. *Rheumatology international.* 2008;28(11):1105-1109.

85. Andrew JG, Palan J, Kurup HV, Gibson P, Murray DW, Beard DJ. Obesity in total hip replacement. *The Journal of bone and joint surgery British volume.* 2008;90(4):424-429.

86. Tsai S-J, Wang C-T, Jiang C-C. The effect of posterior capsule repair upon post-operative hip dislocation following primary total hip arthroplasty. *BMC musculoskeletal disorders.* 2008;9:29.

87. Sadr Azodi O, Adami J, Lindstrom D, Eriksson KO, Wladis A, Bellocco R. High body mass index is associated with increased risk of implant dislocation following primary total hip replacement: 2,106 patients followed for up to 8 years. *Acta orthopaedica.* 2008;79(1):141-147.

88. Arthursson AJ, Furnes O, Espehaug B, Havelin LI, Soreide JA. Prosthesis survival after total hip arthroplasty--does surgical approach matter? Analysis of 19,304 Charnley and 6,002 Exeter primary total hip arthroplasties reported to the Norwegian Arthroplasty Register. *Acta orthopaedica.* 2007;78(6):719-729.

89. Peters CL, McPherson E, Jackson JD, Erickson JA. Reduction in early dislocation rate with large-diameter femoral heads in primary total hip arthroplasty. *The Journal of arthroplasty.* 2007;22(6 Suppl 2):140-144.

90. Lubbeke A, Stern R, Garavaglia G, Zurcher L, Hoffmeyer P. Differences in outcomes of obese women and men undergoing primary total hip arthroplasty. *Arthritis and rheumatism.* 2007;57(2):327-334.

91. Berry DJ, von Knoch M, Schleck CD, Harmsen WS. Effect of femoral head diameter and operative approach on risk of dislocation after primary total hip arthroplasty. *The Journal of bone and joint surgery American volume.* 2005;87(11):2456-2463.

92. Zwartele RE, Brand R, Doets HC. Increased risk of dislocation after primary total hip arthroplasty in inflammatory arthritis: a prospective observational study of 410 hips. *Acta orthopaedica Scandinavica.* 2004;75(6):684-690.

93. Lawton RL, Morrey BF. Dislocation after long-necked total hip arthroplasty. *Clinical orthopaedics and related research.* 2004(422):164-166.

94. Suh KT, Park BG, Choi YJ. A posterior approach to primary total hip arthroplasty with soft tissue repair. *Clinical orthopaedics and related research.* 2004(418):162-167.

95. Bystrom S, Espehaug B, Furnes O, Havelin LI, Norwegian Arthroplasty R. Femoral head size is a risk factor for total hip luxation: a study of 42,987 primary hip arthroplasties from the Norwegian Arthroplasty Register. *Acta orthopaedica Scandinavica.* 2003;74(5):514-524.

96. Weeden SH, Paprosky WG, Bowling JW. The early dislocation rate in primary total hip arthroplasty following the posterior approach with posterior soft-tissue repair. *The Journal of arthroplasty.* 2003;18(6):709-713.

97. van Stralen GMJ, Struben PJ, van Loon CJM. The incidence of dislocation after primary total hip arthroplasty using posterior approach with posterior soft-tissue repair. *Archives of orthopaedic and trauma surgery.* 2003;123(5):219-222.

98. Mahomed NN, Barrett JA, Katz JN, et al. Rates and outcomes of primary and revision total hip replacement in the United States medicare population. *The Journal of bone and joint surgery American volume.* 2003;85-A(1):27-32.

99. von Knoch M, Berry DJ, Harmsen WS, Morrey BF. Late dislocation after total hip arthroplasty. *The Journal of bone and joint surgery American volume.* 2002;84-A(11):1949-1953.

100. Jolles BM, Zangger P, Leyvraz PF. Factors predisposing to dislocation after primary total hip arthroplasty: a multivariate analysis. *The Journal of arthroplasty.* 2002;17(3):282-288.

101. Katz JN, Losina E, Barrett J, et al. Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the United States medicare population. *The Journal of bone and joint surgery American volume.* 2001;83-A(11):1622-1629.

102. Li E, Meding JB, Ritter MA, Keating EM, Faris PM. The natural history of a posteriorly dislocated total hip replacement. *The Journal of arthroplasty.* 1999;14(8):964-968.

103. Woolson ST, Rahimtoola ZO. Risk factors for dislocation during the first 3 months after primary total hip replacement. *The Journal of arthroplasty.* 1999;14(6):662-668.

104. Mallory TH, Lombardi AV, Jr., Fada RA, Herrington SM, Eberle RW. Dislocation after total hip arthroplasty using the anterolateral abductor split approach. *Clinical orthopaedics and related research.* 1999(358):166-172.

105. Inacio MC, Ake CF, Paxton EW, et al. Sex and risk of hip implant failure: assessing total hip arthroplasty outcomes in the United States. *JAMA Intern Med.* 2013;173(6):435-441.

106. Jorgensen CC, Kjaersgaard-Andersen P, Solgaard S, Kehlet H, Lundbeck Foundation Centre for Fast-track H, Knee Replacement Collaborative G. Hip dislocations after 2,734 elective unilateral fast-track total hip arthroplasties: incidence, circumstances and predisposing factors. *Arch Orthop Trauma Surg.* 2014;134(11):1615-1622.

107. Esposito CI, Gladnick BP, Lee YY, et al. Cup position alone does not predict risk of dislocation after hip arthroplasty. *J Arthroplasty.* 2015;30(1):109-113.

108. Chee YH, Teoh KH, Sabnis BM, Ballantyne JA, Brenkel IJ. Total hip replacement in morbidly obese patients with osteoarthritis: results of a prospectively matched study. *J Bone Joint Surg Br.* 2010;92(8):1066-1071.

109. Ibrahim T, Hobson S, Beiri A, Esler CN. No influence of body mass index on early outcome following total hip arthroplasty. *Int Orthop.* 2005;29(6):359-361.

110. Lehman DE, Capello WN, Feinberg JR. Total hip arthroplasty without cement in obese patients. A minimum two-year clinical and radiographic follow-up study. *J Bone Joint Surg Am.* 1994;76(6):854-862.

111. Namba RS, Paxton L, Fithian DC, Stone ML. Obesity and perioperative morbidity in total hip and total knee arthroplasty patients. *J Arthroplasty.* 2005;20(7 Suppl 3):46-50.

112. Paterno SA, Lachiewicz PF, Kelley SS. The influence of patient-related factors and the position of the acetabular component on the rate of dislocation after total hip replacement. *J Bone Joint Surg Am.* 1997;79(8):1202-1210.

113. Hernigou P, Trousselier M, Roubineau F, Bouthors C, Flouzat Lachaniette CH. Dual-mobility or Constrained Liners Are More Effective Than Preoperative Bariatric Surgery in Prevention of THA Dislocation. *Clinical orthopaedics and related research.* 2016;474(10):2202-2210.

114. Houdek MT, Watts CD, Wyles CC, Trousdale RT, Milbrandt TA, Taunton MJ. Total Hip Arthroplasty in Patients with Cerebral Palsy: A Cohort Study Matched to Patients with Osteoarthritis. *J Bone Joint Surg Am.* 2017;99(6):488-493.

115. White RE, Jr., Forness TJ, Allman JK, Junick DW. Effect of posterior capsular repair on early dislocation in primary total hip replacement. *Clin Orthop Relat Res.* 2001(393):163-167.

116. Sierra RJ, Raposo JM, Trousdale RT, Cabanela ME. Dislocation of primary THA done through a posterolateral approach in the elderly. *Clinical orthopaedics and related research.* 2005;441:262-267.

117. Pellicci PM, Bostrom M, Poss R. Posterior approach to total hip replacement using enhanced posterior soft tissue repair. *Clin Orthop Relat Res.* 1998(355):224-228.

118. Carlson DC, Robinson HJ, Jr. Surgical approaches for primary total hip arthroplasty. A prospective comparison of the Marcy modification of the Gibson and Watson-Jones approaches. *Clin Orthop Relat Res.* 1987(222):161-166.

119. Roberts JM, Fu FH, McClain EJ, Ferguson AB, Jr. A comparison of the posterolateral and anterolateral approaches to total hip arthroplasty. *Clin Orthop Relat Res.* 1984(187):205-210.

120. Robinson RP, Robinson HJ, Jr., Salvati EA. Comparison of the transtrochanteric and posterior approaches for total hip replacement. *Clin Orthop Relat Res.* 1980(147):143-147.

121. Vicar AJ, Coleman CR. A comparison of the anterolateral, transtrochanteric, and posterior surgical approaches in primary total hip arthroplasty. *Clin Orthop Relat Res.* 1984(188):152-159.

122. Weaver JK. Total hip replacement: a comparison between the transtrochanteric and posterior surgical approaches. *Clin Orthop Relat Res.* 1975(112):201-207.

123. Barrett WP, Turner SE, Leopold JP. Prospective randomized study of direct anterior vs postero-lateral approach for total hip arthroplasty. *J Arthroplasty.* 2013;28(9):1634-1638.

124. Cheng TE, Wallis JA, Taylor NF, et al. A Prospective Randomized Clinical Trial in Total Hip Arthroplasty-Comparing Early Results Between the Direct Anterior Approach and the Posterior Approach. *The Journal of arthroplasty.* 2017;32(3):883-890.

125. Rosenlund S, Broeng L, Holsgaard-Larsen A, Jensen C, Overgaard S. Patient-reported outcome after total hip arthroplasty: comparison between lateral and posterior approach. *Acta Orthop.* 2017;88(3):239-247.

126. Martin CT, Pugely AJ, Gao Y, Clark CR. A comparison of hospital length of stay and short-term morbidity between the anterior and the posterior approaches to total hip arthroplasty. *J Arthroplasty.* 2013;28(5):849-854.

127. Laffosse JM, Chiron P, Tricoire JL, Giordano G, Molinier F, Puget J. [Prospective and comparative study of minimally invasive posterior approach versus standard posterior approach in total hip replacement]. *Rev Chir Orthop Reparatrice Appar Mot.* 2007;93(3):228-237.

128. Rodriguez JA, Deshmukh AJ, Rathod PA, et al. Does the direct anterior approach in THA offer faster rehabilitation and comparable safety to the posterior approach? *Clin Orthop Relat Res.* 2014;472(2):455-463.

129. Faldini C, Perna F, Mazzotti A, et al. Direct anterior approach versus posterolateral approach in total hip arthroplasty: effects on early post-operative rehabilitation period. *J Biol Regul Homeost Agents.* 2017;31(4 suppl 1):75-81.

130. Rathod PA, Bhalla S, Deshmukh AJ, Rodriguez JA. Does fluoroscopy with anterior hip arthroplasty decrease acetabular cup variability compared with a nonguided posterior approach? *Clin Orthop Relat Res.* 2014;472(6):1877-1885.

131. Tripuraneni KR, Munson NR, Archibeck MJ, Carothers JT. Acetabular Abduction and Dislocations in Direct Anterior vs Posterior Total Hip Arthroplasty: A Retrospective, Matched Cohort Study. *J Arthroplasty.* 2016;31(10):2299-2302.

132. Tsukada S, Wakui M. Lower Dislocation Rate Following Total Hip Arthroplasty via Direct Anterior Approach than via Posterior Approach: Five-Year-Average Follow-Up Results. *Open Orthop J.* 2015;9:157-162.

133. Amlie E, Havelin LI, Furnes O, et al. Worse patient-reported outcome after lateral approach than after anterior and posterolateral approach in primary hip arthroplasty. A cross-sectional questionnaire study of 1,476 patients 1-3 years after surgery. *Acta Orthop.* 2014;85(5):463-469.

134. Downing ND, Clark DI, Hutchinson JW, Colclough K, Howard PW. Hip abductor strength following total hip arthroplasty: a prospective comparison of the posterior and lateral approach in 100 patients. *Acta Orthop Scand.* 2001;72(3):215-220.

135. Homma Y, Baba T, Kobayashi H, et al. Benefit and risk in short term after total hip arthroplasty by direct anterior approach combined with dual mobility cup. *European journal of orthopaedic surgery & traumatology : orthopedie traumatologie.* 2016;26(6):619-624.

136. Chiu FY, Chen CM, Chung TY, Lo WH, Chen TH. The effect of posterior capsulorrhaphy in primary total hip arthroplasty: a prospective randomized study. *The Journal of arthroplasty.* 2000;15(2):194-199.

137. Goldstein WM, Gleason TF, Kopplin M, Branson JJ. Prevalence of dislocation after total hip arthroplasty through a posterolateral approach with partial capsulotomy and capsulorrhaphy. *J Bone Joint Surg Am.* 2001;83-A Suppl 2(Pt 1):2-7.

138. Kim YS, Kwon SY, Sun DH, Han SK, Maloney WJ. Modified posterior approach to total hip arthroplasty to enhance joint stability. *Clinical orthopaedics and related research.* 2008;466(2):294-299.

139. Tarasevicius S, Kesteris U, Kalesinskas RJ, Wingstrand H. Dynamics of hip joint effusion after posterior soft tissue repair in total hip arthroplasty. *Int Orthop.* 2006;30(4):233-236.

140. Tarasevicius S, Robertsson O, Wingstrand H. Posterior soft tissue repair in total hip arthroplasty: a randomized controlled trial. *Orthopedics.* 2010;33(12):871.

141. Cobb TK, Morrey BF, Ilstrup DM. The elevated-rim acetabular liner in total hip arthroplasty: relationship to postoperative dislocation. *J Bone Joint Surg Am.* 1996;78(1):80-86.

142. Hedlundh U, Ahnfelt L, Hybbinette CH, Weckstrom J, Fredin H. Surgical experience related to dislocations after total hip arthroplasty. *J Bone Joint Surg Br.* 1996;78(2):206-209.

143. Stroh DA, Issa K, Johnson AJ, Delanois RE, Mont MA. Reduced dislocation rates and excellent functional outcomes with large-diameter femoral heads. *J Arthroplasty.* 2013;28(8):1415-1420.

144. Epinette J-A. Clinical outcomes, survivorship and adverse events with mobile-bearings versus fixed-bearings in hip arthroplasty-a prospective comparative cohort study of 143 ADM versus 130 trident cups at 2 to 6-year follow-up. *The Journal of arthroplasty.* 2015;30(2):241-248.

145. Kelley SS, Lachiewicz PF, Hickman JM, Paterno SM. Relationship of femoral head and acetabular size to the prevalence of dislocation. *Clinical orthopaedics and related research.* 1998(355):163-170.

