Risk factors and prevalence of DVT after total hip replacement: A systematic review and meta-analysis

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Abstract

Objective: To systematically evaluate the risk factors for deep vein thrombosis (DVT) in patients after hip replacement.

Methods: A computer search of PubMed, EMbase, The Cochrane Library, China Biology Medicine (CBM), China National Knowledge Internet (CNKI) and WanFang Data databases was conducted to collect case-control studies, cohort studies and cross-sectional studies on risk factors for DVT in hip replacement patients. January 2020. Meta-analysis was carried out using Stata 16.0 software after 2 researchers independently screened the literature, extracted data and evaluated the risk of bias of the included studies.

Results: A total of 27 studies were included, including 82,872 subjects with 16 risk factors, and the results of the meta-analysis showed that women [OR=3.06 (1.36, 6.88), p=0.0001], age [OR=2.04, 95% CI (1.73, 2.42), p<0.0001], body mass index (BMI) [OR=0.0001], and men [OR=0.0001] were at risk of bias. 3.95, 95% CI (2.69, 5.78), p=0.007], hypertension [OR=2.52, 95% CI (1.42, 4.46), p<0.0001], hyperlipidemia [OR=2.47, 95% CI (1.44, 4.24), p<0.0001]. Combined cardio-vascular underlying diseases [OR=2.53, 95% CI (1.47, 4.37), p<0.0001], varicose veins or DVT [OR=4.21, 95%]. CI (3.24, 5.47), p=0.012], anaesthetic methods [OR=3.55, 95% CI (1.85, 6.82), p<0.0001], duration of operation [OR=2.33, 95% CI (1.35, 4.04), p<0.0001 0.0001], bone cement prosthesis [OR=2.79, 95% CI (2.37, 3.29), p<0.0001] are risk factors for DVT in hip replacement patients, and appropriate postoperative training reduces the risk of DVT in these patients [OR=0.40, 95% CI (0.32, 0.51)].

Conclusions: Current evidence of this study suggests that women, older age, high BMI, hypertension, hyperlipidemia, combined cardio-vascular underlying diseases, varicose veins or deep vein disease, general anesthesia, prolonged operation time and the use of bone cement prosthesis are risk factors for the development of DVT in hip replacement patients. Healthcare professionals should enhance the protection of high-risk patients with these risk factors in order to reduce the incidence of DVT after hip replacement and to improve the clinical outcome of patients.

1. Introduction

The common hip joint diseases are severe osteoarthritis, rheumatoid arthritis, advanced aseptic necrosis of the femoral head and neck fracture[1]. At present, one of the effective methods for the treatment of the above-mentioned hip diseases is hip arthroplasty. Artificial hip arthroplasty has a history of 30 years [2]. It is widely used in the clinic because of its mature technology, good effect, postoperative pain relief and complete recovery of lower limb function. This technique has a remarkable clinical effect in helping patients recover hip joint function and relieving pain, and have been popularly recognized by medical workers and patients. Although this method can better restore the functional activities of patients' lower limbs, eliminate pain and improve their quality of life, it will also bring some complications after operation. Such as infection, periprosthetic fracture, dislocation, lower limb unequal length, lesser limb deep vein thrombosis (DVT) and other problems, of which lower limb DVT is the most common[3, 4]. Related studies have shown that if no preventive measures are taken, the incidence of postoperative DVT is 34.1% to

77.2%, the incidence of symptomatic pulmonary embolism (PE) is in the range of 1.9% to 6.8%, and the mortality is as high as 2%[5]. DVT seriously threatens the quality of life of patients and brings a serious economic burdens to the society, so it has important clinical significance for the effective prevention and treatment of DVT after hip arthroplasty.

The risk factors of DVT after hip arthroplasty are numerous and complex. It can enable patients to progress step by step from asymptomatic, eventually leading to death. However, it is still difficult to effectively prevent damage caused by it [6]. Therefore, it is necessary to further study the risk factors and effective preventive measures of DVT. To provide appropriate intervention measures for high-risk factors to prevent the occurrence and development of DVT and to control it before irreversible damage.

Systematic reviews and meta-analysis can provide scientific evidence for health decisions and can also form higher-level recommendations in the guidelines [7]. Therefore, we adopt the method of meta-analysis of published on associated risk factors, to determine whether the risk factors associated with DVT.

2. Methods And Analysis

2.1. Study registration

This systematic review and meta-analysis was implemented on the strength of the Preferred Reporting Items for Systematic Reviews and MetaAnalyses (PRISMA) [8] and Assessing the methodological quality of systematic reviews (AMSTAR) Guidelines [9], which has also been registered at the International Prospective Register of Systematic Reviews (PROSPERO) and International Platform of Registered Systematic Review and Meta-analysis Protocols (INPLASY).

2.2. Study inclusion and exclusion criteria

2.2.1. 2.1 Types of studies. Inclusion: (1) cohort studies; (2) case-control studies. Exclusion: (1) non-Chinese and English literature; (2) incomplete or missing research data; (3) unable to obtain original documents; (4) repeated publication of literature; (5) editorials (6) commentaries.

2.2.2. Types of participants. formation of DVT after hip replacement.

2.2.3. Risk factors. advanced age, gender, basic disease, operation time, advanced age, gender, operation time, diabetes, hypertension, hyperlipidemia, etc.

2.2.4. Types of outcomes measures.

Incidence of DVT after total hip replacement.

2.3. Search scheme and strategy

2.3.1. Electronic searches strategy.

“arthroplasties, replacement, hip, hip replacement arthroplasty, thrombosis, relative risk, cohort studies, et al.” was used as the English search term, database retrieval was carried out on PubMed, Embase, The Cochrane Library, China Biology Medicine (CBM), China National Knowledge Internet (CNKI), Wanfang data and literatures on DVT after total hip replacement published from the establishment of the database to November 2020 were collected systematically. In PubMed, for example, the search strategy is shown in **Box 1**.

2.3.2. Other resources.

(1) Manual and other search: search relevant literatures by Baidu, Google and other search engines. (2) Document tracing method as an auxiliary retrieval.

2.4. Study selection

All search results are imported into EndNote X9 literature management software, Two reviewers will screen the titles and abstracts of literature independently, then read the full text to assess literature according to the inclusion and exclusion criteria, Any disagreements will be resolved by a third reviewer. Study selection will be summarized in PRISMA flow diagram [8].

