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The influence of body mass index on the outcomes of primary total knee arthroplasty

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Abstract
Purpose The body mass index (BMI) is widely recognized as a prognostic factor in multiple operations; however, the relationship between the BMI and outcomes following total knee arthroplasty (TKA) is extensively debated. We aimed to evaluate the effect of the BMI at different cutoff values on the outcomes following primary TKA.
Methods Electronic databases (PubMed/Medline, CENTRAL, Embase and Web of Science) were systematically searched for studies investigating the association between the BMI and outcomes following primary TKA. Two investigators independently reviewed studies for eligibility, assessed the study quality using the Newcastle-Ottawa Scale and extracted the data. A meta-analysis was performed using Review Manager software.
Results Twenty-eight articles including a total of 20,988 TKAs were identified. The postoperative Knee Society Score appeared to trend lower in obese (BMI $\geq$ 30 kg/m^2) patients than in non-obese (BMI < 30 kg/m^2) patients. The meta-analysis showed that revision with follow-up $\geq$5 years, any infection, superficial infection and deep vein thrombosis occurred statistically more frequently in obese patients, whereas a deep infection occurred statistically more frequently in morbidly obese (BMI $\geq$ 40 kg/m^2) patients than in non-obese patients. No differences in aseptic loosening with follow-up $\geq$5 years, pulmonary embolism and perioperative mortality rates were found between obese and non-obese patients.
Conclusions Patients with a BMI $\geq$ 30 kg/m^2 are at a higher risk of lower functional scores and developing complications following primary TKA. It appears reasonable to encourage obese patients to lose weight before selective TKA.
Level of evidence Prognostic study, Level III.

Keywords Total knee arthroplasty · Body mass index · Obesity · Systematic review · Meta-analysis

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Introduction

According to the World Health Organization (WHO) Guidelines, a body mass index (BMI) of $\geq$30 kg/m^2 is defined as obese, $\geq$35 kg/m^2 as highly obese and $\geq$40 kg/m^2 as morbidly obese [8, 39]. With its incidence increasing worldwide, obesity is widely recognized as a frequent cause of multiple medical comorbidities [3, 14, 32], and many studies have indicated that obesity is a well-documented risk factor for the pathogenesis and progression of knee osteoarthritis (OA) [25, 34, 40]. Conservative treatment is used initially to treat knee OA; however, total knee arthroplasty (TKA) becomes necessary as the disease progresses.

Many obese patients are among the patients treated by TKA. It is reasonable to assume that a high BMI would lead to increased stress across the implant-bone interface and an increased load on the surrounding bone that might be associated with poor outcomes and higher failure rates. The relationship between the BMI and the outcomes of TKA is presently unclear, and the literature includes differing opinions. Some studies have found similar results from TKA in obese and non-obese patients [5, 13, 18, 33], whereas others have determined that obesity has a negative influence on TKA outcomes [21, 24, 33, 42]. Such consequences include poor functional outcomes, increased risk of perioperative complications and failures/revisions of the prosthesis [8, 10, 24, 42]. Additionally, there is no definitive cutoff of BMI that accurately separates high-risk from low-risk patients. A threshold of 30 kg/m^2 remains controversial, and studies in which patients were categorized using BMI cutoff values of 35 and 40 kg/m^2 were able to identify more differences [7, 8, 30].

Thus, defining the relationship between BMI and TKA outcomes has become increasingly important, and evidence-based findings might be helpful for orthopedic surgeons in evaluating the risk of postoperative complications and determining whether losing weight should be encouraged before selective TKA in obese patients. The objectives of this study were to evaluate the influence of BMI on the outcomes following primary TKA and to attempt to establish a BMI cutoff level above which patients were at a higher risk of poor outcomes.