146. Surace MF, Monestier L, D'Angelo F, Bertagnon A. Factors Predisposing to Dislocation After Primary Total Hip Arthroplasty: A Multivariate Analysis of Risk Factors at 7 to 10 Years Follow-up. *Surgical technology international.* 2016;30:274-278.

147. Karrholm J, Herberts P, Garellick G. [Increasing incidence of early reoperation of dislocation after primary hip arthroplasty. An analysis of the national hip arthroplasty registry]. *Tidig omoperation for luxation av primar hoftprotes okar En analys av nationella hoftprotesregistret.* 2006;103(36):2547-2550.

148. Ravi B, Jenkinson R, Austin PC, et al. Relation between surgeon volume and risk of complications after total hip arthroplasty: propensity score matched cohort study. *BMJ (Clinical research ed).* 2014;348:g3284.

149. Prietzel T, Hammer N, Schleifenbaum S, et al. [The impact of capsular repair on the dislocation rate after primary total hip arthroplasty: a retrospective analysis of 1972 cases]. *Der Einfluss der Kapselrekonstruktion auf die Luxationsrate nach primarer Huftendoprothetik: eine retrospektive Analyse von 1972 Fallen.* 2014;152(2):130-143.

Appendix 7. Characteristics of studies included in review

Author, year of publication	Year of study	Country	Mean/median age (years)	Study design	% Males	Mean/median follow-up duration (years)	No. of participants	No. of dislocations	Study quality
Salib, 2019	1988-2015	USA	71·0	Retrospective cohort	44·0	6·0	291	9	8
Angerame, 2018	2007-2014	USA	60·2	Retrospective cohort	40·5	0·8	6894	26	8
Giardina, 2018	2000-2016	Italy	61·9-67·5	Retrospective cohort	27·4	7·0	57 359	376	6
Ponzio, 2018	2010-2012	USA	64·7	Retrospective cohort	44·6	4-6	4538	66	8
Hwang, 2018	2013-2015	South Korea	72·0	Prospective cohort	30·5	1·8	167	4	8
Gausden, 2018	2012-2014	USA	64·5	Retrospective cohort	45·1	40 days	207 285	2842	6
Rondon, 2018	2000-2016	USA	69·3	Retrospective cohort	55·0	5·3	145	4	8
Li, 2018	2010-2012	China	42·8	Retrospective cohort	56·0	5·7	141	4	7
Malkani, 2018	1997-2014	USA	65-85+	Retrospective cohort	65-85+*	Up to 10·0	62 387	3042	7
Seagrave, 2017	2010-2015	Denmark	NR	Retrospective cohort	NR	1·9	1326	59	6
Cheng, 2017	2014-2015	Australia	61·0	RCT	45·0	12 weeks	73	2	NA
Rosenlund, 2017	2012-2014	Denmark	61·0	RCT	67·5	1·0	77	1	NA
Graves, 2017	1999-2014	Australia	NR	Retrospective cohort	NR	10·0	262 454	2023	7
Utsunomiya, 2017	1998-2010	Japan	57·8	Retrospective cohort	50·0	8·3	44	4	6
Shah, 2017	1999-2014	Australia	NR	Prospective cohort	NR	13·0	192 275	1219	7
Mjaaland, 2017	2008-2013	Norway	65·0	Prospective cohort	37·1	4·3	21 860	154	7
Abdel, 2017	2004-2006	USA	66·0	RCT	44·4	8·5	71	5	NA
Gofton, 2017	2005-2012	USA	62·2	Prospective cohort	45·0	5·7	809	9	8
Buckland, 2017	2005-2012	USA	<65-85+	Retrospective cohort	38·5	1·0	853 677	13 446	6
Houdek, 2017	1990-2013	USA	49·0	Prospective cohort	66·7	7·0	117	6	6
Faldini, 2017	2014-2017	Italy	64·5	Retrospective cohort	41·7	0·5	127	1	6
Zijlstra, 2017	2007-2015	Netherlands	60-74	Prospective cohort	NR	6·0	166 231	1095	6
Meneghini, 2017	2011-2014	USA	61·9	Retrospective cohort	46·5	5·0	342	40	8
Tarasevicius, 2017	2011-2014	Lithuania	67·4	Prospective cohort	36·7	2·5	2790	56	8
Prudhon, 2017	1994-2015	France	69·3	Retrospective cohort	37·6	13·5	1091	57	6
Perfetti, 2017	2005-2015	USA	64·5	Retrospective cohort	38·3	1·0	1868	32	7
Kurtz, 2017	2005-2014	USA	74·3	Retrospective cohort	38·0	9·0	315 784	4737	7
Charles, 2017***	2008-2013	USA	43·1	Case-control	35·9	4·2	78	2	6
Sadhu, 2017***	1997-2013	USA	59·5	Retrospective cohort	45·8	1·1	192	96	7
Werner, 2017	2005-2012	USA	<65-80+	Retrospective cohort	<65-80+	90 days	891 567	12 447	8
Cafri, 2017	2001-2013	USA	67·0	Retrospective cohort	43·0	1·0	28 772	236	8
Ancelin, 2016	1997-2007	France	47·8	Prospective cohort	47·8	11·4	282	9	7
Lee, 2016	2006-2013	Korea	49·0	Retrospective cohort	60·7	2·0	258	6	7

Author, year of publication	Year of study	Country	Mean/median age (years)	Study design	% Males	Mean/median follow-up duration (years)	No. of participants	No. of dislocations	Study quality
Sing, 2016	2005-2012	USA	<65-85+	Retrospective cohort	38·0	2·0	598 995	14 395	8
Blizzard, 2016	2005-2012	USA	<65-85+	Retrospective cohort	38·9	1·0	71 4654	20 551	7
Menendez, 2016	2002-2011	USA	65·9	Retrospective cohort	43·4	5 days	176 5115	2173	7
Malek, 2016	2010-2014	UK	70·5	Retrospective cohort	45·3	1·5	452	2	7
Tripuraneni, 2016	2012-2015	USA	60·2	Retrospective cohort	39·4	1·1	132	3	6
Wagner, 2016	1985-2012	USA	66·0	Prospective cohort	47·0	0·5	21 361	340	8
Hernigou, 2016	1990-2000	France	72·5	Case-control	39·1	14·0	430	36	6
Homma, 2016	2011-2015	Japan	74·8	Retrospective cohort	16·5	0·5	120	1	7
Opperer, 2016	2005-2014	USA	68·9	Retrospective cohort	48·6	1·5	148	37	8
Garcia-Rey, 2016	1992-2012	Spain	60·1	Retrospective cohort	55·6	2-22	1414	38	8
Surace, 2016	2005-2008	Italy	66·0	Retrospective cohort	45·8	3·5	387	6	5
Haughom, 2016	2002-2012	USA	63·1	Retrospective cohort	52·3	10·0	501	14	6
Fujishiro, 2016	2005-2010	Japan	62·5	Retrospective cohort	16·5	4·4	1555	50	7
Abdel, 2016	2003-2012	USA	63·0	Retrospective cohort	37·0	2·3	9784	206	6
Spaans, 2015	2010-2011	Netherlands	69·9	Retrospective cohort	15·1	1·0	465	8	7
Pitto, 2015	1999-2012	New Zealand	69·0	Prospective cohort	47·0	7·0	73 386	867	8
Epinette, 2015	2007-2011	France	68·2	Prospective cohort	39·0	4·1	273	7	8
Jamsen, 2015	1998-2009	Finland	NR	Prospective cohort	NR	4·2	1780	137	6
Tsukada, 2015	2006-2009	Japan	63·9	Retrospective cohort	13·9	7·5	316	7	6
Sheth, 2015	2001-2011	USA	66·0	Retrospective cohort	42·0	3·0	42 438	276	8
Maisongrosse, 2015	2004-2012	France	76·8	Retrospective cohort	29·2	4·9	502	2	7
Sanz-Reig, 2015	2005-2007	Spain	68·9	Retrospective cohort	40·7	6·8	454	22	7
Esposito, 2015	2007-2012	USA	66·0	Prospective cohort	42·3	0·5	7040	147	8
Delaunay, 2014	1988-2000	France	66·0	Retrospective cohort	56·4	9·8	193	11	7
Insull, 2014	1999-2012	New Zealand	NR	Prospective cohort	NR	NR	12 116	88	7
Kaneko, 2014	2008	Japan	65·2	Retrospective cohort	17·0	35·4 days	8321	117	7
Rathod, 2014***	2006-2011	USA	61·5	Retrospective cohort	44·0	1·9	675	3	7
Amlie, 2014	2008-2010	Norway	66·3	Retrospective cohort	34·4	2·4	1273	39	8
Caton, 2014	2000-2002	France	73·2	Retrospective cohort	42·5	10·0	320	27	7
Jamsen, 2014***	1998-2009	Finland	NR	Retrospective case control	NR	6·0	1188	NR	8
Rodriguez, 2014	2010	USA	59·5	Prospective cohort	45·0	1·0	120	1	7
Gerhardt, 2014	2008-2011	Netherlands	65·0	Retrospective cohort	45·8	1·0	190	8	6
Ravi, 2014c	2002-2009	Canada	68·0	Retrospective cohort	45·2	2·0	43 997	569	8
Jameson, 2014	NR	UK	69·1	Retrospective cohort	42·7	1·0	37 593	55	7
Jorgensen, 2014	2010-2011	Denmark	70·0	Retrospective cohort	45·9	90 days	2734	65	7
Bergh, 2014	1995-2011	Denmark, Finland,	68·9	Retrospective cohort	40·6	6·3	427 806	4222	8

Author, year of publication	Year of study	Country	Mean/median age (years)	Study design	% Males	Mean/median follow-up duration (years)	No. of participants	No. of dislocations	Study quality
		Norway, Sweden							
Ravi, 2014	2002-2009	Canada	68·0	Retrospective cohort	46·1	2·0	37 881	458	8
Prietzel, 2014	2002-2009	Germany	NR	Retrospective cohort	NR	2·8-6·1	1972	28	8
Nakashima, 2014	2006-2011	Japan	63·4	Retrospective cohort	16·8	2·5	634	11	8
Kostensalo, 2013	1996-2010	Finland	18-100	Prospective cohort	43·7	10·0	42 379	472	8
Stroh, 2013	2001-2010	USA	54·0	Retrospective cohort	46·6	5·0	807	10	6
Barrett, 2013	2010-2011	USA	62·3	RCT	55·2	1·0	87	1	NA
Leichtle, 2013***	1984-2005	Germany	NR	Retrospective case control	50·5	NR	111	56	6
Lachiewicz, 2013	2001-2006	USA	78·0	Prospective cohort	31·3	6·5	122	NR	6
Martin, 2013	2005-2010	USA	59·8	Retrospective cohort	40·0	0·5	88	4	7
Inacio, 2013	2001-2010	USA	65·7	Prospective cohort	42·5	3·0	35 140	307	8
Hailer, 2012	2005-2010	Sweden	<50->75*	Retrospective cohort	40·0	2·7	78 098	399	7
Lindgren, 2012	1992-2009	Sweden	70-73	Retrospective cohort	39·6	5·7	90 662	656	8
Howie, 2012	2001-2007	Australia	72·3	RCT	41·3	1·0	533	14	NA
Zhang, 2012***	1991-2006	China	62·2	Retrospective cohort	NR	12·8	307	12	6
Davis, 2011	1998-2005	UK	69·0	Prospective cohort	38·5	5·0	1617	42	8
Lazarinis, 2011	1992-2009	Sweden	NR	Retrospective cohort	49·0	10·0	4772	8	8
Molli, 2011	1996-2006	USA	61·6	Retrospective cohort	47·0	3·8	2368	5	6
Edmunds, 2011	1990-2008	UK	65·7-68·9	Retrospective cohort	35·0	1·0	3416	67	6
Clement, 2011	2006-2008	UK	68·1	Prospective cohort	NR	1·0	1359	29	8
Peter, 2011	1996-2008	Switzerland	70·6	Prospective cohort	44·4	1·0	2734	50	8
Bouchet, 2011	2003-2007	France	75·4	Retrospective cohort	45·5	4·3	213	5	6
Makela, 2011***	1998-2005	Finland	NR	Retrospective cohort	NR	NR	30 266	NR	7
Chee, 2010	1998-2003	UK	63·6	Prospective cohort	22·6	5·0	110	4	6
Dudda, 2010***	1978-2004	Switzerland	70·0	Case-control	34·0	31 days	826	175	7
Krenzel, 2010	1987-2008	USA	67·3	Retrospective cohort	43·9	6·6	3379	94	8
Amlie, 2010	2002-2009	Norway	68·5	Retrospective cohort	25·9	0·5-8	2572	53	8
Soohoo, 2010	1995-2005	USA	66·0	Retrospective cohort	57·0	90 days	138 399	1930	7
Bozic, 2010	2005-2007	USA	74·5	Retrospective cohort	NR	NR	57 047	NR	8
Tarasevicius, 2010	2003-2008	Lithuania	69·0	RCT	NR	1·0	276	10	NA
Kim, 2009	2000-2006	South Korea	57·0	Retrospective cohort	63·4	4·8	1648	60	6
Sexton, 2009	1999-2007	Australia	68·1	Prospective cohort	44·5	7·0	110 239	862	8
Hooper, 2009	1999-2006	New Zealand	<55->75*	Prospective cohort	NR	>90 days	42 665	514	5
Lubbeke, 2009	1998-2007	Switzerland	NR	Prospective cohort	NR	6 months	2601	46	7
Palan, 2009	1999-2002	UK	68·0	Prospective cohort	37·8	5·0	1089	24	6