2.5. Data extraction

Two researchers independently screened the literature in strict accordance with the inclusion and exclusion criteria. During the screening, they first read the title, eliminated the obviously irrelevant literature, and then further read the abstract of the literature and the full text to determine whether to include it or not. If necessary, contact the original study author via email or other means for information. If there is any difference in the content of data extraction, the third party shall be consulted.

2.6. Risk of bias assessment

The risk of bias of the included studies was evaluated independently by two investigators and the results cross-checked. The risk of bias was evaluated using the criteria recommended by the Agency for Healthcare Quality and Research (AHRQ) for evaluating the risk of bias in cross-sectional studies [10]. Disagreement will be solved by discussion or by consulting the third person.

2.7. Data synthesis

Statistical analysis was performed on the extracted data using Stata 16.0 software. For measurement data, Heterogeneity between the results of the included studies was analysed using the $\chi 2$ test (test level $\alpha=0.1$), and the magnitude of heterogeneity was determined in conjunction with the I^2 quantification. If $P\geq 0.1$, $I^2<50\%$, it indicates that there is homogeneity among the studies or the heterogeneity is within the acceptable range, and the fixed effects model is used to merge the calculation of the effect size; on the contrary, it is considered that there is heterogeneity between the studies. The level of Meta-analysis was set at $\alpha=0.05$. Subgroup analysis was used for significant clinical heterogeneity. Alternatively sensitivity analysis, or just a descriptive analysis. Egger’s and Beggs method were used to assess publication bias.

2.8. Subgroup analysis

If the evidence is sufficient, we will conduct a subgroup analysis to determine the difference between different gender, age, etc.

3. Results

3.1 Literature filtering process and results

A total of 1027 relevant literatures were obtained from the initial screening, which led to the inclusion of 27 studies [11-37], including 82872 patients. The literature selection process and results are shown in **Figure 1**. Concurrently, the basic characteristics of the included literature are shown in **Table 1** and the results of the risk of bias evaluation in **Table 2**.

3.2 Meta analysis results

3.2.1 Prevalence

27 cross-sectional studies [11-37] were ultimately included, including 1691 adults with DVT after hip replacement. A random effects model Meta-analysis showed that the prevalence of DVT after hip arthroplasty was 21% [95% CI (17%, 25%)] **(Figure 2)**.

3.2.2 General factors

3.2.2.1 Gender

A total of 7 studies [10, 11, 13-15, 17-23, 25-31, 33-36] were included. A random effects model Meta-analysis showed that women are risk factors for DVT after hip replacement [OR= 3.06, 95% CI (1.36 6.88), P=0.0001] **(Table 3)**.

3.2.2.2 Age

A total of 22 studies [10, 11, 13-15, 17-23, 25-31, 33, 35, 36] were included to describe age. Random effects model Meta-analysis showed that age was a risk factor for DVT after hip arthroplasty [OR= 2.66, 95% CI (2.32, 3.11), P=0.0001] **(Figure 4, Table 3)**. Subgroup analysis according to age (≥70 years, ≥65 years, ≥60 years) was unchanged.

3.2.2.3 Body mass index (BMI)

14 studies [11, 16-18, 20-22, 24, 28, 29, 31, 32, 34, 36] were included. The random effects model Meta-analysis showed that BMI was a risk factor for DVT after hip replacement [OR=0.73, 95% CI (0.45, 1.19), P=0.21] **(Table 3)**.

3.2.2.4 Blood type

3 studies were included and a random effects model Meta-analysis showed that blood type did not increase the risk of DVT in hip replacements [OR=0.55, 95% CI (0.36⁒0.82), P=0.37] **(Table 3)**.

3.3.3 Past medical history factors

3.3.3.1 Diabetes mellitus

A total of 8 studies [11, 15, 20, 21, 23, 29, 31, 36] were included. Meta-analysis of fixed-effects models showed that diabetes is not a risk factor for DVT in hip replacement patients [OR=2.78, 95% CI(2.26⁒3.43), P=0.230] **(Table 3)**.

3.3.3.2 Hypertension

A total of 7 studies [11, 15, 19, 23, 29, 31, 33] were included. Random effects model Meta-analysis showed that hypertension was a risk factor for DVT in hip replacement patients OR=2.52, 95% CI (1.42⁒4.46), P=0.0001] **(Table 3)**.

3.3.3.3 Hyperlipidemia

9 cohort studies [11, 12, 14, 17-19, 25, 26, 31]were included and a random effects model Meta-analysis showed an increased risk of DVT in hip replacement patients with comorbid hyperlipidemia [OR= 2.47, 95% CI (1.44⁒4.24),P=0.0001] **(Table 3)**.

3.3.3.4 Combined cardio-vascular underlying diseases

8 studies[14, 15, 19, 24, 27, 34-36] were included and a random effects model Meta-analysis showed an increased risk of DVT in hip replacement patients with underlying cardiovascular and cerebrovascular disease [OR= 2.53, 95% CI (1.47⁒4.37), P=0.0001] **(Table 3)**.

3.3.3.5 History of varicose veins or DVT.

9 studies[13, 17-19, 27, 30, 32, 35, 36] were included and a random effects model Meta-analysis showed that History of varicose veins or DVT can increase the risk of DVT in hip replacement patients OR= 4.21, 95% CI (3.24⁒5.47), P=0.012] **(Table 3)**.

3.3.4 Intraoperative factors

3.3.4.1 Anaesthetic methods

A total of 6 studies [10, 14, 16, 22, 23, 29] were included. Random effect model Meta-analysis showed that general anesthesia was a risk factor for DVT in patients after hip replacement [OR=3.55, 95% CI(1.85⁒6.82), P<0.000 1] **(Table 3)**.

3.3.4.2 Duration of operation

A total of 6 studies [10, 20, 25, 26, 29, 31] were included. Random effect model Meta-analysis showed that Duration of operation was a risk factor for DVT in patients after hip replacement [OR=2.33, 95% CI(1.35 4.04), P<0.000 1] **(Table 3)**.

3.3.4.3 Bleeding

4 studies[19, 20, 23, 32] were included and a random effects model Meta-analysis showed that intraoperative blood loss did not increase the risk of DVT in hip replacement patients OR= 2.46, 95% CI (1.62 3.72), P=0.254] **(Table 3)**.

3.3.4.4 Bone cement prosthesis

9 studies[14, 16, 21, 22, 25, 26, 28, 29, 34] were included and a random effects model Meta-analysis showed that Applications for cemented prostheses can increase the risk of DVT in hip replacement patients OR= 2.79, 95% CI (2.37 3.29), P=0.001] **(Table 3)**.