Materials and methods

Search strategy and selection criteria

The search strategy followed the recommendations of the Cochrane Collaboration [19]. The electronic databases of PubMed/Medline (1966 to March 2014), CENTRAL (The Cochrane Central Register of Controlled Trials, Issue 3 of 12, March 2014), Embase (1984 to March 2014) and Web of Science (1994 to March 2014) were searched for publications on BMI and TKA. The search strategy used a combination of the following terms: total knee arthroplasty or total knee replacement, and body mass index, BMI, body weight or obesity. The reference lists of the retrieved publications were searched for additional studies that potentially met the criteria without having been retrieved by the electronic search.

A study was included if it met the following inclusion criteria: (1) cohort (Level II or Level III) or case–control (Level III) studies; (2) all the participants underwent a primary TKA; (3) BMI values were calculated and categorized according to the WHO Guidelines described above; (4) postoperative functional outcomes and/or complications were reported; (5) exposures and outcomes were measured by health professionals or trained investigators or extracted from medical records; and (6) the article was written in English. The exclusion criteria for the studies were as follows: (1) The participants were part of a BMI intervention/health promotion program; (2) the participants underwent a primary TKA because of the failure of previous knee surgery; (3) the BMI values were categorized using arbitrary cutoff points; (4) the exposures and/or outcomes were patient-reported; and (5) the publication was a review article, case-report or meeting abstract, or the publication documented a surgical technique or expert opinion.

After exclusion of the duplicates, two investigators independently screened the titles and abstracts to enable exclusion of irrelevant studies and identify relevant articles for the full-text review. Then, two reviewers independently reviewed the full text of the remaining articles and evaluated them against the inclusion/exclusion criteria described above to select articles for inclusion in this review. Disagreements regarding whether an article should be included or excluded were resolved by discussion, with arbitration by a third author if discrepancies remained.

The level of evidence and quality assessment

The level of evidence of each included study was assessed according to the level-of-evidence rating system which categorizes each article at one of five levels (I, II, III, IV or V) on the basis of its design and as one of four types (therapeutic, prognostic, diagnostic, or economic or decision analysis) on the basis of its content [41]. The quality of the included studies was assessed using the Newcastle-Ottawa Scale (NOS) based on recommendations by the Cochrane non-randomized studies methods working group during the initial paper screening and selection. Details of the NOS are provided at http://www.ohri.ca/programs/clinical_epidemiology/oxford.htm. This scale is designed specifically for assessing non-randomized studies on the basis of: (1) selection of study groups, (2) comparability of study groups and (3) assessment of exposures and outcomes. High-quality characteristics within each of these items are awarded a star, up to a maximum of four stars for selection, two stars for comparability and three stars for assessment. Two investigators independently assessed the quality of the studies according to the NOS criteria and any differences were resolved by discussion, with arbitration by a third author if differences remained.

Statistical analysis

Two reviewers independently extracted the data from each included study for further analysis. Disagreements were resolved by discussion, with arbitration by a third author if disagreements remained. A meta-analysis of the available data was performed if the data could be pooled, using Review Manager 5.2 software from the Cochrane Collaboration. The weighted odds ratio and 95 % confidence interval (95 % CI) were calculated for the dichotomous variables; the weighted mean difference and accompanying 95 % CI were calculated for the continuous variables. The heterogeneity of the included studies was calculated using the I^2 statistic and chi-square test [20]. An I^2 of 0 % could be considered to represent no heterogeneity, 25 % represents low, 50 % represents moderate and 75 % represents high heterogeneity. It is correct to use a fixed-effects model for an I^2 value of up to 50 %, and a random-effects model when I^2 exceeds 50 %. A chi-square test with a p value <0.10 was considered suggestive of statistical heterogeneity.