Author, year of publication	Year of study	Country	Mean/median age (years)	Study design	% Males	Mean/median follow-up duration (years)	No. of participants	No. of dislocations	Study quality
Blom, 2008	1993-1996	UK	NR	Prospective cohort	NR	8 to 11	1567	53	6
Conroy, 2008***	1999-2004	Australia	NR	Prospective cohort	46·3	NR	65 992	531	8
Grant, 2008	NR	USA	56·6	Retrospective cohort	100·0	1·6	255	13	8
Andrew, 2008	1999-2002	UK	68·1	Prospective cohort	37·3	5·0	1421	24	6
Tsai, 2008	2000-2005	Taiwan	59·9	Retrospective cohort	44·6	3·5	204	9	7
Kim, 2008	1997-2005	Korea	47·6	Retrospective cohort	NR	1·0	450	20	6
Sadr, 2008	1997-2004	Sweden	30-80+	Retrospective cohort	NR	2·0	2106	53	8
Laffosse, 2007	NR	France	57·3	Prospective cohort	58·6	0·5	116	2	6
Arthursson, 2007	1987-2004	Norway	71-73	Prospective cohort	29·0	5·6-6·0	25 306	176	8
Peters, 2007	1995-2004	USA	60·0	Prospective cohort	44·0	4·3	296	4	6
Lubbeke, 2007	1996-2005	Switzerland	68·6	Prospective cohort	44·3	5·0	2495	53	8
Karrholm 2006	1992-2004	Sweden	NR	Retrospective cohort	NR	2·0	142 000	644	8
Tarasevicius, 2006	NR	Lithuania	70·0	RCT	63·6	1·0	33	1	NA
Ibrahim, 2005	2000-2002	UK	68·1	Retrospective cohort	33·9	1·0	343	3	5
Namba, 2005	2001-2002	USA	65·4	Retrospective cohort	42·4	1·0	1071	8	6
Berry, 2005	1969-1999	USA	64·0	Prospective cohort	48·8	9·5-10·5	21 047	868	8
Sierra, 2005	1992-2002	USA	83·0	Retrospective cohort	42·0	2·2	150	8	8
Zwartele, 2004	1996-1999	Netherlands	66·9	Prospective cohort	14·0	2·0	410	17	8
Lawton, 2004	1990-1994	USA	NR	Retrospective cohort	NR	NR	250	14	7
Suh, 2004	1993-1998	South Korea	53·4	Retrospective cohort	66·3	1·0	346	17	8
Bystrom, 2003	1987-2000	Norway	72·0	Prospective cohort	29·0	5·3	42 987	311	8
Weeden, 2003	1994-2000	USA	62·3	Retrospective cohort	41·0	4·4	945	8	6
van Stralen, 2003	1995-1998	Netherlands	69·5	Retrospective cohort	26·0	2·5	884	12	6
Mahomed, 2003	1995-1996	USA	≥65*	Retrospective cohort	NR	90 days	61 568	1909	8
von Knoch, 2002	1969-1995	USA	66·0	Retrospective cohort	48·5	11·3	19 680	513	7
Jolles, 2002***	1991-1998	Switzerland	69·0	Retrospective cohort	42·9	NR	42	21	7
Downing, 2001	1995-1997	UK	66·0	Retrospective cohort	45·0	1·0	100	4	6
White, 2001	NR	USA	NR	Case-control	NR	0·5	1515	55	5
Katz, 2001	1995-1996	USA	74·3	Retrospective cohort	36·0	90 days	58 521	1834	7
Goldstein, 2001	1993-1999	USA	NR	Retrospective cohort	NR	1·0	1000	17	6
Chiu, 2000	1994-1997	Taiwan	52·4	RCT	61·7	3·2	180	2	NA
Li, 1999	1989-1992	USA	66·0	Retrospective cohort	50·0	7·0	812	24	6
Woolson, 1999	1985-1995	USA	64·0	Retrospective cohort	50·2	3 months	315	14	7
Mallory, 1999	1992-1996	USA	63·0	Retrospective cohort	46·0	3·0	1518	12	6
Kelley, 1998 Kelley, 1998	1995-1996 1984-1994	USA	63·0	RCT Retrospective cohort	26·7 32·1	1·0 5·4	31 308	5 5	NA 7

Author, year of publication	Year of study	Country	Mean/median age (years)	Study design	% Males	Mean/median follow-up duration (years)	No. of participants	No. of dislocations	Study quality
Pellicci, 1998** (***)	1991-1996	USA	NR	Retrospective cohort	NR	NR	284 (790)	11 (16)	6
Paterno, 1997	1983-1994	USA	58·8-61·2	Retrospective cohort	32·0	5 to 6	391	17	8
Cobb, 1996	1985-1991	USA	NR	Retrospective cohort	NR	2·0	4117	75	6
Hedlundh, 1996***	1979-1991	Sweden	69·3	Retrospective cohort	44·1	NR	4230	129	8
Lehman, 1994	1983-1990	USA	48-52	Retrospective cohort	69·8	2·0	202	6	6
Carlson, 1987	1982-1983	USA	65·2	Retrospective cohort	87·8	16-17 days	74	5	5
Vicar, 1984	1976-1980	USA	64·8	Retrospective cohort	38·4	3·2	269	9	6
Roberts, 1984	1975-1979	USA	60·0	Retrospective cohort	50·0	10 weeks	175	5	6
Robinson, 1980	1972-1978	USA	61·5	Retrospective cohort	41·4	1·6	316	12	7
Weaver, 1975	1969-1973	USA	NR	Retrospective cohort		2·2-3·5	60	4	5

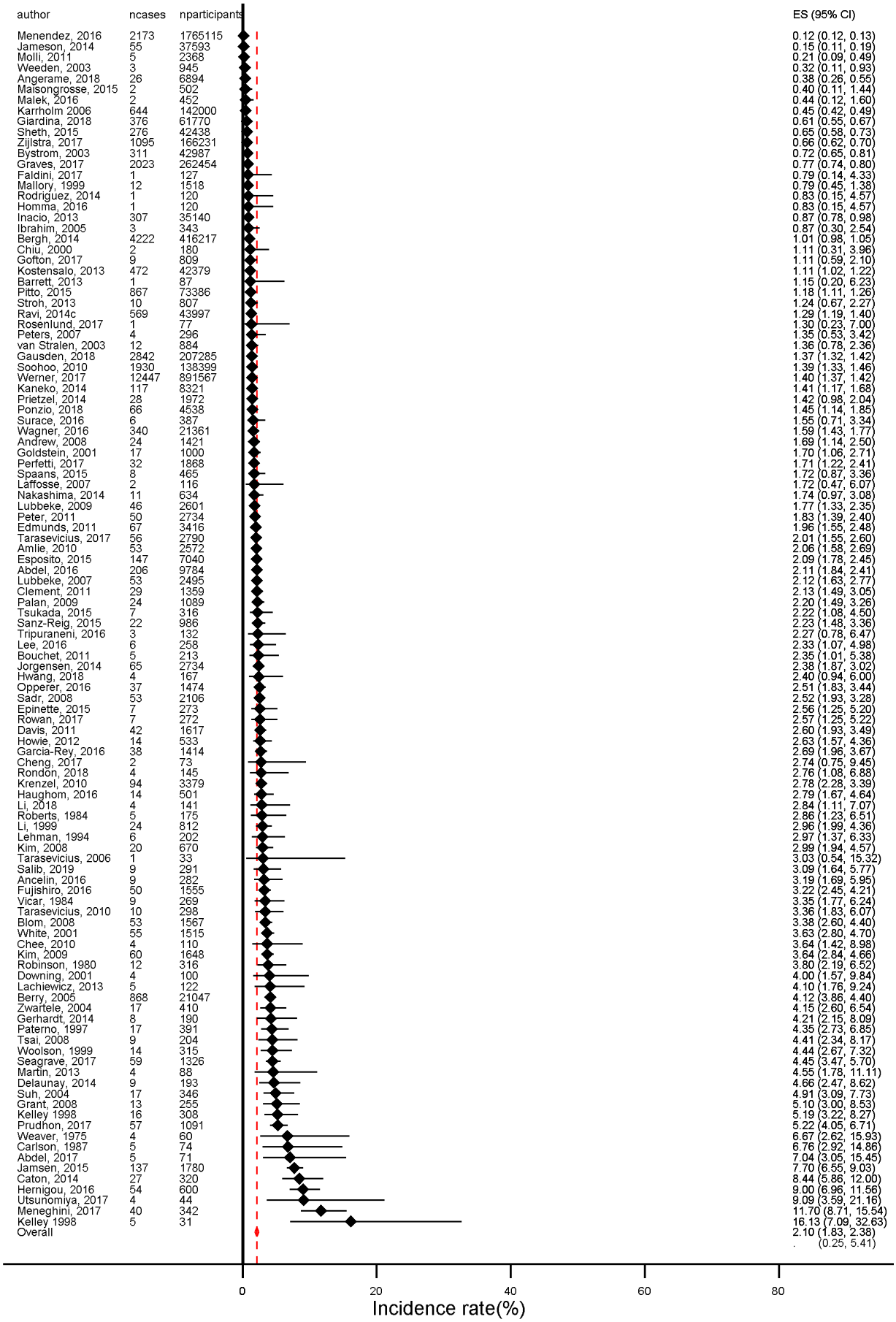
*, age range of participants; **, based on two studies; ***, the following studies were not included in incidence rates calculation because the sample was very selected, there was no data on follow-up duration or there was no data on number of dislocation events; NA, not applicable; NR, not reported; RCT, randomised controlled trial

Appendix 8. Cochrane risk of bias assessment for randomised controlled trials

	Random sequence generation	*Allocation concealment*	*Blinding of participants & personnel*	*Blinding of outcome assessments*	*Incomplete outcome data*	*Selective reporting*	*Other bias*
Kelly, 1998	?	?	-	-	+	+	-
Chiu, 2000	?	?	-	-	+	+	-
Tarasevicius, 2006	?	?	-	-	-	+	-
Tarasevicius, 2010	?	?	-	-	+	+	-
Howie, 2012	+	+	-	-	+	+	?
Barrett, 2013	+	?	-	-	+	+	?
Abdel, 2017	+	+	?	-	+	+	?
Cheng, 2017	+	+	+	+	+	+	?
Rosenlund, 2017	+	+	+	?	+	+	+

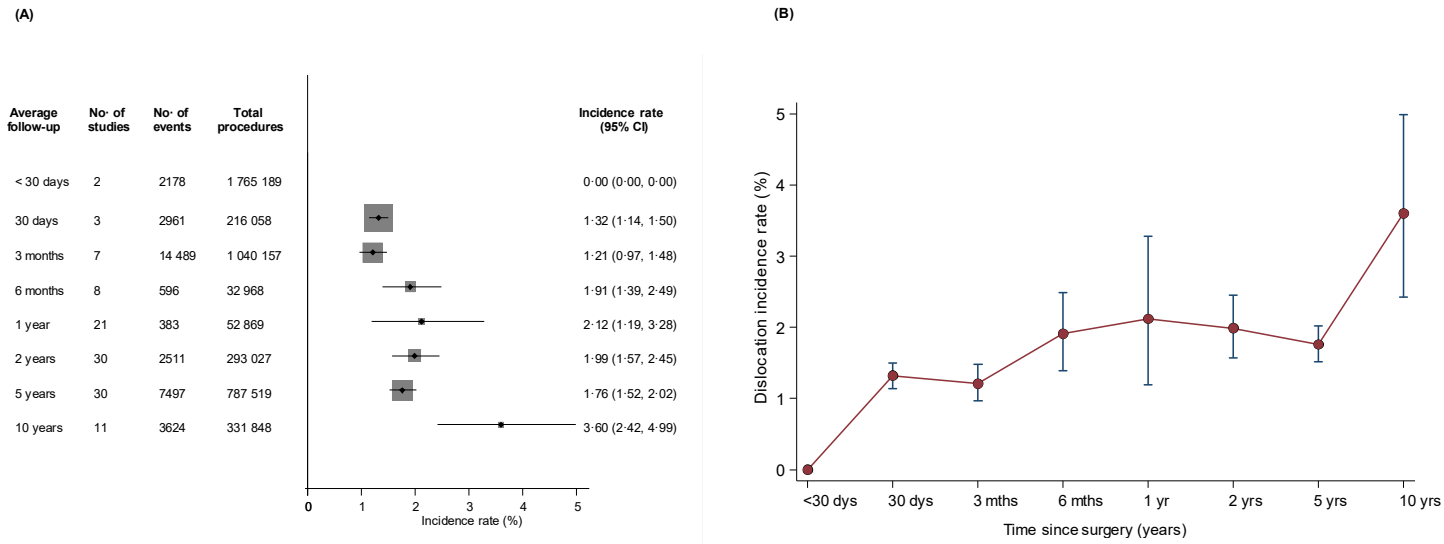
+	Low risk of bias
?	Unclear risk of bias
-	High risk of bias

Appendix 9. Incidence rate of dislocation across 112 relevant studies



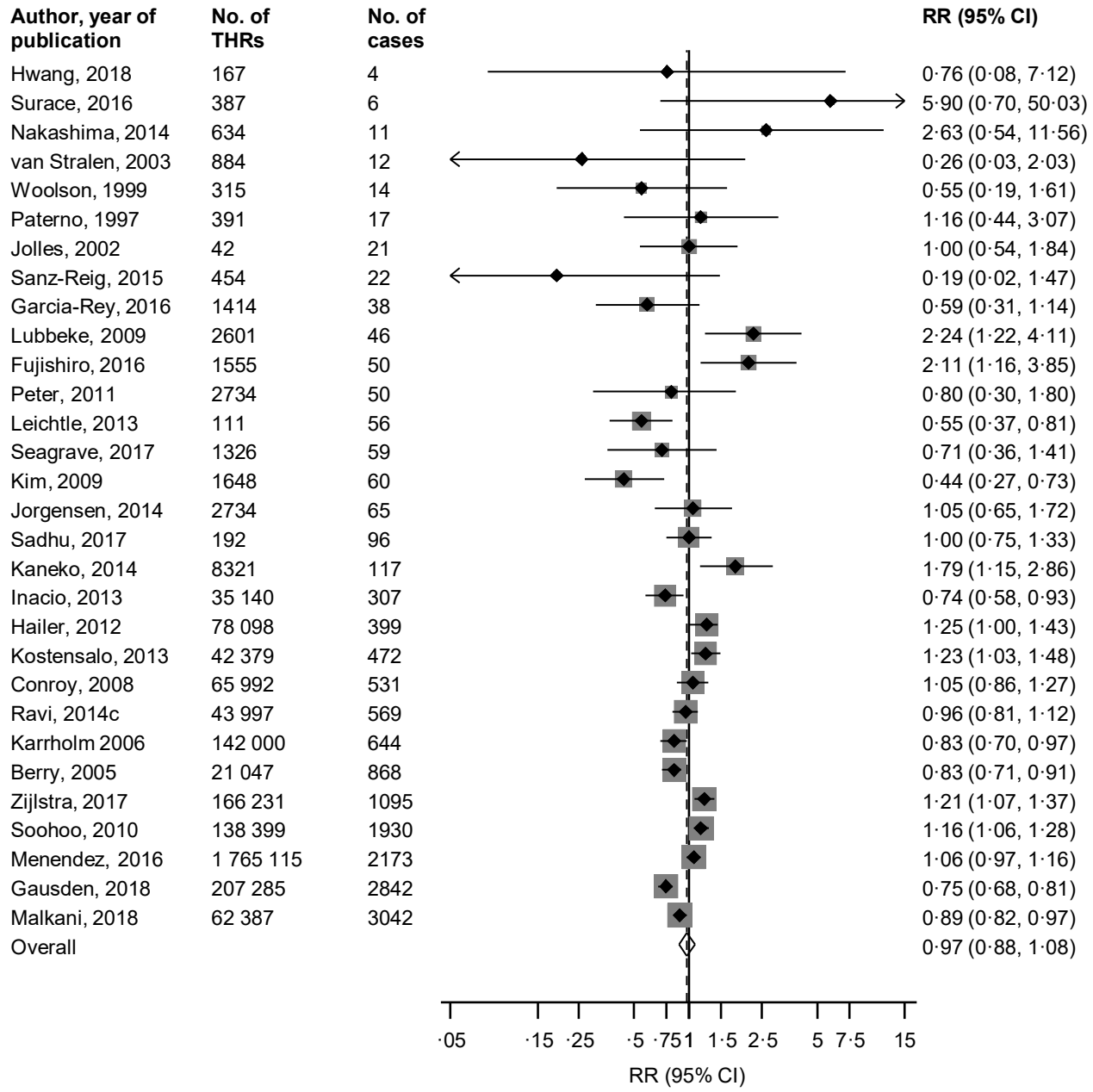
Only unique studies were included in pooled analysis to avoid the potential of double counting