3.3.4.5 Infection

2 studies [10, 19] were included and a random effects model Meta-analysis showed that infection did not increase the risk of DVT in hip replacement patients OR= 3.97, 95% CI (1.65, 9.59), P=0.002] **(Table 3)**.

3.3.5 Others

3.3.5.1 Training

A total of 6 studies [15, 19, 23, 27] were included. Random effect model Meta-analysis showed that postoperative training reduced the risk of DVT in hip replacement patients [OR=0.40, 95% CI(0.32 0.51), P=0.02] **(Table 3)**.

3.3.5.2 Current steroid use

3 studies[13, 31, 35] were included and a random effects model Meta-analysis showed that Current steroid use did not increase the risk of DVT in hip replacement patients OR= 4.51, 95% CI (3.76 5.41), P=0.486] **(Table 3)**.

3.4 Sensitivity analysis

The arbitrary deletion of the literature in this study will not affect the results of this study and means that the results of the random effects calculations above are stable and reliable **(Figure 3)**.

3.5 Subgroup analysis

The 22 studies [10, 11, 13-15, 17-23, 25-31, 33, 35, 36] that had set age as a risk factor were grouped into three groups according to age ≥ 70, ≥ 65 and ≥ 60 years and subjected to meta-analysis **(Figure 4)**.

3.6 Publication bias

A funnel plot of studies where BMI was a risk factor was performed for publication bias and showed that the left-right distribution of study sites was generally symmetrical **(Figure 5)**, which, when combined with Egger's test (P=0.573), suggests that publication bias is unlikely.

4. Discussion

As medical technology and quality of life have improved, the acceptance of surgical procedures has increased. Many elderly patients with hip disease are choosing hip replacement surgery to relieve their pain and improve their quality of life. With the increasing use of hip arthroplasty, the impact of post-operative complications on patient prognosis has become increasingly important, and DVT has been the most common post-operative complication, with no obvious clinical manifestations in the early stages and most patients presenting with only mild weakness or pain in the lower limbs, making it difficult for clinicians to diagnose the disease based on experience alone [38]. There is a certain lag. With the continuous development of theories and practices related to metrological diagnostics, many scholars have started to try to diagnose diseases comprehensively, determine disease types and make differential diagnoses on the basis of patients' multifaceted clinical data.

All current theories on the pathogenesis of DVT are framed by the three classical theories proposed by Rudolph Virchow in 1846: damage to the vein wall, slow venous blood flow and hypercoagulable state of the blood [39]. The results of this study show that women, age, BMI, having hypertension, hyperlipidemia, cardiovascular disease, varicose veins, as well as general anesthesia, duration of operation, and use of bone cement prosthesis are influential factors in the development of DVT in patients after total hip surgery ($P< 0.05$), and that postoperative training can reduce the incidence of DVT.

There are few existing studies on the correlation between gender and DVT. Most studies have concluded that gender is not associated with the development of DVT after hip replacement. The results of this study found that women with a hip replacement were more likely than men to experience DVT. Roach et al[40] showed that 20% of the gender difference in DVT prevalence may be due to differences in height, with increased height affecting males more than females, and may also be associated with X or Y gene mutations. Previous studies have shown that hormonal contraceptives are an independent risk factor for the development of DVT, with a 2 to 4 fold increased risk of DVT in women receiving hormone replacement therapy during the perimenopause. The possible mechanisms are mainly that oestrogen causes an increase in blood viscosity, fibrinogen, factor Ⅷ and Ⅸ, platelet adhesion and aggregation, thus increasing the risk of DVT. Furthermore more research is needed in the future to further investigate the correlation between gender and the occurrence of DVT [41-43].

In a prospective study conducted in the USA over a 25-year period, the annual incidence of DVT was found to increase with age [44]. In this study, the incidence was higher in patients over 70 years of age than in other age groups. On the one hand, increasing age decreases vascular elasticity and makes the vascular lining more susceptible to disruption[45].

A number of recent studies have shown that preoperative comorbidities such as hypertension, diabetes and hyperlipidemia contribute significantly to the development of lower limb DVT [46-48]. Both diabetes and hyperlipidemia can cause endothelial cell damage, platelet activation and imbalances in the coagulation fibrinolytic system, resulting in fluid hypercoagulation, which increases the risk of lower extremity DVT [49]. It used to be thought that hypertension and diabetes only caused damage to the arterial wall, especially the small arteries, but with recent research it has been found that hypertension and diabetes can also cause damage to the venous wall. This promotes the development of deep veins in the lower limbs. Prolonged hypertension not only affects the deformability of red blood cells, but also changes the aggregation of red blood cells. Changes in the aggregation of red blood cells affect the release of blood components during blood flow, causing platelets to be pushed against the blood vessel wall during the flow process and to be damaged by the impact, causing platelet aggregation and increased adherence, which in turn obstructs the microvasculature, increases vascular resistance, slows down blood flow and increases blood viscosity. Aggregation of platelets and slowing of blood flow can significantly increase the development of DVT. High blood glucose levels in diabetes reduce the deformability of red blood cells and increase their aggregation. This affects the flow of red blood cells in small veins and capillaries, and the aggregated red blood cell complexes can damage the vein walls and aggravate the formation of DVT[50-53]. In this study, diabetes did not have a significant effect on the occurrence of DVT, which may be related to the limited number of statistics or to the preventive protection measures already applied.

Orthopaedic surgery is an invasive procedure which in itself is a major pro-coagulant and can cause a number of physiological reactions in the body, including damage to the venous walls, alterations in flow velocity, changes in viscosity, etc. Therefore, in patients undergoing major orthopaedic surgery, the risk of DVT is assessed as extremely high. Therefore, in the patient risk assessment for DVT, all patients undergoing major orthopaedic surgery are assessed as being at very high risk. In addition, it has been shown that postoperative DVT is associated with a low blood flow [52]. In addition, the patient's stress and anxiety associated with the procedure can put the body in a state of stress, which can also lead to increased blood viscosity and an increased risk of DVT.