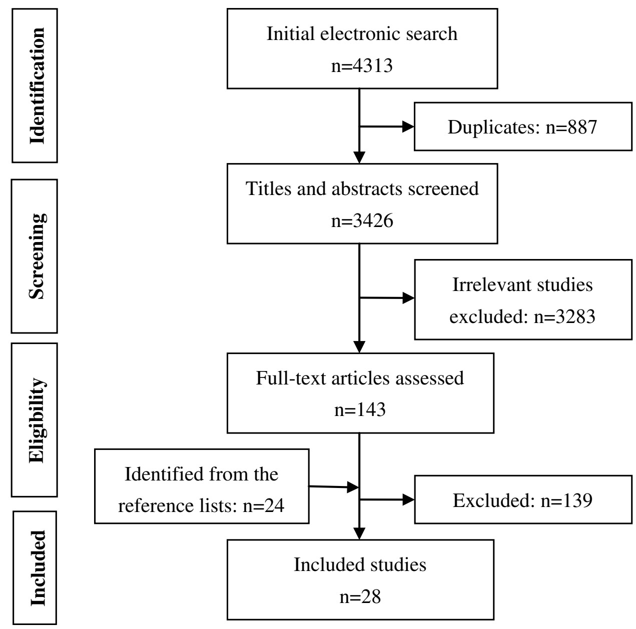


Fig. 1 Flow chart showing the identification of the included studies

Results

The identification of the studies is shown in Fig. 1. We identified 4,337 potential articles (1,053 from PubMed; 2,236 from Embase; 66 from CENTRAL; 958 from Web of Science; and 24 from the reference lists). Twenty-eight articles that included a total of 20,988 TKAs fulfilled the inclusion criteria [1, 2, 4–13, 15–18, 21–24, 27–30, 33, 36, 37, 42]. The major characteristics, evidence level, NOS scores and results are shown in Table 1. Twenty-six of the 28 studies were published after 2000, and 11 were published in the previous 5 years. All of the included studies scored five or more stars on the NOS.

There were more female than male patients in both groups, and the obese patients (BMI $\geq$ 30 kg/m^2) were younger than the non-obese patients (BMI < 30 kg/m^2; see Table 1). The most commonly reported functional outcomes of primary TKA were the Knee Society Score (KSS), which consists of a separate postoperative knee and function score [1]. Some studies have found significant differences in the postoperative knee and/or function score and/or improvement of the KSS (postoperative minus preoperative) between obese and non-obese patients [8, 15–17, 24], as well as between highly/morbidly obese and non-obese patients [1, 8, 15]. However, many studies observed no significant differences between the scores of obese and non-obese patients [2, 4, 9, 10, 13, 15, 17, 18, 21, 24, 29, 33, 36], although in most of these studies, there was a tendency for obese patients to have a lower postoperative knee and/or function score, and/or lower improvement in KSS compared with non-obese patients. Most of the studies reported the KSS with a range rather than a mean value and standard deviation, and these data could not be pooled for the meta-analysis. The postoperative KSS and/or improvement of the KSS appeared to trend lower in obese patients than in non-obese patients and even lower in highly and morbidly obese patients.

Results of the meta-analysis

Table 2 shows the results of the meta-analysis. The TKA revision rate with follow-up ≥5 years in the obese and non-obese patients was reported in 11 studies that included 2,925 TKAs. No heterogeneity among these studies was found (I^2, 0 %). Revision occurred more frequently in obese patients than in non-obese patients, with an odds ratio of 1.60 (95 % CI 1.07–2.40) (Fig. 2). There were four studies including 788 TKAs that reported revision rates in morbidly obese and non-obese patients. No heterogeneity among these studies was found (I^2, 0 %). Morbidly obese patients did not have a significantly higher revision rate than non-obese patients, with an odds ratio of 1.98 (95 % CI 0.88–4.45).

The presence of any infection after TKA in obese and non-obese patients was reported in 15 studies that included 15,938 TKAs. The heterogeneity among these studies was low, with an I^2 of 9 %. The risk of any infection was significantly greater in obese patients than non-obese patients, with an odds ratio of 1.45 (95 % CI 1.13–1.84) (Fig. 3). The infection rate was higher in highly and

Table 1 Summary of the characteristics, level of evidence, NOS scores and results of the included studies