Appendix 10. Incidence of dislocation following primary total hip replacement at specific average follow-up periods



Capped vertical bars represent 95% confidence intervals

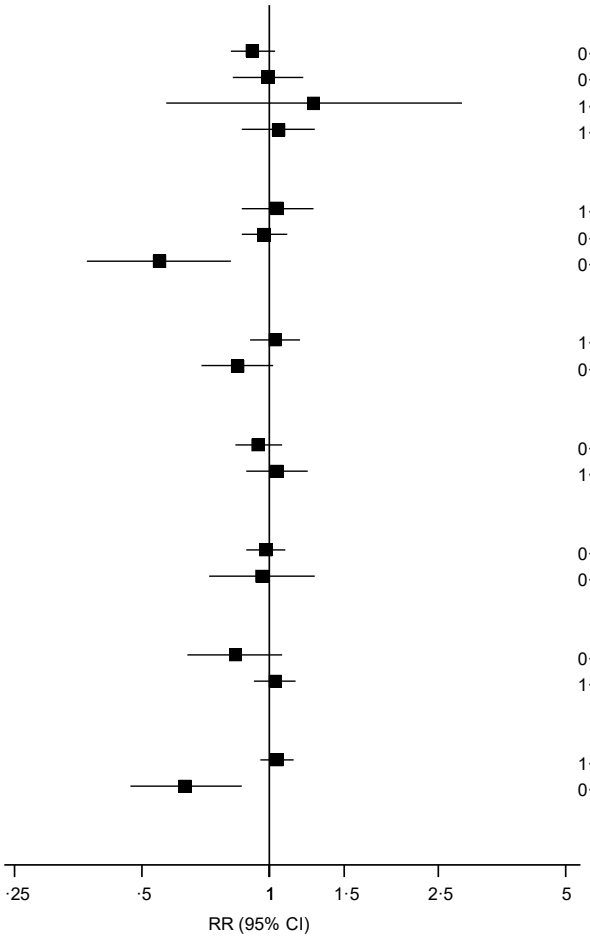
Appendix 11. Risk of dislocation comparing males to females



CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

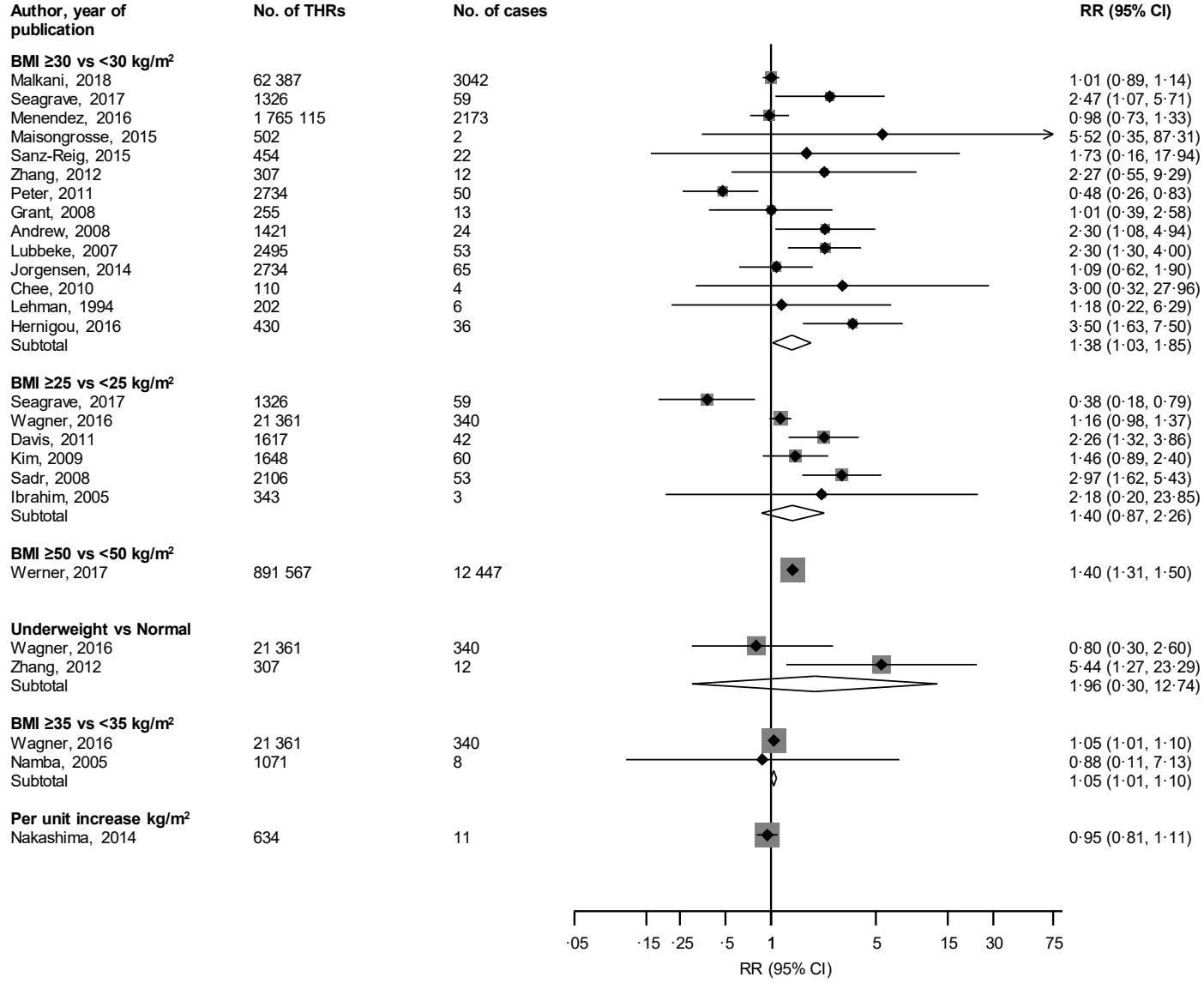
Appendix 12. Risk of dislocation comparing males to females, grouped according to study level characteristics

Subgroup	No. of THRs	No. of cases	RR (95% CI)	*p*-value
Location				
North America	2 274 268	11 858	0·91 (0·81, 1·03)	·53
Europe	441 395	2985	0·99 (0·82, 1·20)	
Asia	12 325	242	1·27 (0·57, 2·85)	
Pacific	65 992	531	1·05 (0·86, 1·28)	
Design				
Prospective cohort	336 291	3373	1·04 (0·86, 1·27)	·10
Restrospective cohort	2 457 578	12 187	0·97 (0·86, 1·10)	
Case-control	111	56	0·55 (0·37, 0·81)	
Average baseline age, yrs				
≥65	1 998 374	5276	1·03 (0·90, 1·18)	·07
<65	234 481	3996	0·84 (0·69, 1·02)	
Type of dislocation				
Dislocation	2 264 140	12 168	0·94 (0·83, 1·07)	·37
Revision for dislocation	529 840	3448	1·04 (0·88, 1·23)	
No· of dislocations				
≥300	2 768 070	14872	0·98 (0·88, 1·09)	·84
< 300	25 910	744	0·96 (0·72, 1·28)	
Degree of adjustment				
Univariate	44 980	746	0·83 (0·64, 1·07)	·04
Multivariate	2 749 000	14 870	1·03 (0·92, 1·15)	
Study quality				
≥7	2 582 339	12 581	1·04 (0·95, 1·14)	<0·001
<7	211 641	3035	0·63 (0·47, 0·86)	



CI, confidence interval (bars); RR, relative risk; *p*-values are for meta-regression

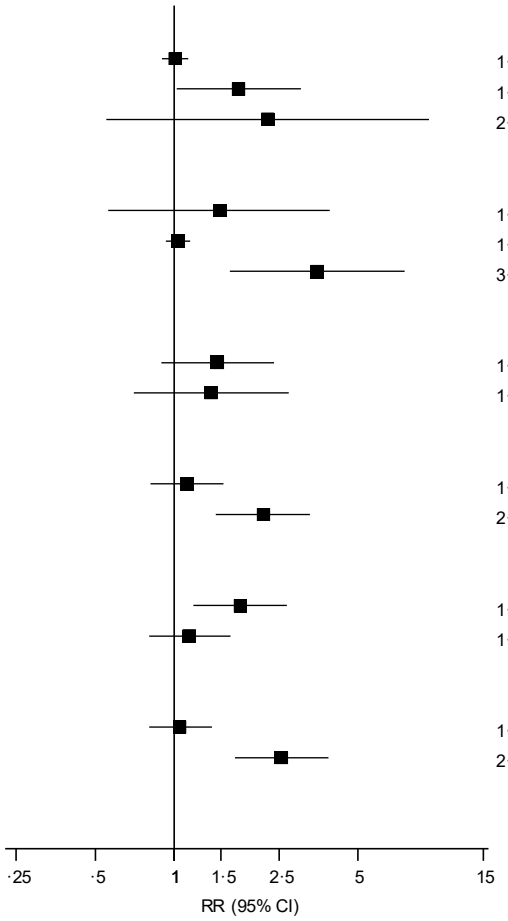
Appendix 13. Risk of dislocation for BMI comparisons



BMI, body mass index; CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

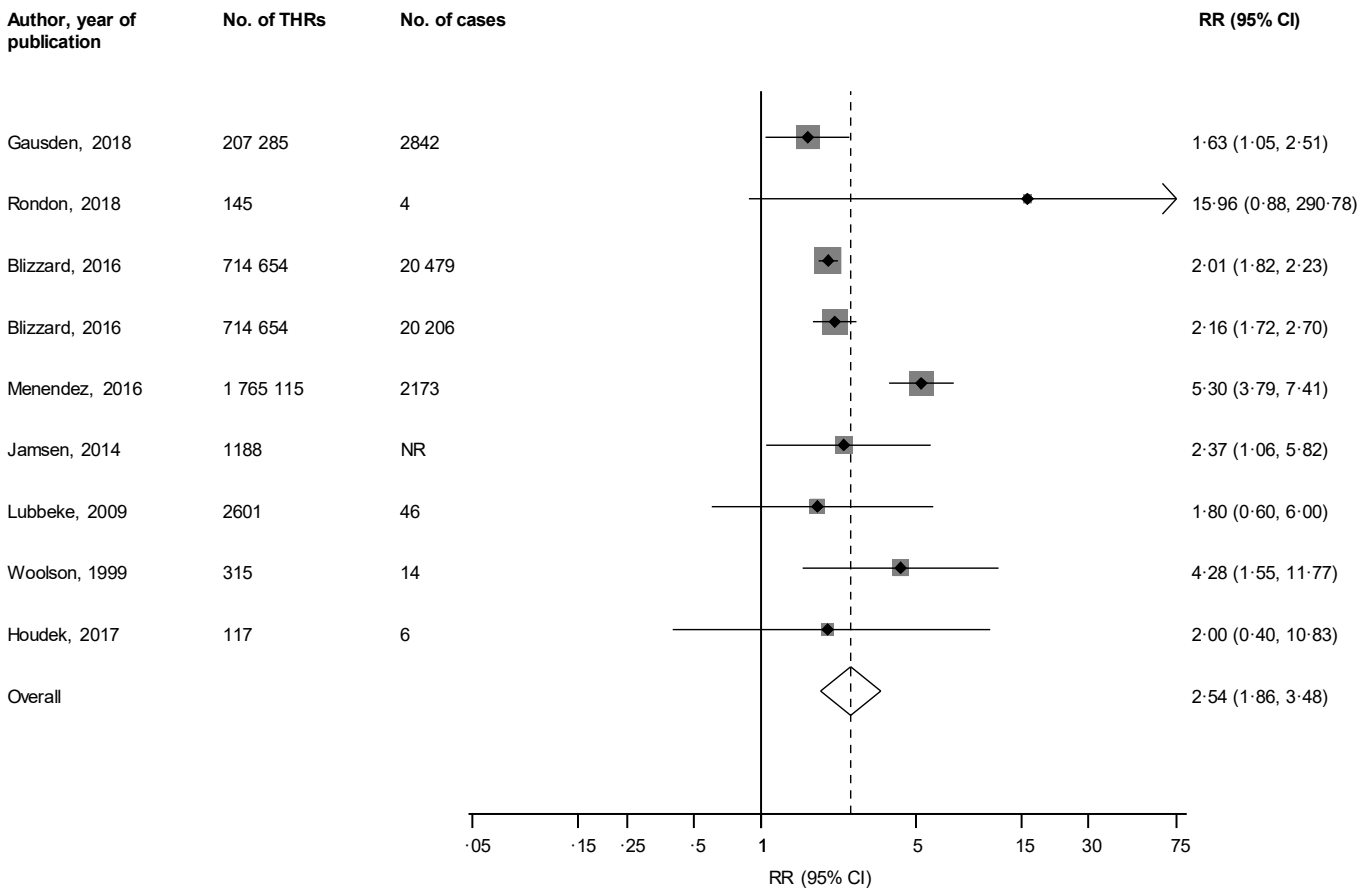
Appendix 14. Risk of dislocation comparing individuals with a BMI ≥30 versus <30 kg/m^2, grouped according to study level characteristics