In this study, it was noted that general anesthesia may also increase the formation of DVT after hip replacement. Studies have shown that, with the same surgical approach and perioperative prophylactic treatment, there is a significant increase in the number of patients who can be treated. In the case of therapeutic measures, anesthesia by means of endotracheal anesthesia is more likely to reduce the incidence of postoperative DVT than general anesthesia. The reason for this may be that some of the local anaesthetic is absorbed in the epidural space, which inhibits the excitation of the sympathetic nerves and causes vasodilation of the lower extremities, resulting in increased flow and promoting blood return to the lower extremities, thereby reducing venous stasis during surgery and reducing the adhesion, aggregation and release of platelets[54, 55]. Other studies have shown that the use of intravertebral anesthesia combined with controlled hypotension for surgery can significantly reduce bleeding during surgery, maintain the circulating blood volume in the lower limbs and further effectively reduce the incidence of DVT [56, 57].

Weaknesses of this study: (i) Due to the limitation of the search language and the incomplete search of grey literature, studies meeting the inclusion criteria may have been missed, which may affect the results of the analysis; (ii) The included studies were cross-sectional, and due to the study design, bias in selection, implementation and measurement could not be avoided; (iii) The baseline of the included subjects varied considerably and the risk factors influenced each other, but due to the limited number of included studies, a more detailed subgroup analysis could not be carried out.

Current evidence of this study suggests that women, older age, high BMI, hypertension, Hyperlipidemia, Combined cardio-vascular underlying diseases, varicose veins or deep vein disease, general anesthesia, prolonged operation time and the use of bone cement prosthesis are risk factors for the development of DVT in hip replacement patients. Healthcare professionals should enhance the protection of high-risk patients with these risk factors in order to reduce the incidence of DVT after hip replacement and to improve the clinical outcome of patients. Due to limitations in the number and quality of studies included, these conclusions need to be validated in more high quality studies.

Abbreviations

DVT: deep vein thrombosis; CBM: China Biology Medicine; CNKI: China National Knowledge Internet; BMI: body mass index; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; AMSTAR: Assessing the methodological quality of systematic review; PROSPERO: Prospective Register of Systematic Reviews; INPLASY: International Platform of Registered Systematic Review and Meta-analysis Protocols; AHRQ: Agency for Healthcare Quality and Research.

Declarations

Ethics approval and consent to participate

Not applicable. All analyses were based on previous published studies; thus,

no ethical approval and patient consent are required.

Consent for publication

Not applicable.

Availability of data and materials

All data are fully available without restriction.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ZH, XLM, and QD contributed to the study design. NNJ, WT, DDC, and XS contributed to the article search. ZH, CH, NNJ, and WT contributed to data extraction. WT, DDC, and XS contributed to table-form making. ZH and QD contributed to the article writing. XLM and QD made the final decision. All authors read and approved the final manuscript.

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Tables

Table 1 Basic characteristics of the included studies

Author	Year	Region	Study type	Number of cases	Number of controls	Control source	Risk factors*
P. Maxwell	2017	USA	Case-Control Studies	324	74081	Patients who underwent hip replacement during the same period without DVT	1,2,3,4,5
GUAN	2019	China	Case-Control Studies	68	60	Patients who underwent hip replacement during the same period without DVT	2,6,8,9,10
Xu	2015	China	Case-Control Studies	30	194	Patients who underwent hip replacement during the same period without DVT	7,10
Kawai	2020	Japan	Case-Control Studies	26	474	Patients who underwent hip replacement during the same period without DVT	2,12,19
SU	2018	China	Case-Control Studies	51	85	Patients who underwent hip replacement during the same period without DVT	2,3,10,11,13
XU	2018	China	Case-Control Studies	15	86	Patients who underwent hip replacement during the	1,2,8,9,11,14,15

						same period without DVT	
LIU	2014	China	Case-Control Studies	20	140	Patients who underwent hip replacement during the same period without DVT	3,6,13
JIA	2015	China	Case-Control Studies	22	29	Patients who underwent hip replacement during the same period without DVT	2,6,10,19
WU	2012	China	Case-Control Studies	30	60	Patients who underwent hip replacement during the same period without DVT	2,6,10,19
YE	2020	China	Case-Control Studies	72	212	Patients who underwent hip replacement during the same period without DVT	2,4,9,10,11,14,16,17,19
DONG	2017	China	Case-Control Studies	212	503	Patients who underwent hip replacement during the same period without DVT	2,5,6,8,16,17
YE	2020	China	Case-Control Studies	46	467	Patients who underwent hip replacement during the same period	2,6,8,13,17

						without DVT	
ZHANG	2015	China	Case-Control Studies	50	112	Patients who underwent hip replacement during the same period without DVT	2,3,6,13
ZANG	2010	China	Case-Control Studies	136	1780	Patients who underwent hip replacement during the same period without DVT	2,3,8,9,14,15,16
ZHANG	2016	China	Case-Control Studies	29	61	Patients who underwent hip replacement during the same period without DVT	6,11
LIU	2013	China	Case-Control Studies	40	262	Patients who underwent hip replacement during the same period without DVT	1,2,5,10,13
ZHONG	2012	China	Case-Control Studies	20	131	Patients who underwent hip replacement during the same period without DVT	1,2,5,10,13
ZHA	2005	China	Case-Control Studies	35	277	Patients who underwent hip replacement during the same period	2,11,14,19

						without DVT	
WEN	2009	China	Case-Control Studies	45	100	Patients who underwent hip replacement during the same period without DVT	2,6,13,18
JIANG	2018	China	Case-Control Studies	154	936	Patients who underwent hip replacement during the same period without DVT	2,3,5,6,8,9,13,18
ZHANG	2016	China	Case-Control Studies	45	491	Patients who underwent hip replacement during the same period without DVT	2,19
MA	2009	China	Case-Control Studies	16	35	Patients who underwent hip replacement during the same period without DVT	1,2,5,6,8,9,10,12,16,18
GAO	2019	China	Case-Control Studies	65	177	Patients who underwent hip replacement during the same period without DVT	6,16,17,19
GUO	2017	China	Case-Control Studies	67	11	Patients who underwent hip replacement during the same period	2,9,17

						without DVT	
GUAN	2005	China	Case-Control Studies	95	45	Patients who underwent hip replacement during the same period without DVT	1,6,11,13
YANG	2010	China	Case-Control Studies	148	68	Patients who underwent hip replacement during the same period without DVT	2,11,12,14,19
GUO	2015	China	Case-Control Studies	118	16	Patients who underwent hip replacement during the same period without DVT	1,2,6,8,11,14,15,19

*1 Male Gender□2 Age>70years□3 General Anesthesia□4 Infection□5 Operating Time□6 BMI□7 HDL-C□8 Diabetes history□9 Hypertension history□10 Hyperlipidemia history□11 Combined cardio-vascular underlying diseases□12 Current steroid use□13 Bone cement prosthesis□14 Training□15 Anticoagulants after surgery□16 Bleeding□17 Postoperative bedtime >3d□18 Type O blood□19 History of varicose veins or deep vein thrombosis.