References	Patients (knees)		Sex (male: female)		Mean BMI (kg/m^2)		Mean age (years)		Mean F/U (years)		Study type	Level of evidence	NOS	Results
	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG				
Razak et al. [33]	256	113	56:200	17:96	17.9–22.9	30.0–51.3	67	63	2	2	Co	III	8★	−
Issa et al. [21]	210	210	NA	NA	18–29.9	30–39.9	64	62	4.7	4.7	Co	III	7★	+
Jarvenpaa et al. [24]	29	23	NA	NA	NA	NA	NA	NA	10.8	10.8	Co	III	7★	+
Collins et al. [8]	236	209	NA	NA	26.4	34.5	66.4	64.9	9	9	Co	II	8★	+
Yeung et al. [42]	50	50	12:38	12:38	25.2 ± 3.2	34.1 ± 3.8	69 ± 5.5	69 ± 5.9	7.4 ± 1.9	7.2 ± 1.9	CC	III	8★	±
Jarvenpaa et al. [23]	48	52	20:28	14:38	26.1	33.0	68.8	67.4	0.3	0.3	Co	II	5★	+
Dowsey et al. [12]	211	318	84:127	80:238	27	NA	74	NA	1	1	Co	II	7★	+
Jackson et al. [22]	382	153	162:220	46:107	25.2 ± 2.7	34.5 ± 4.0	72 ± 8.4	67 ± 9.6	9.2 ± 2.4	9.4 ± 2.5	Co	II	8★	±
Dowsey et al. [11]	499	715	232:267	217:498	26	NA	74	NA	1	1	Co	II	6★	±
Dewan et al. [10]	85	135	35:50	67:68	25 ± 0.3	NA	66 ± 1.3	NA	6 ± 0.3	5.4 ± 0.2	Co	III	7★	±
Bordini et al. [5]	6,532	3,203	1,678:4,854	603:2600	NA	NA	NR	NR	3.1	3.1	Co	III	7★	−
Ersozlu et al. [13]	40	96	28:12	18:78	27.3 ± 3.7	NA	67.2 ± 8.9	NA	2.7	2.8	Co	III	7★	−
Chesney et al. [7]	710	568	NA	NA	NR	NR	NA	NA	5	5	Co	II	8★	−
Krushell et al. [27]	39	39	NR	NR	25.5	44.2	68.9	67.4	7.5	7.5	CC	III	8★	±
Bourne et al. [6]	299	496	NA	NA	NR	NR	NA	NA	9.5	9.5	Co	II	6★	−
Hamoui et al. [18]	53	30	NA	NA	25.7	32.3	NA	NA	11.2	11.5	Co	III	7★	−
Amin et al. [2]	181	147	97:84	60:87	26.3 ± 2.3	34.2 ± 3.1	69.8 ± 7.6	67.4 ± 7.5	5	5	Co	II	7★	−
Amin et al. [1]	41	41	11:30	11:30	27.0	43.2	62.8	62.2	3.7	3.2	CC	III	8★	+
Namba et al. [30]	1,391	422	590:801	106:316	29 ± 4	41 ± 5	69 ± 10	64 ± 9	1	1	Co	II	7★	+
Foran et al. [16]	30	30	19:11	19:11	25	34	59	62	15.4	14.5	CC	III	9★	±
Foran et al. [15]	78	78	28:50	16:62	26.2 ± 2.5	35.3 ± 4.2	70 ± 7.9	66 ± 8.6	6.9	6.7	CC	II	8★	+
Vazquez-Vela et al. [37]	301	138	109:192	55:83	NR	NR	NA	NA	10	10	Co	III	6★	±
Deshmukh et al. [9]	114	66	NS	NA	NA	NA	NA	NA	5 − 10	5 − 10	Co	II	8★	−
Miric et al. [28]	404	108	NA	NA	NA	NA	NA	NA	<5	<5	Co	III	7★	+
Spicer et al. [36]	425	326	176:249	124:202	NR	NR	69.7	NA	6.1	6.3	Co	III	7★	±
Benjamin et al. [4]	239	166	98:141	54:112	NA	NA	NR	NR	>0.5	>0.5	Co	III	6★	−
Griffin et al. [17]	41	32	NR	NR	25.4	35	67.8	67.8	10.6	10.6	Co	III	7★	±
Mont et al. [29]	50	50	NA	NA	NR	NR	58	61	5.2	5.4	CC	III	8★	−