Subgroup	No. of THRs	No. of cases	RR (95% CI)	*p*-value
Location				
North America	1 827 959	5234	1·01 (0·90, 1·13)	·21
Europe	12 206	315	1·76 (1·02, 3·03)	
Asia	307	12	2·27 (0·55, 9·33)	
Design				
Prospective cohort	6760	131	1·49 (0·56, 3·91)	·14
Restrospective cohort	1833282	5394	1·03 (0·93, 1·15)	
Case-control	430	36	3·50 (1·63, 7·51)	
Average baseline age, yrs				
≥65	1 775 885	2425	1·46 (0·89, 2·39)	·96
<65	874	35	1·38 (0·70, 2·72)	
No· of dislocations				
50	1 836 791	5442	1·12 (0·81, 1·54)	·02
<50	3681	119	2·18 (1·44, 3·28)	
Degree of adjustment				
Univariate	5961	162	1·78 (1·18, 2·68)	·11
Multivariate	1 834 511	5399	1·14 (0·80, 1·64)	
Study quality				
≥7	1 836 676	5420	1·05 (0·80, 1·39)	<0·001
<7	3796	141	2·56 (1·70, 3·86)	



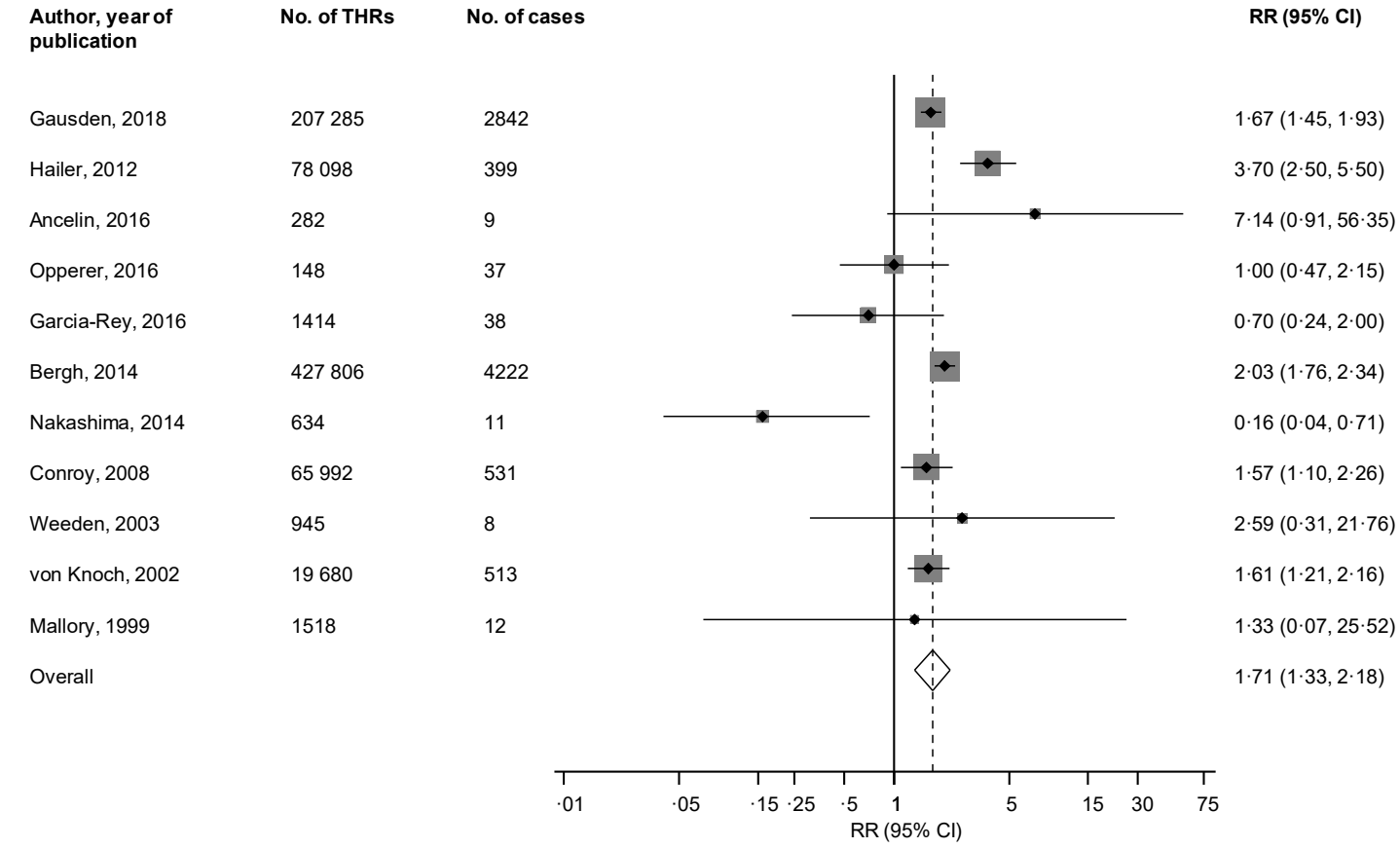
BMI, body mass index; CI, confidence interval (bars); RR, relative risk; THR, total hip replacement; *p*-values are for meta-regression

Appendix 15. Risk of dislocation comparing patients with neurological disorder versus no neurological disorder



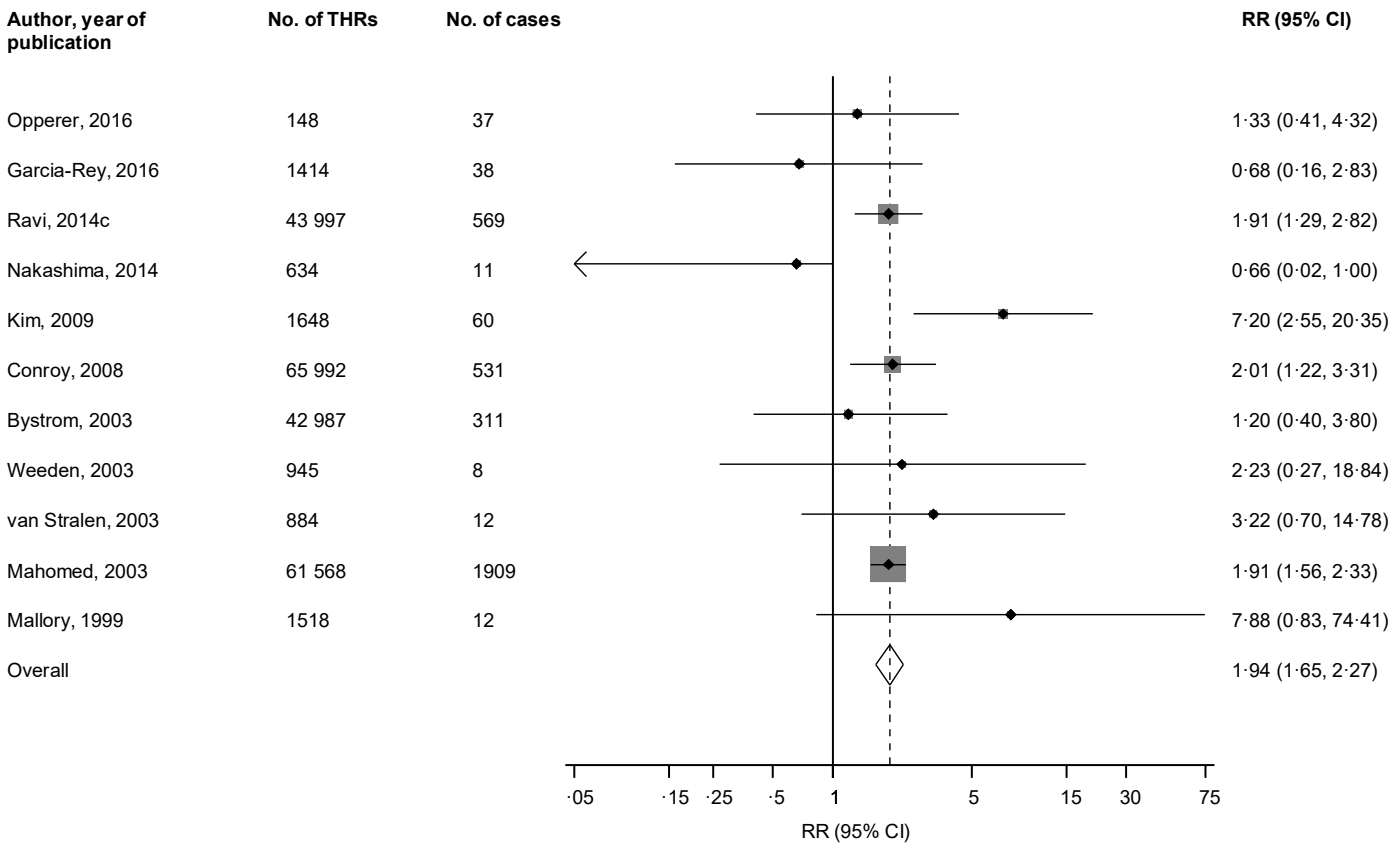
CI, confidence interval (bars); NR, not reported; RR, relative risk; THR, total hip replacement

Appendix 16. Risk of dislocation comparing a surgical indication of avascular necrosis versus osteoarthritis



CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

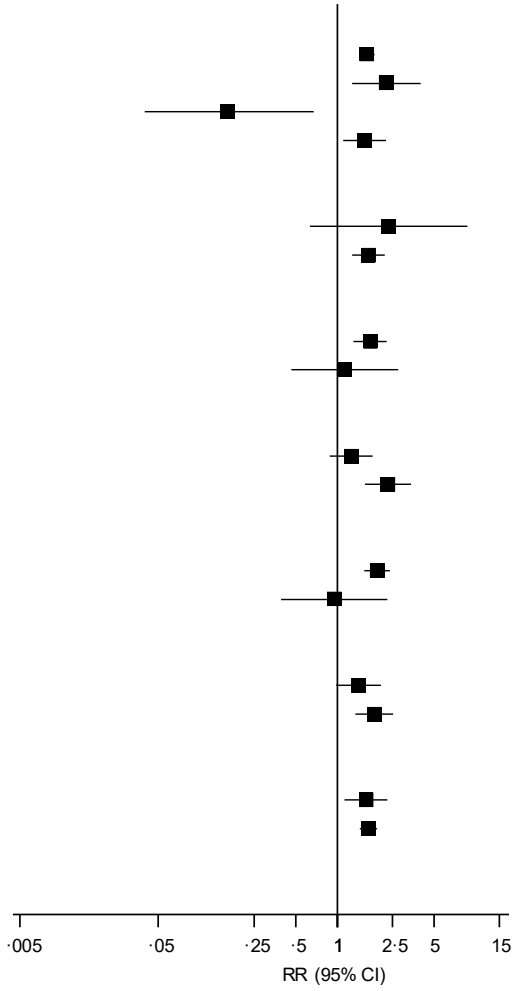
Appendix 17. Risk of dislocation comparing a surgical indication of rheumatoid arthritis versus osteoarthritis



CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

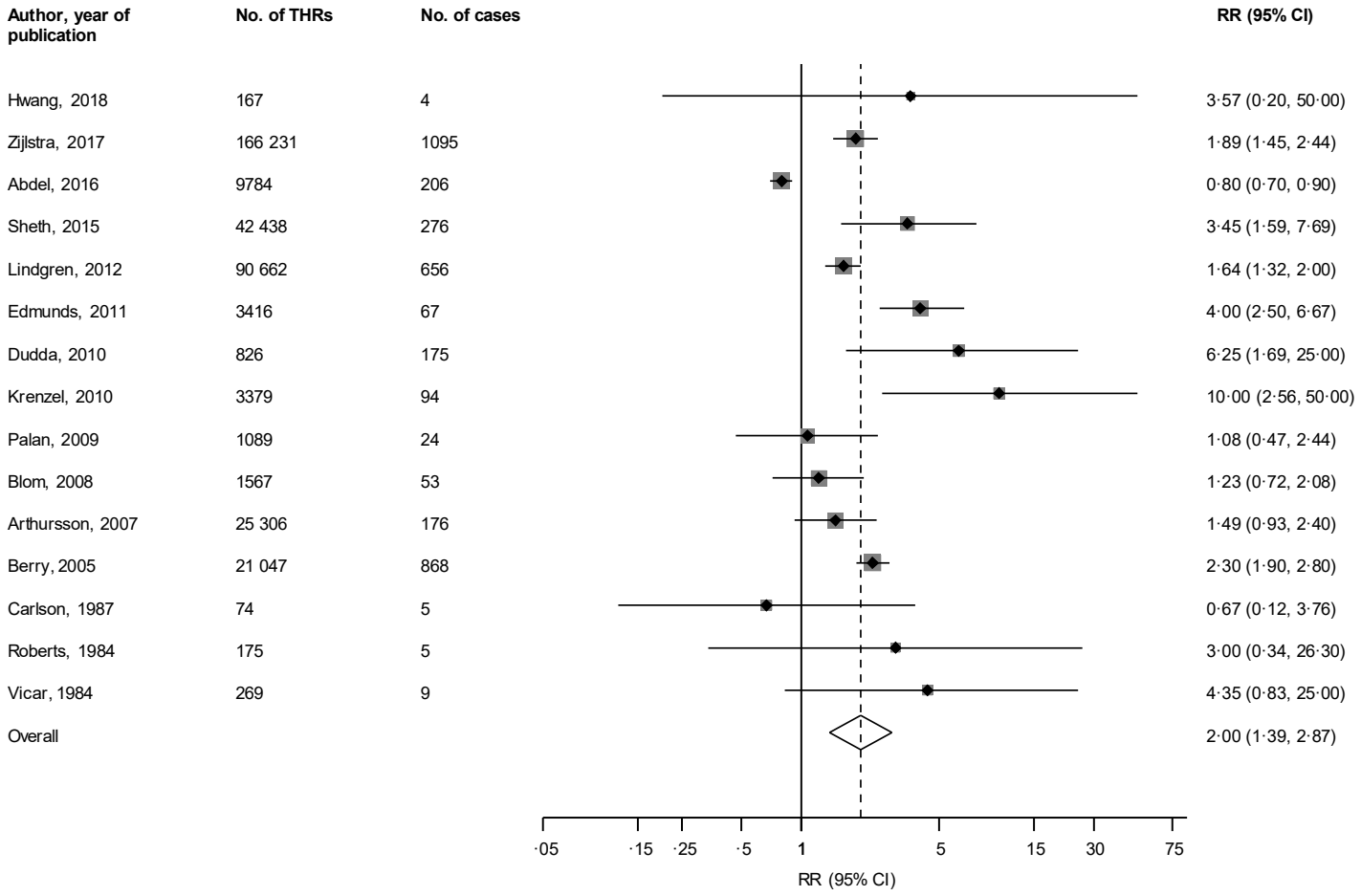
Appendix 18. Risk of dislocation comparing a surgical indication of avascular necrosis versus osteoarthritis, grouped according to study level characteristics