Table 2 Results of the risk of bias evaluation of the included studies

studies	□	□	□	□	□	□	□	□	□	□	□	Total score
P.Maxwell (2017)	Y	Y	Y	Y	U	Y	N	Y	N	Y	N	7
GUAN (2019)	Y	Y	N	Y	U	Y	N	Y	N	N	N	5
XU (2015)	Y	Y	Y	Y	N	Y	N	Y	N	Y	N	7
Kawai (2020)	Y	Y	Y	Y	N	N	N	Y	N	N	N	5
SU (2018)	Y	Y	Y	U	N	U	N	Y	N	N	N	5
XU (2018)	Y	Y	N	Y	N	Y	N	Y	N	N	N	5
LIU (2014)	Y	Y	N	Y	N	Y	N	Y	N	Y	N	6
KIA (2015)	Y	Y	Y	Y	N	Y	N	Y	N	N	N	6
WU (2012)	Y	Y	Y	Y	U	Y	N	Y	N	N	N	6
YE (2020)	Y	Y	Y	Y	N	Y	N	Y	N	N	N	6
DONG (2017)	Y	Y	Y	Y	N	Y	N	N	N	N	N	5
YE (2020)	Y	Y	Y	Y	N	Y	N	N	N	N	N	5
ZHANG (2015)	Y	Y	Y	Y	N	Y	N	Y	N	Y	N	7
ZANG (2010)	Y	Y	Y	Y	U	Y	N	N	N	Y	N	6
ZHANG (2016)	Y	Y	N	Y	N	Y	N	Y	N	N	N	5
LIU (2013)	Y	Y	Y	Y	N	Y	N	Y	N	N	N	6
ZHONG (2012)	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	7
ZHA (2005)	Y	Y	Y	Y	N	Y	N	N	N	N	N	5
WEN (2009)	Y	Y	Y	Y	N	Y	N	N	N	N	N	5
JIANG (2018)	Y	Y	N	Y	N	Y	N	Y	N	N	N	5
ZHANG (2016)	Y	Y	Y	Y	N	Y	Y	Y	N	N	N	7
MA (2009)	Y	Y	Y	Y	U	N	N	N	Y	N	N	5
GAO (2019)	Y	Y	Y	Y	N	Y	N	N	N	N	N	5
GUO (2017)	Y	Y	Y	Y	N	Y	N	N	N	N	N	5
GUAN (2005)	Y	Y	Y	Y	N	Y	Y	N	N	Y	N	7
YANG (2010)	Y	Y	N	Y	N	Y	N	N	N	Y	N	5
GUO (2015)	Y	Y	Y	Y	N	Y	N	N	N	N	N	6

□ Is the source of information identified, □whether inclusion and exclusion criteria for both exposed and non-exposed groups (cases and controls) or reference to previous publications are listed; □ whether the time

of subject collection is specified; ▯ whether the subjects are representative; ▯whether the measured variables are masked by other characteristics;▯ It describes any assessments carried out for quality assurance, ▯A description of the excluded subjects from the outcome analysis; ▯ A description of how confounding factors were evaluated and/or controlled; ▯ A description of the treatment of missing data; ▯ A summary of the patient response rate and completeness of data collection; ▯ If follow-up is available, identify the expected percentage of patients with incomplete data or the outcome of the follow-up. Y, yes; N, no; U, unclear.

Table 3 Meta-analysis results

Risk factors	Included studies	I^2	Effect models	Meta-analysis results	
				OR（95%CI）	*P-value*
Prevalence	27	98.5%	Random	0.21（0.17，0.25）	<0.0001
Gender	7	93.2%	Random	3.06（1.36，6.88）	0.0001
Age	22	90.7%	Random	2.04（1.73，2.42）	<0.0001
BMI	14	54.7%	Random	3.95（2.69，5.78）	0.007
Blood type	3	0.0%	Fixed	0.55（0.36，0.82）	0.370
Diabetes mellitus	8	25.0%	Fixed	2.78（2.26，3.43）	0.230
Hypertension	7	86.4%	Random	2.52（1.42，4.46）	<0.0001
Hyperlipidemia	9	89.4%	Random	2.47（1.44，4.24）	<0.0001
Combined cardio-vascular underlying diseases	8	85.5%	Random	2.53（1.47，4.37）	<0.0001
History of varicose veins or DVT	9	59.3%	Random	4.21（3.24，5.47）	0.012
Anaesthetic methods	6	93.4%	Random	3.55（1.85，6.82）	<0.0001
Duration of operation	6	91.1%	Random	2.33（1.35，4.04）	<0.0001
Bleeding	4	26.3%	Fixed	2.46（1.62，3.72）	0.254
Bone cement prosthesis	9	93.2%	Random	2.79（2.37，3.29）	<0.0001
Infection	2	41.5%	Fixed	5.66（3.15，10.15）	0.191
Training	6	0.0%	Fixed	0.40（0.32，0.51）	0.020
Current steroid use	3	0.0%	Fixed	4.51（3.76，5.41）	0.486

Box

Box 1 PubMed search strategy

#1 arthroplasties, replacement, hip [Mesh]

#2 arthroplasties, replacement, hip OR hip replacement arthroplasty OR implantation, hip prosthesis OR hip replacement arthroplasty OR total hip replacements

#3 #1 OR #2

#4 thrombosis [Mesh]

#5 thromboses OR blood clot OR clot, blood OR thrombus

#6 #4 OR #5

#7 #3 AND #6

#8 incidence [Mesh]

#9 relative risk

#10 cohort studies [Mesh]