BMI body mass index, *CG* control group that patients with a BMI < 30 kg/m^2, *EG* experimental group that patients with a BMI ≥ 30 kg/m^2, *F/U* follow-up, *NOS* Newcastle-Ottawa Scale, *NA* not applicable, *NR* not reported, *Co* cohort study, *CC* case–control study

+ positive correlation between BMI and outcomes

− negative correlation between BMI and outcomes

± both positive and negative correlation between BMI and outcomes were reported morbidly obese patients than in non-obese patients, with odds ratios of 1.68 (95 % CI 1.03–2.74) and 4.01 (95 % CI 2.26–7.11), respectively (Table 2). Additionally, we analyzed superficial and deep infections separately in studies that distinguished between them. Superficial infection occurred more frequently in obese patients than in non-obese patients, with an odds ratio of 1.67 (95 % CI 1.19–2.34). Morbidly obese patients had an even higher risk of superficial infection, with an odds ratio of 6.81 (95 % CI 3.36–13.81). The deep infection rates did not differ significantly between obese and non-obese patients, with an odds ratio of 1.26 (95 % CI 0.88–1.81), or between highly obese and non-obese patients, with an odds ratio of 1.67 (95 % CI 0.71–3.90). However, the deep infection rate was significantly higher in morbidly obese patients than in non-obese patients, with an odds ratio of 2.89 (95 % CI 1.37–6.07; (Fig. 4).

In addition to revision and infection, the major postoperative complications reported in the included studies were deep vein thrombosis (DVT), pulmonary embolism (PE), aseptic loosening and perioperative mortality. Six studies, comprising 11,566 TKAs, reported DVT occurrence in obese and non-obese patients, and three studies, comprising 7,054 TKAs, reported DVT occurrence in morbidly obese and non-obese patients. No heterogeneity was found among the studies. DVT occurred more frequently in obese and morbidly obese patients than in non-obese patients, with an odds ratios of 2.70 (95 % CI 1.35–5.39) and 8.19 (95 % CI 1.85–36.37), respectively. There were no statistically significant differences in the rates of prosthetic aseptic loosening with follow-up ≥5 years or in the rates of PE or perioperative mortality rates between obese and non-obese patients, with odds ratios of 1.49 (95 % CI 0.47–4.66), 0.68 (95 % CI 0.27–1.68) and 0.49 (95 % CI 0.15–1.64), respectively.

Discussion

With the alarming increase in the number of obese individuals worldwide, orthopedic surgeons might perform a large proportion of TKA on these patients in the future. Obesity is known as a risk factor for postoperative complications. However, the relationship between the BMI and the outcome after TKA is frequently debated because conflicting results have been reported [40]. In this review, we examined the available published studies to evaluate the influence of the BMI on the outcomes following primary TKA. This meta-analysis showed that obese patients (BMI ≥ 30 kg/m^2) had a higher revision rate after TKA with follow-up ≥5 years as well as higher rates of any infection, superficial infection and DVT than did non-obese patients (BMI < 30 kg/m^2). No difference in the deep infection rate was found between obese and non-obese patients or between highly obese (BMI ≥ 35 kg/m^2) and non-obese patients. However, deep infection occurred more frequently in morbidly obese patients (BMI ≥ 40 kg/m^2) than in non-obese patients. As the BMI increased, the rates of any infection, superficial infection and DVT increased in highly and morbidly obese patients compared with those in non-obese patients. There was no statistically significant difference in the revision rate between morbidly obese and non-obese patients. The small number of included studies—four studies containing 788 TKAs (Table 2)—might have contributed to this finding, and it might not reflect the true effect of morbid obesity on the revision rate following primary TKA. Additionally, there were no significant differences in the rates of aseptic loosening of the artificial joint with follow-up ≥5 years, pulmonary embolism and perioperative mortality between obese and non-obese patients; however, these three outcomes could not be evaluated at a BMI cutoff level of 35 or 40 kg/m^2 because too few studies have been published. Obesity was a risk factor in the increasing rates of revision with follow-up ≥5 years, infection and DVT following primary TKA, and more research is necessary to evaluate the effect of BMI on complications of primary TKA.