Subgroup	No. of THRs	No. of cases	RR (95% CI)	*p*-value
Location				
North America	229 576	3412	1·64 (1·44, 1·86)	·01
Europe	507 600	12 035	2·26 (1·27, 4·02)	
Asia	634	11	0·16 (0·04, 0·67)	
Pacific	65 992	531	1·57 (1·10, 2·25)	
Design				
Prospective cohort	66 274	540	2·35 (0·63, 8·72)	·83
Restrospective cohort	737 528	15 449	1·68 (1·27, 2·22)	
Average baseline age, yrs				
≥65	447 634	12 139	1·73 (1·31, 2·28)	·44
<65	212 078	2920	1·13 (0·46, 2·77)	
Type of dislocation				
Dislocation	231 624	3461	1·27 (0·88, 1·81)	·02
Revision for dislocation	572 178	12 528	2·32 (1·58, 3·43)	
No· of dislocations				
≥300	798 861	15 874	1·94 (1·57, 2·40)	·01
<300	4941	115	0·95 (0·39, 2·31)	
Degree of adjustment				
Univariate	23 987	617	1·42 (0·98, 2·06)	·30
Multivariate	779 815	15 372	1·85 (1·35, 2·53)	
Study quality				
≥7	594 054	13 127	1·61 (1·13, 2·30)	·88
<7	209 748	2862	1·67 (1·45, 1·93)	



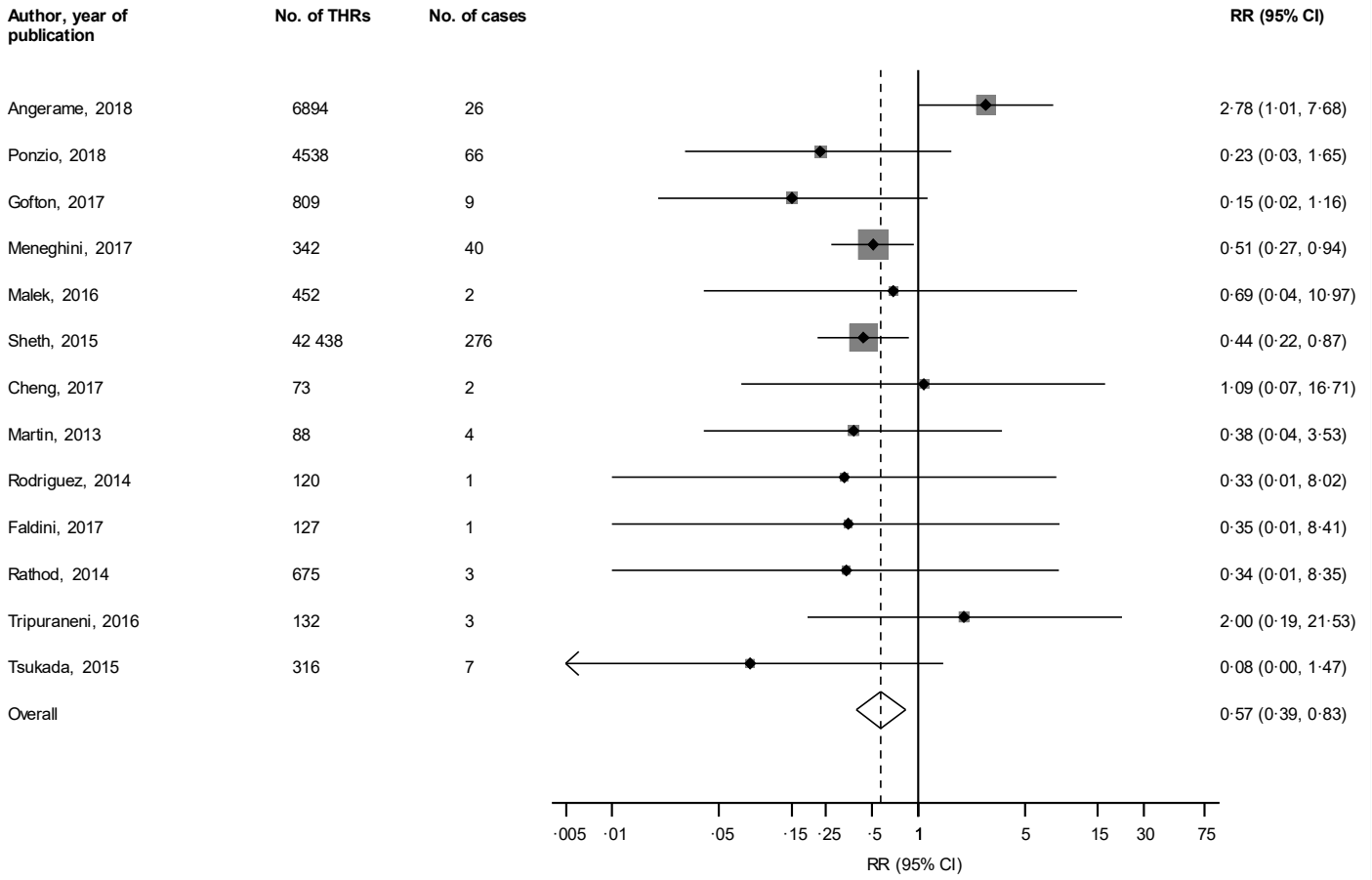
CI, confidence interval (bars); RR, relative risk; THR, total hip replacement; *p*-values are for meta-regression

Appendix 19. Risk of dislocation comparing a posterior with an anterolateral approach



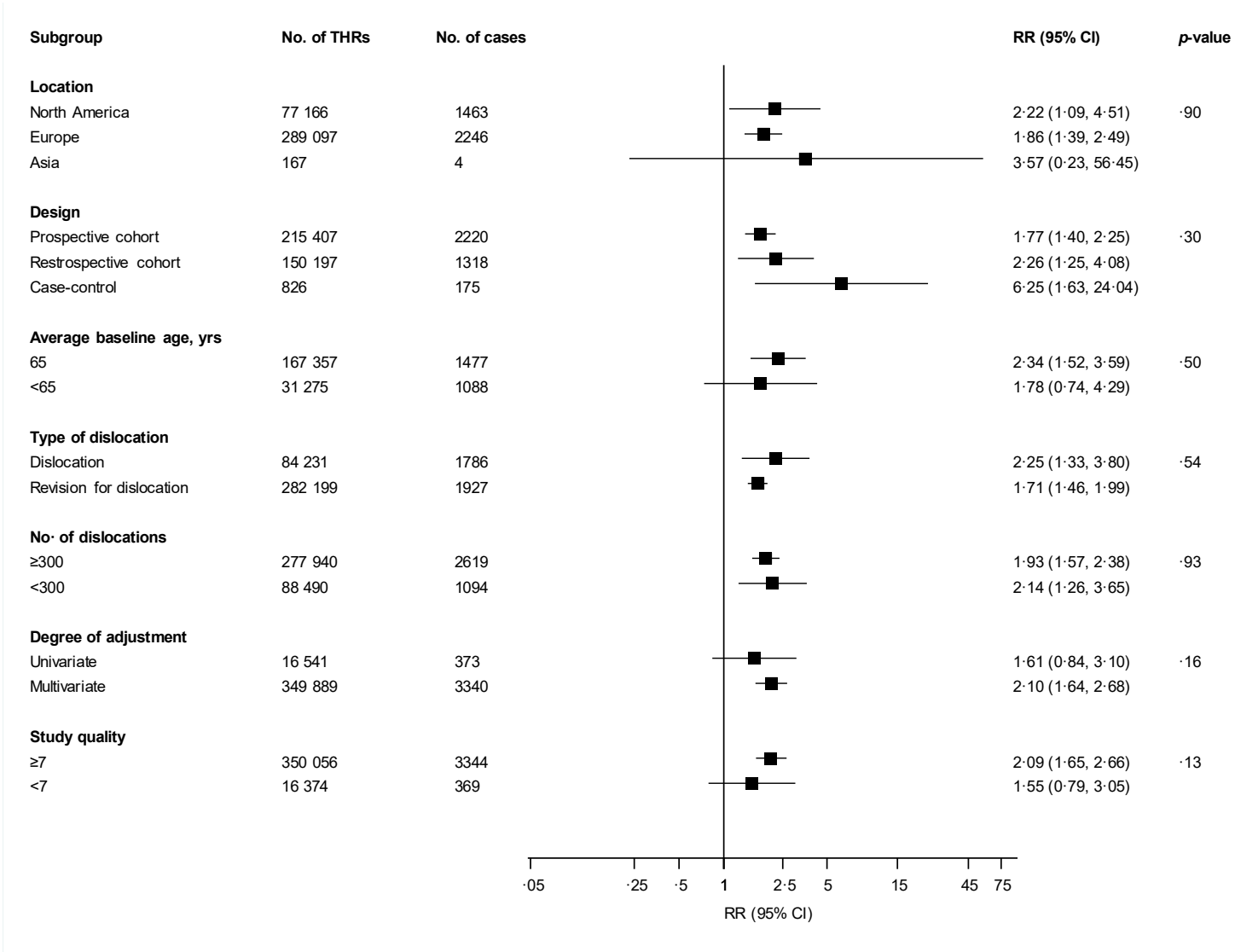
CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

Appendix 20. Risk of dislocation comparing a direct anterior with a posterior approach



CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

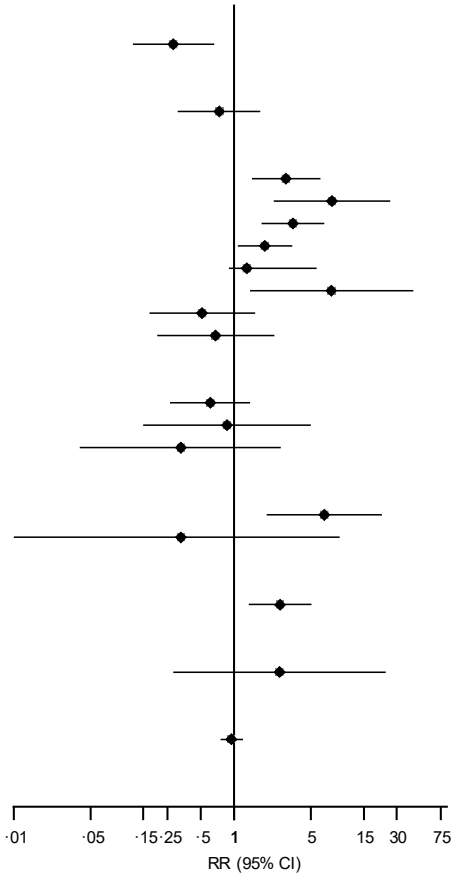
Appendix 21. Risk of dislocation comparing a posterior with an anterolateral approach, grouped according to study level characteristics



CI, confidence interval (bars); RR, relative risk; THR, total hip replacement; *p*-values are for meta-regression

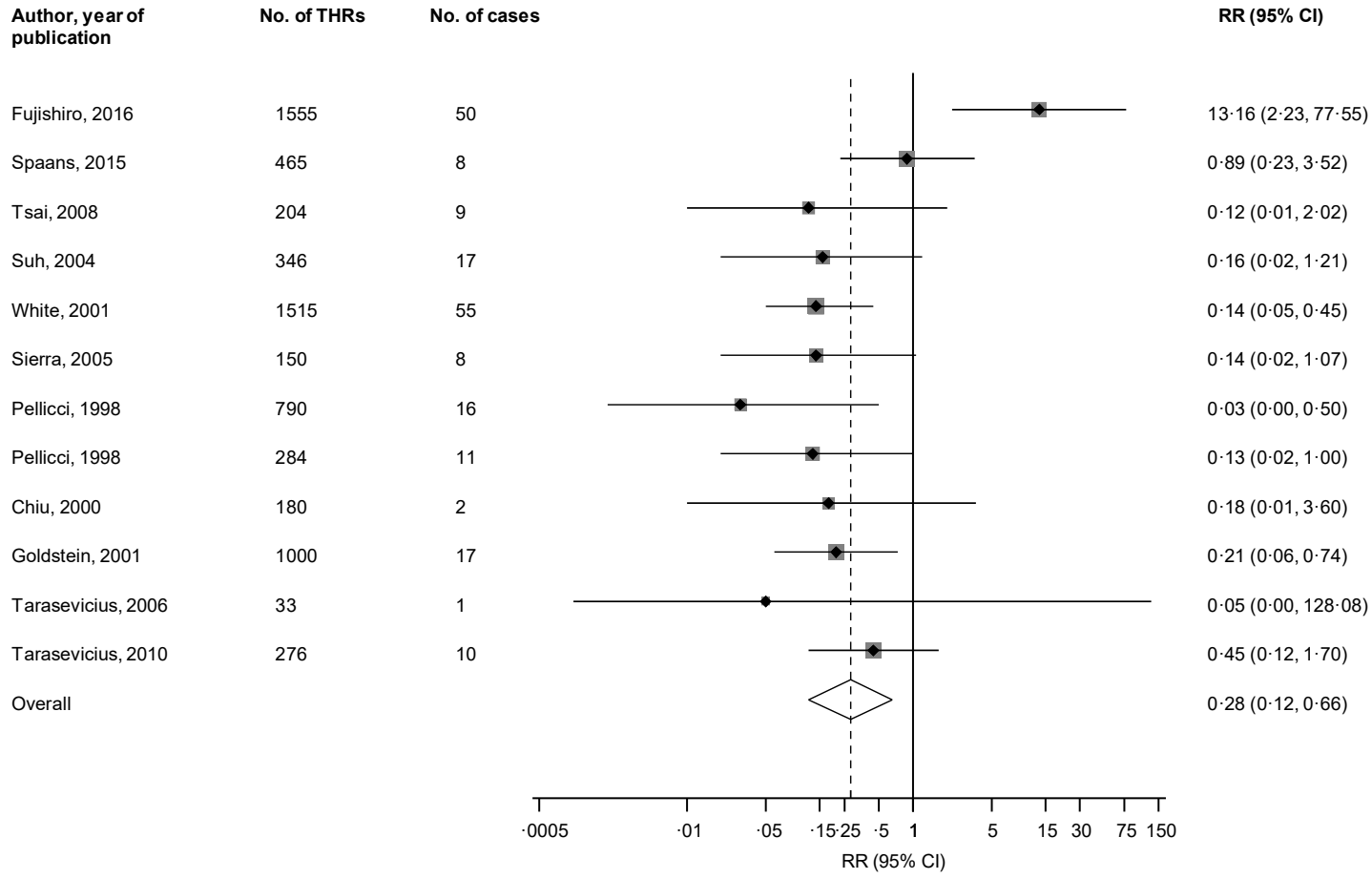
Appendix 22. Summary associations of surgery-related factors and risk of dislocation