#11 #8 OR #9 OR #10

#12 #7 AND #11

Figures

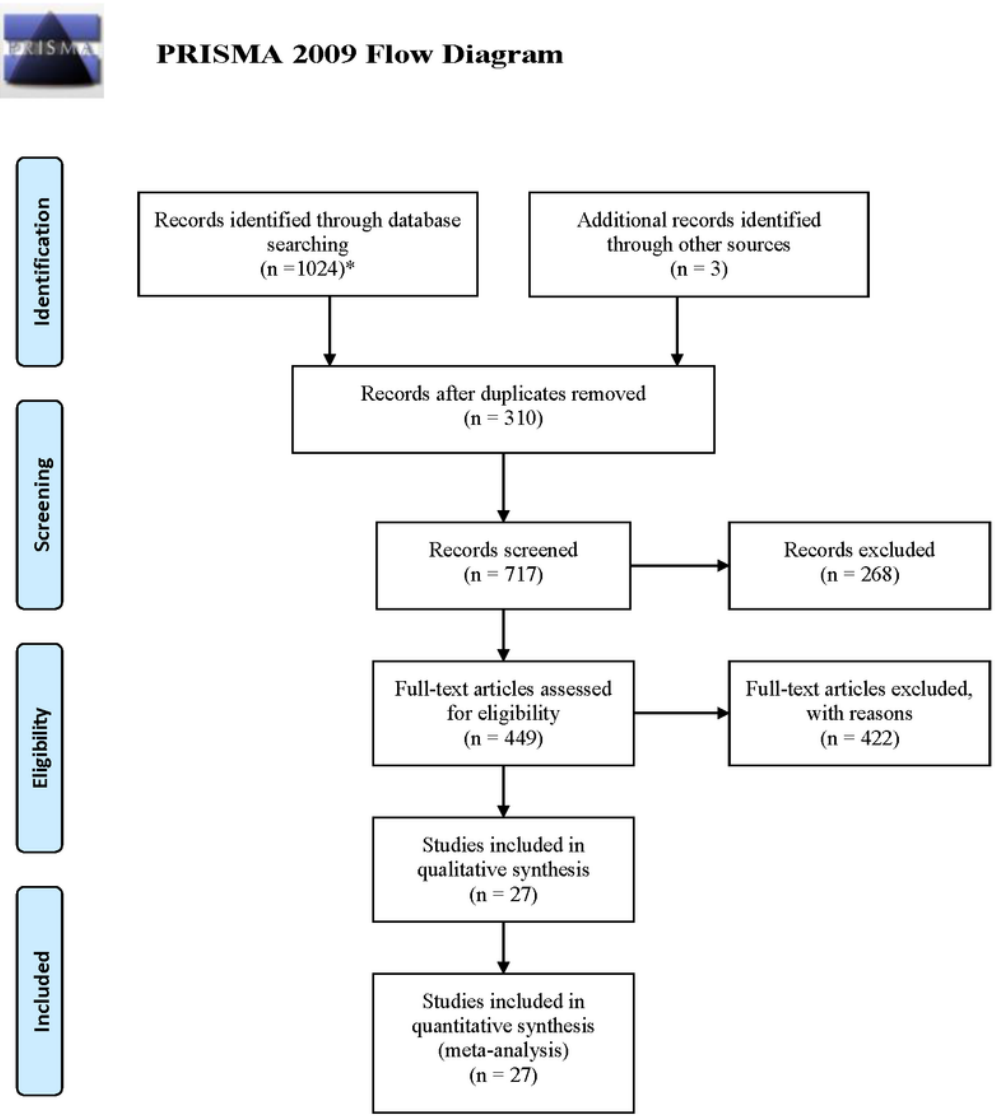

Figure 1

Literature screening process and results. *The databases searched and the number of references found are as follows: PubMed (n=151), Embase (n=69), The Cochrane Library (n=9), CBM (n=67), CNKI (n=409), Wanfang data (n=252), VIP (n=66).