The KSS, a joint-specific outcome scoring system compromised of separate knee and function scores, was the most commonly reported functional outcome. Positive and negative results have been reported, and we could not qualitatively estimate the effect of the BMI on KSS because most of the studies reported the KSS with a range rather than a mean value and standard deviation, which are required for a meta-analysis. Walter and Yao [38] described a method of calculating the standard deviation for a continuous variable reported with a range. However, this method is valid only if the variable is normally distributed, and some caution might be required for non-normal data. We could not judge the distribution of the data from the included studies, and even if this method had been used, the converted KSS data could not be pooled because of high heterogeneity. Thus, further research on the functional outcomes after TKA is required.

In this review, we attempted to establish a cutoff level of the BMI, above which patients were at a higher risk of developing postoperative complications. According to the results discussed above, a BMI of 30 kg/m^2 might represent the cutoff level of BMI above which patients are at a higher risk of having a revision with follow-up period ≥5 years, superficial infection and DVT following primary TKA. A BMI of 40 kg/m^2 might be the cutoff level above which patients are at higher risk of developing a deep infection.

A study by Bordini et al. consisted of 9,735 TKAs. The infection rate reported was very low, with a rate of any

Table 2 Results of the meta-analysis

Outcomes	Studies (*n*)	TKAs (*n*)	Events (*n*)	Chi^2 (*p* value)	I^2 (%)	Odds ratio (95 % CI)
BMI ≥ 30 kg/m^2 versus BMI < 30 kg/m^2						
Revision[a]	11	2,925	102	0.61	0	1.60 [1.07, 2.40]
Infection						
Superficial infection	9	13,050	149	0.24	23	1.67 [1.19, 2.34]
Deep infection	10	14,906	128	0.29	17	1.26 [0.88, 1.81]
Any infection	15	15,938	289	0.35	9	1.45 [1.13, 1.84]
Aseptic loosening[a]	4	656	10	0.57	0	1.49 [0.47, 4.66]
Deep vein thrombosis	6	11,566	37	0.90	0	2.70 [1.35, 5.39]
Pulmonary embolism	3	10,669	23	0.38	0	0.68 [0.27, 1.68]
Perioperative mortality	3	10,550	14	0.95	0	0.49 [0.15, 1.64]
BMI ≥ 35 kg/m^2 versus BMI < 30 kg/m^2						
Infection						
Deep infection	3	1,728	24	0.71	0	1.67 [0.71, 3.90]
Any infection	3	1,728	80	0.60	0	1.68 [1.03, 2.74]
BMI ≥ 40 kg/m^2 versus BMI < 30 kg/m^2						
Revision[a]	4	788	31	0.91	0	1.98 [0.88, 4.45]
Infection						
Superficial infection	6	7,958	60	0.59	0	6.81 [3.36, 13.81]
Deep infection	7	8,900	67	0.55	0	2.89 [1.37, 6.07]
Any infection	9	9,106	133	0.35	10	4.01 [2.26, 7.11]
Deep vein thrombosis	3	7,054	15	0.68	0	8.19 [1.85, 36.37]