Comparison	No. of studies	No. of THRs	No. of events	RR (95% CI)
Posterior short external rotator and capsule repair				
Yes vs No	12	6798	204	0·28 (0·12, 0·66)
Posterior short external rotator repair				
Yes vs No	1	450	20	0·73 (0·31, 1·72)
Acetabular cup position				
Cup abduction >50 degrees	2	496	43	2·96 (1·44, 6·10)
Cup abduction >55 degrees	1	410	17	7·70 (2·30, 26·00)
Window: Abduction 35 to 50 degrees, anteversion 5 to 25 degrees	1	1414	38	3·42 (1·78, 6·56)
Cup anteversion window 10 to 30 degrees	1	1555	50	1·90 (1·08, 3·36)
Cup anteversion window 10 to 20 degrees	1	454	22	1·30 (0·89, 5·65)
Cup anteversion window 0 to 20 degrees	1	410	17	7·60 (1·40, 42·40)
Vertical offset Negative vs Neutral	1	454	22	0·51 (0·17, 1·55)
Center of rotation lowering >2mm	1	42	21	0·68 (0·20, 2·31)
Stem position				
Stem offset 10% less than preoperative one	2	496	43	0·61 (0·26, 1·39)
Varus/Valgus stem positioning	1	454	22	0·86 (0·15, 4·99)
Stem offset +4mm vs Neutral	1	634	11	0·33 (0·04, 2·64)
Combined stem and cup position				
Combined window 40 to 60 degrees	2	676	32	6·59 (1·98, 21·93)
Combined window 15 to 30 degrees	1	454	22	0·33 (0·01, 9·13)
Abductor lever arm				
Window: 55 to 64mm lever arm, -2 to 5mm trochanteric height	1	1414	38	2·61 (1·36, 5·03)
Anaesthesia				
Spinal vs General	1	167	4	2·60 (0·28, 23·72)
Computer-assisted technique				
CAT vs None	1	207 285	2842	0·94 (0·75, 1·20)



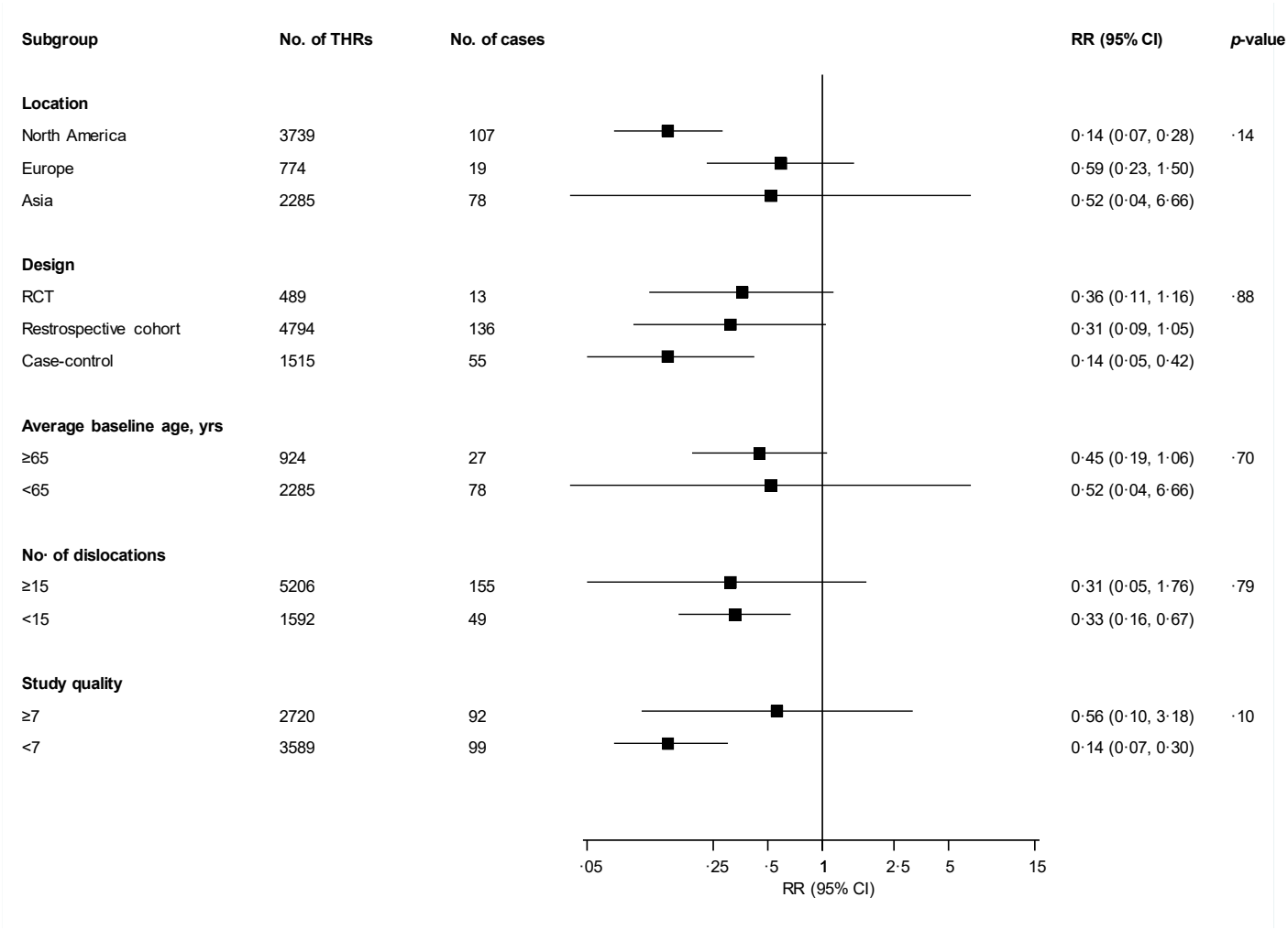
CAT, computer-assisted technique; CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

Appendix 23. Risk of dislocation comparing a posterior short external rotator and capsule repair versus none



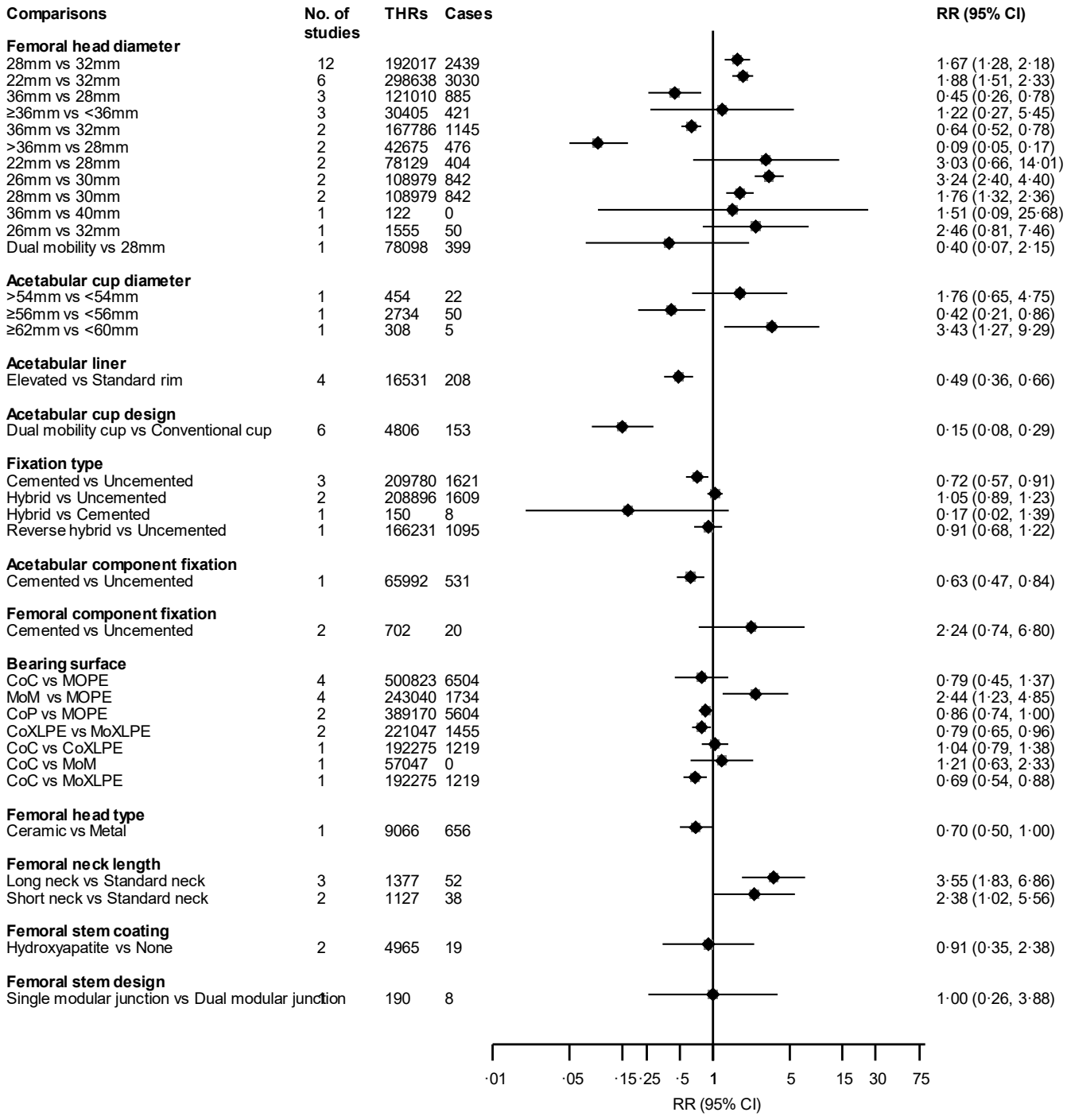
CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

Appendix 24. Risk of dislocation comparing a posterior short external rotator and capsule repair versus none, grouped according to study level characteristics



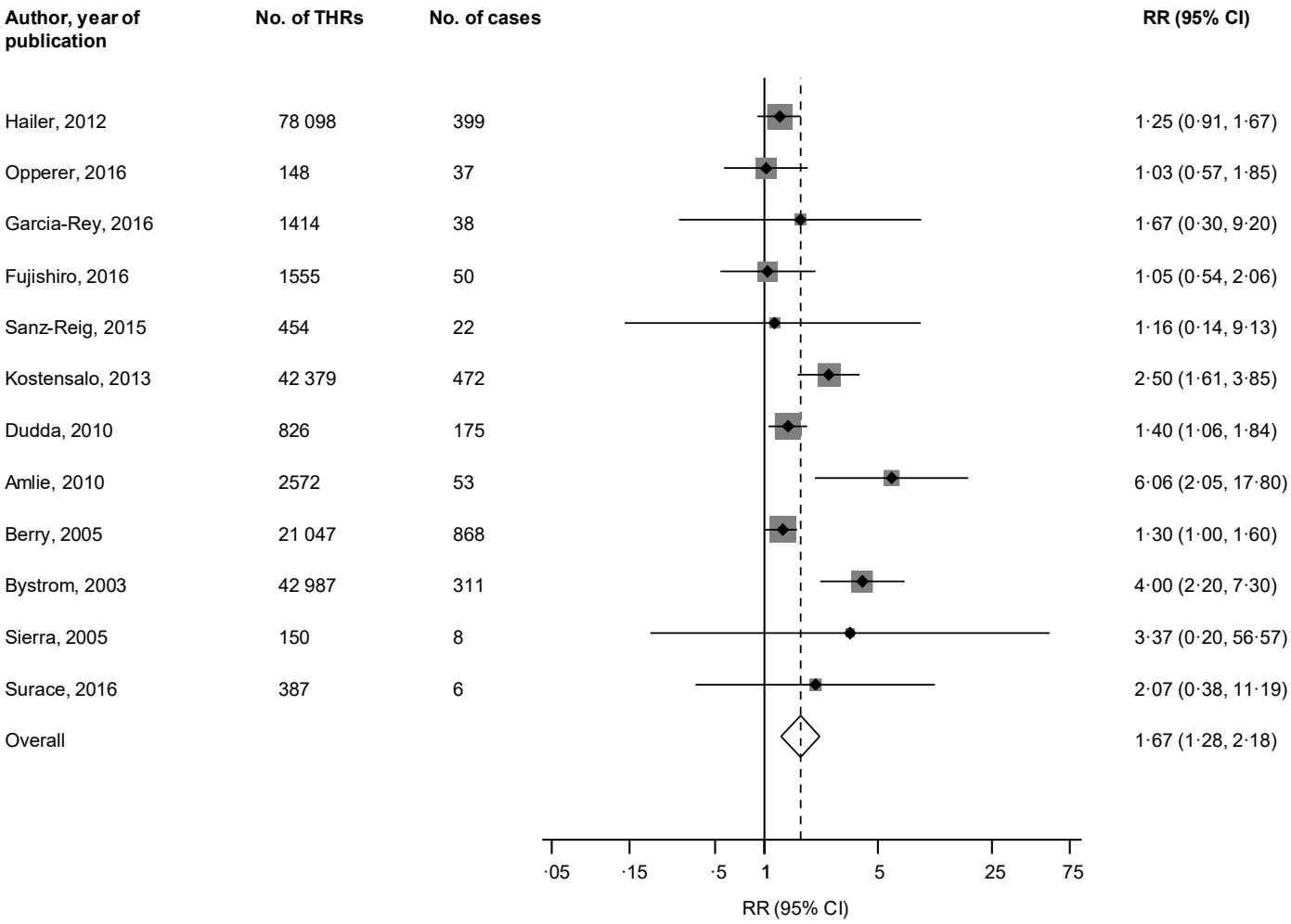
CI, confidence interval (bars); RR, relative risk; *p*-values are for meta-regression