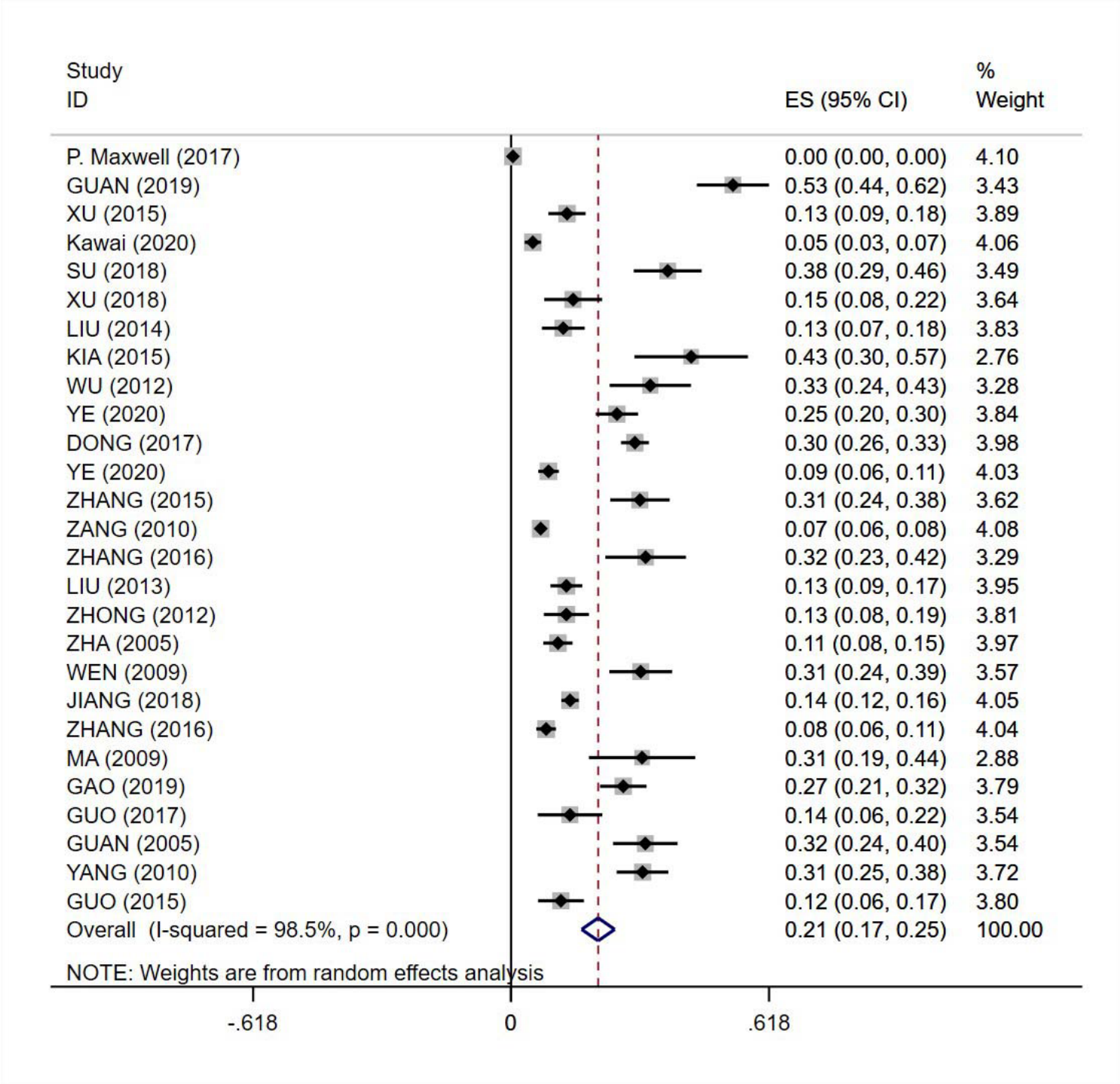

Figure 2

Meta-analysis of the Prevalence of DVT after hip replacement.

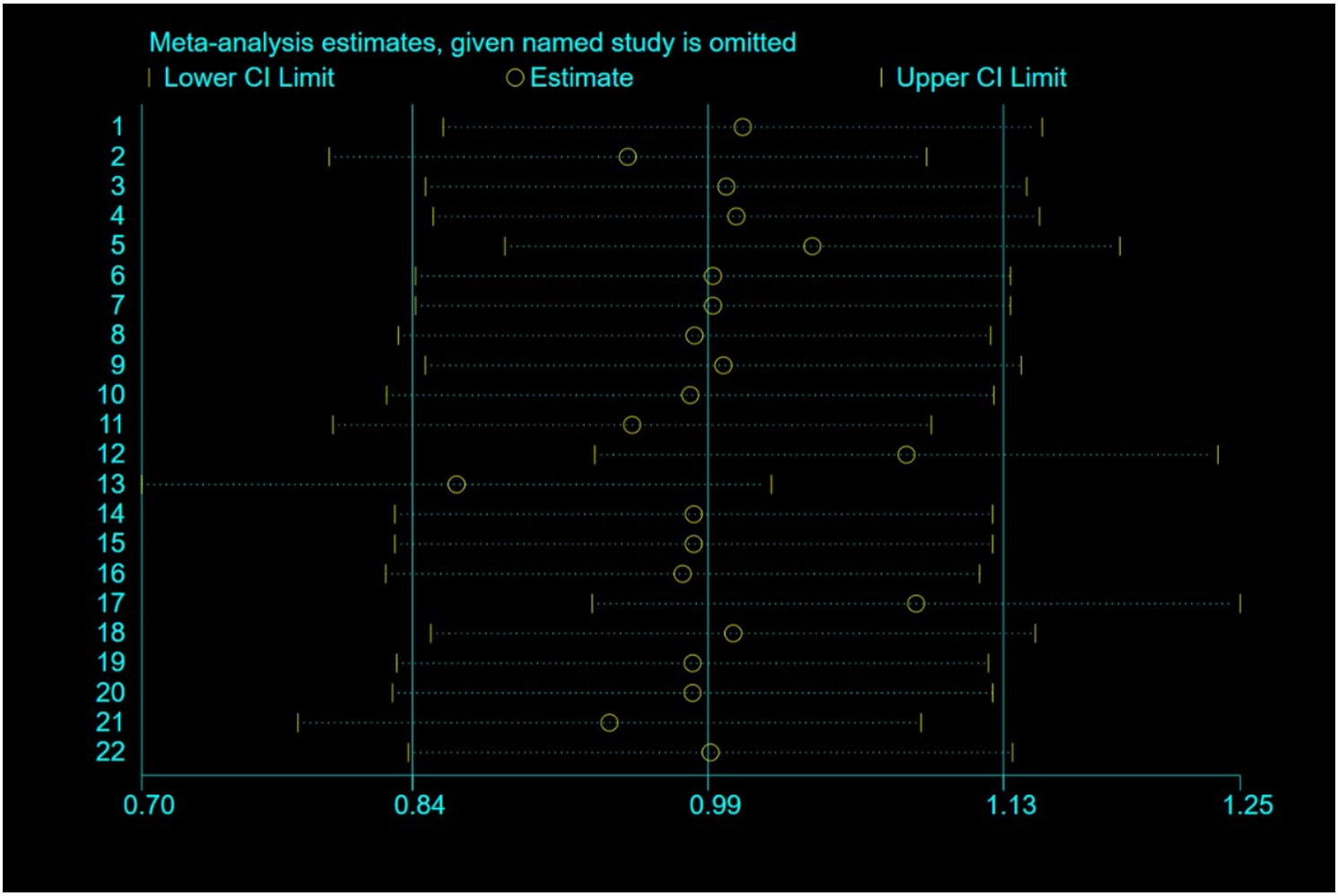

Figure 3

Sensitivity analysis of age as a risk factor for DVT after hip arthroplasty

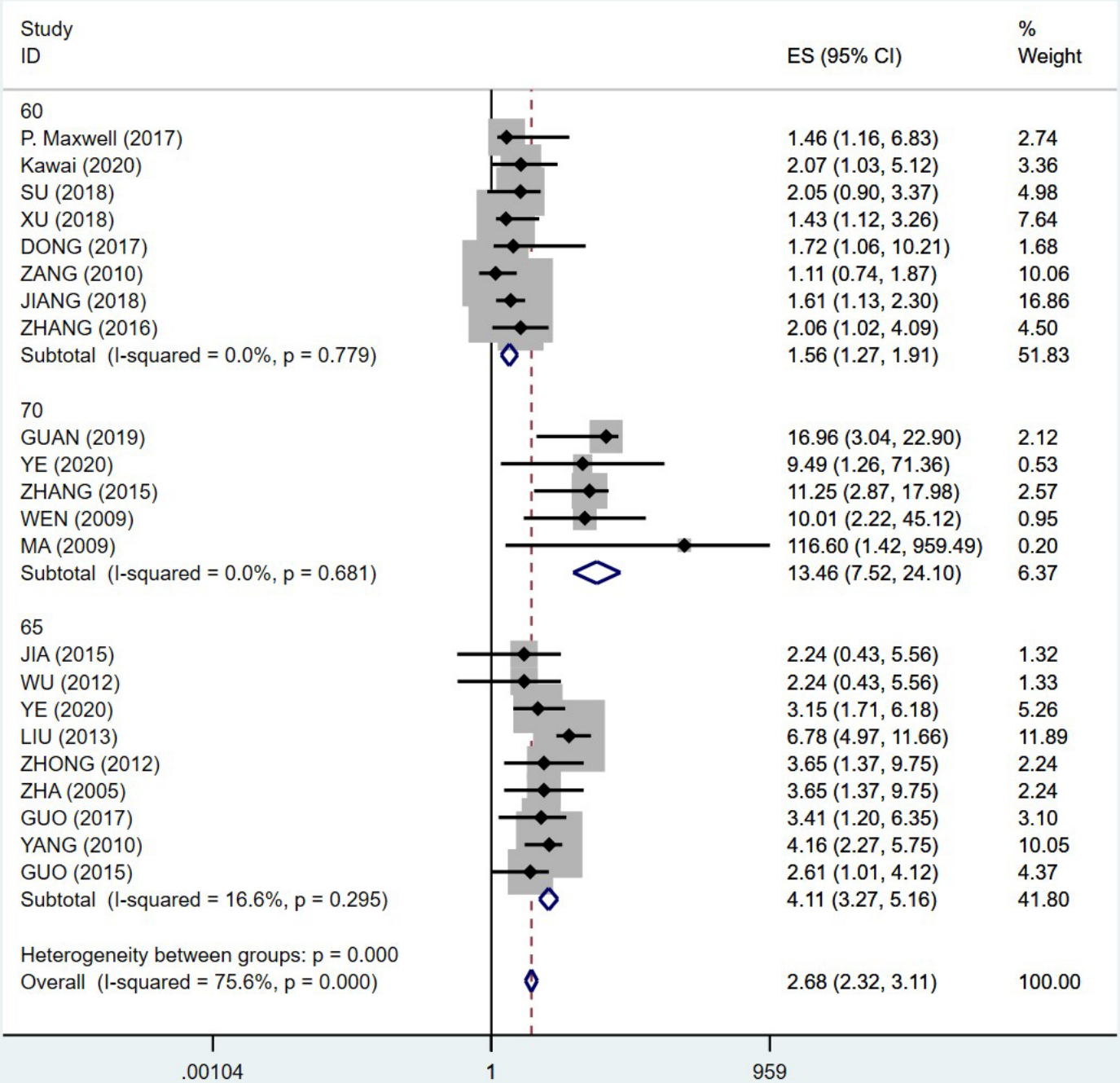

Figure 4

Meta-analysis of the association between age and DVT after hip replacement.

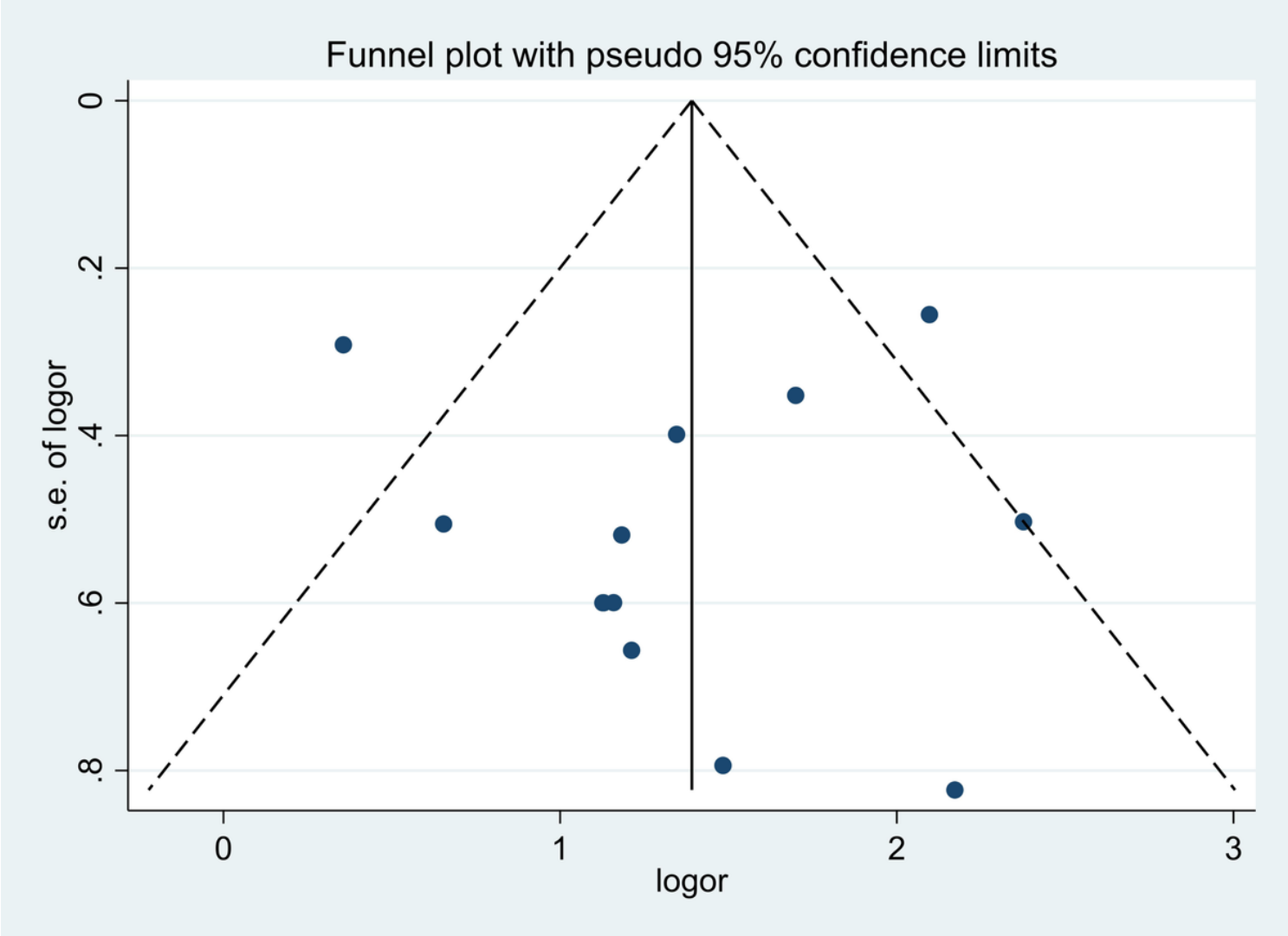

Figure 5

Publication bias for BMI.