Appendix 25. Summary associations of implant-related factors and risk of dislocation



CI, confidence interval (bars); CoC, ceramic-on-ceramic; CoXLPE, ceramic-on-cross-linked polyethylene; MoM, metal-on-metal; MoPE, metal-on-polyethylene; metal-on-cross-linked polyethylene, MoXLPE; RR, relative risk; *, are number of participants or hip replacements

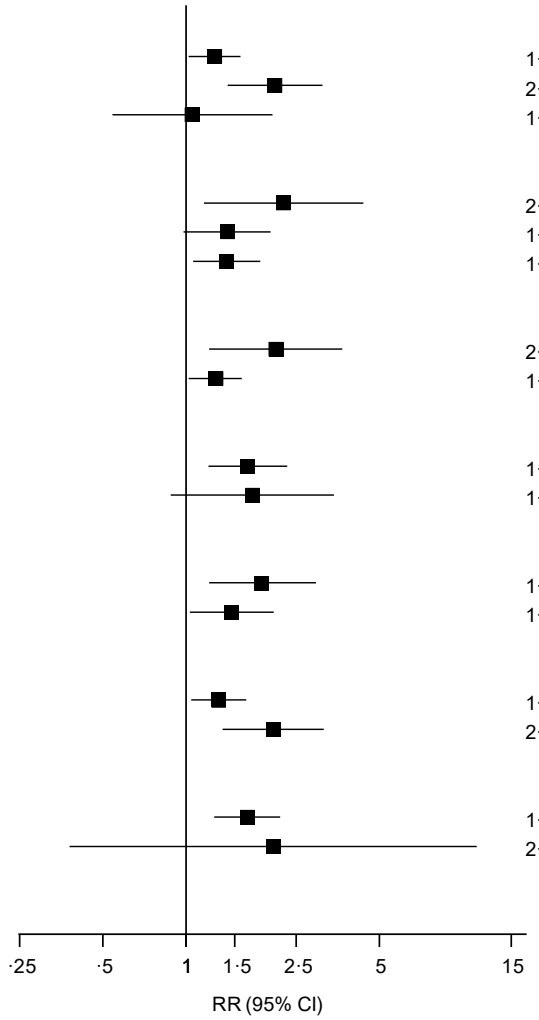
Appendix 26. Risk of dislocation comparing femoral head diameter 28mm versus 32mm



CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

Appendix 27. Risk of dislocation comparing femoral head diameter 28mm versus 32mm, grouped according to study level characteristics

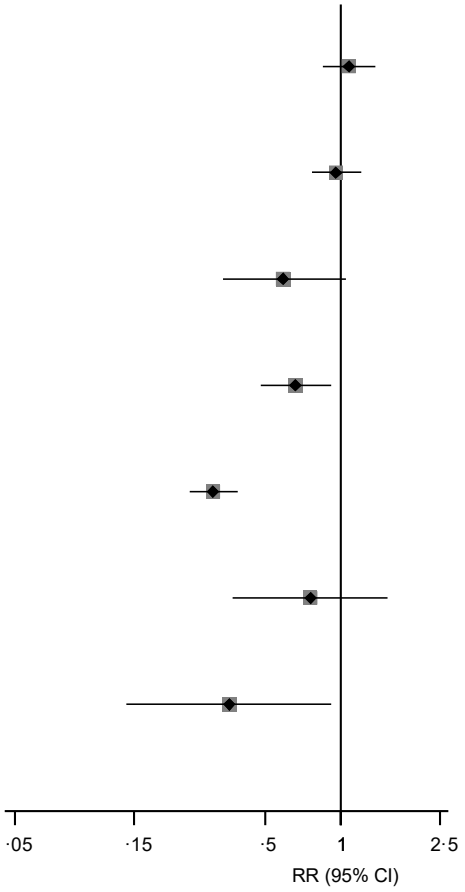
Subgroup	No. of THRs	No. of cases	RR (95% CI)	*p*-value
Location				
North America	21 345	913	1·27 (1·02, 1·57)	·19
Europe	169 117	1476	2·09 (1·41, 3·11)	
Asia	1555	50	1·05 (0·54, 2·05)	
Design				
Prospective cohort	106 413	1651	2·25 (1·16, 4·37)	·52
Restrospective cohort	84 778	613	1·41 (0·98, 2·02)	
Case-control	826	175	1·40 (1·06, 1·85)	
Average baseline age, yrs				
≥65	47 524	612	2·11 (1·21, 3·68)	·21
<65	24 016	956	1·28 (1·02, 1·59)	
Type of dislocation				
Dislocation	71 540	1568	1·67 (1·20, 2·32)	·94
Revision for dislocation	120 477	871	1·74 (0·88, 3·42)	
No· of dislocations				
≥300	184 511	2050	1·88 (1·21, 2·94)	·50
<300	7506	389	1·46 (1·03, 2·07)	
Degree of adjustment				
Univariate	3066	276	1·31 (1·04, 1·65)	·13
Multivariate	188 951	2163	2·07 (1·35, 3·15)	
Study quality				
≥7	191 630	2433	1·67 (1·26, 2·19)	·82
<7	387	6	2·07 (0·38, 11·23)	



CI, confidence interval (bars); RR, relative risk; *p*-values are for meta-regression

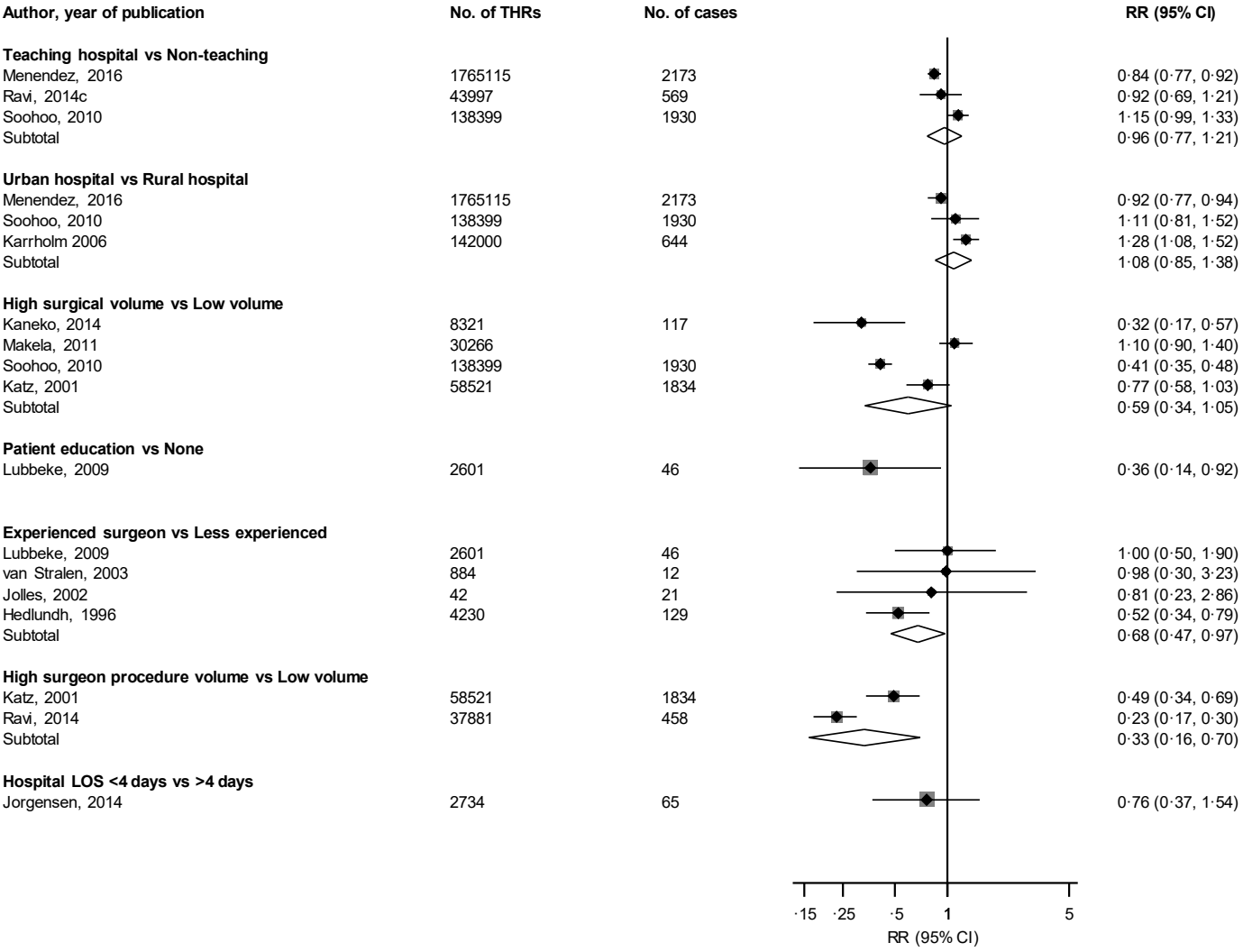
Appendix 28. Summary associations of hospital-related factors and risk of dislocation

Comparison	No· of studies	No· of THRs	No· of events	RR (95% CI)
Hospital location				
Urban vs Rural	3	2 045 514	4747	1·08 (0·85, 1·38)
Hospital type				
Teaching vs Non-teaching	3	1 947 511	4672	0·96 (0·77, 1·21)
Hospital procedure volume				
High vs Low volume	4	235 507	3881	0·59 (0·34, 1·05)
Surgeon experience				
Experienced vs Less experienced	4	7757	208	0·66 (0·48, 0·92)
Surgeon procedure volume				
High vs Low volume	2	96 402	2292	0·31 (0·25, 0·39)
Hospital stay				
Shorter vs Longer stay	1	2734	65	0·76 (0·37, 1·54)
Patient education				
Yes vs No	1	2601	46	0·36 (0·14, 0·92)



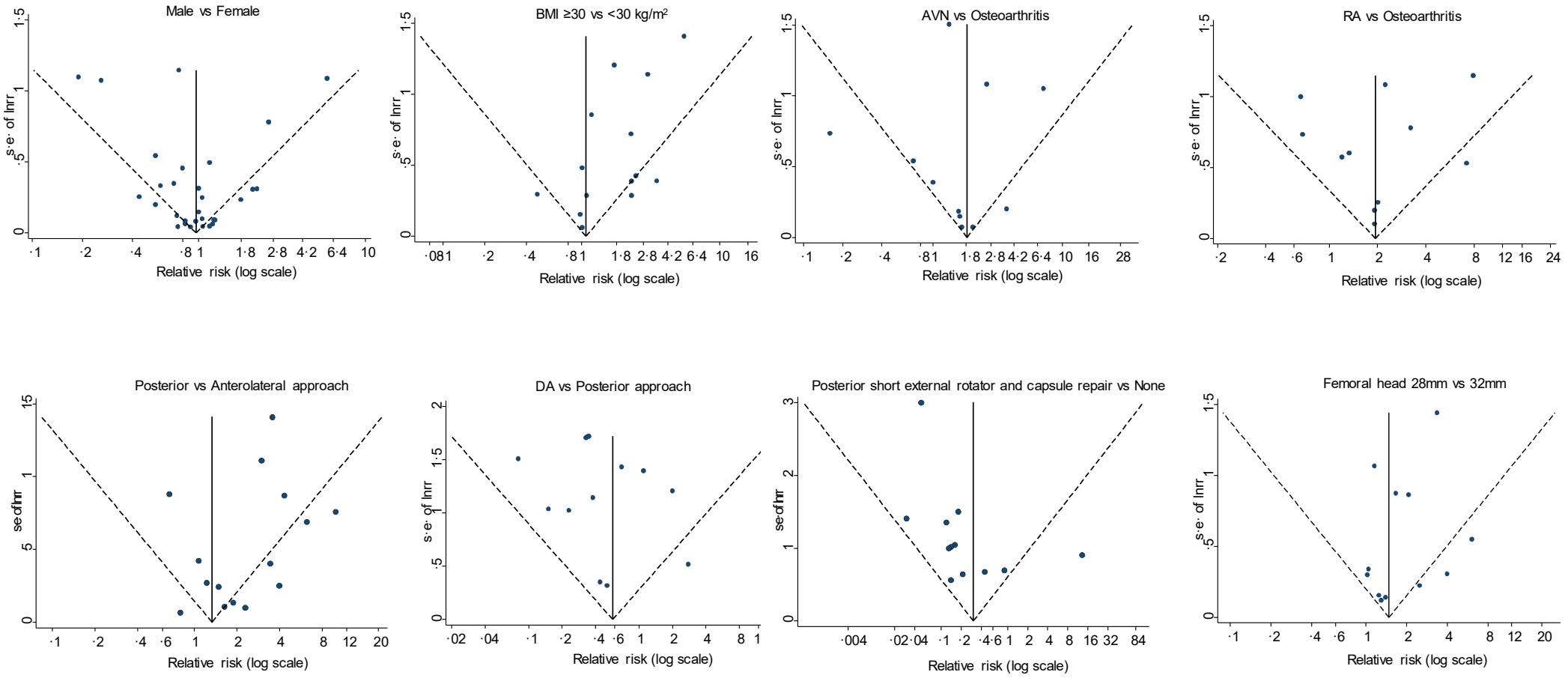
CI, confidence interval (bars); RR, relative risk; THR, total hip replacement

Appendix 29. Hospital-related factors and risk of dislocation



CI, confidence interval (bars); Hb, haemoglobin; LOS, length of stay; RR, relative risk; THR, total hip replacement

Appendix 30. Assessment of small study effects by funnel plots and Egger's regression symmetry tests



The dotted lines show 95% confidence intervals around the overall summary estimate calculated using a fixed effect model;; *P*-values for bias calculated using Egger's test were 0·88; 0·06; 0·50; 0·87; 0·08; 0·63; 0·57; and 0·22 for male versus female; BMI ≥30 versus <30; avascular necrosis versus osteoarthritis; rheumatoid arthritis versus osteoarthritis; posterior versus anterolateral approach; direct anterior versus posterior approach; posterior short external rotator and capsule repair versus none; and femoral head diameter 28mm versus 32mm; AVN, avascular necrosis; BMI, body mass index; DA, direct anterior, RA, rheumatoid arthritis