[a] Follow-up ≥5 years

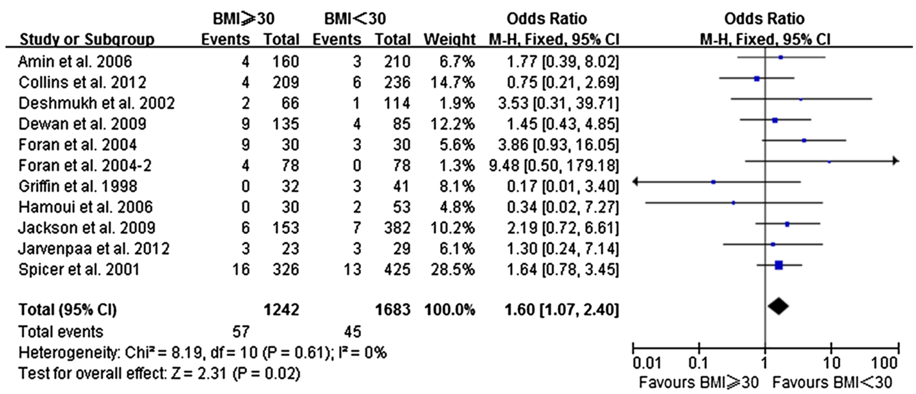


Fig. 2 Revision rate after TKA according to BMI (kg/m^2) in studies with follow-up ≥5 years *CI* confidence Interval, *M–H* Mantel–Haenszel, *df* degrees of freedom

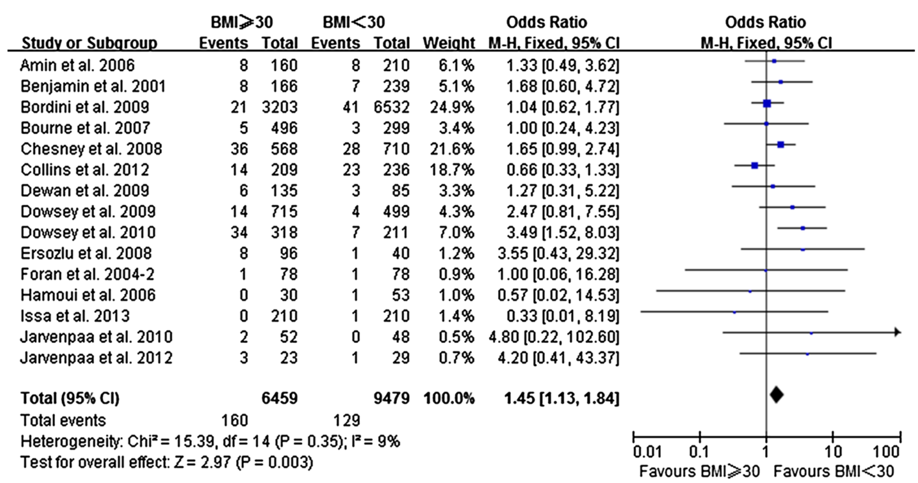
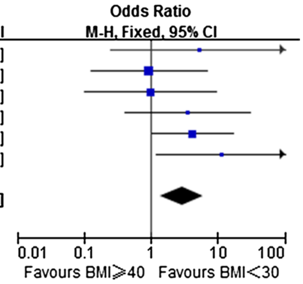


Fig. 3 Any infection rate after TKA according to BMI (kg/m^2) *CI* confidence interval, *M–H* Mantel–Haenszel, *df* degrees of freedom

Fig. 4 Deep infection rate after TKA according to BMI (kg/m^2) *CI* confidence interval, *M–H* Mantel–Haenszel, *df* degrees of freedom

Study or Subgroup	BMI≥40 Events	BMI≥40 Total	BMI<30 Events	BMI<30 Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Amin et al. 2006-2	2	41	0	41	7.2%	5.25 [0.24, 112.88]
Bordini et al. 2009	1	172	41	6532	32.0%	0.93 [0.13, 6.77]
Bourne et al. 2007	1	101	3	299	23.0%	0.99 [0.10, 9.59]
Chesney et al. 2008	1	34	6	710	8.2%	3.56 [0.42, 30.39]
Dowsey et al. 2009	4	123	4	499	23.4%	4.16 [1.03, 16.87]
Dowsey et al. 2010	3	57	1	211	6.2%	11.67 [1.19, 114.39]
Total (95% CI)		**528**		**8292**	**100.0%**	**2.89 [1.37, 6.07]**
Total events	12		55			

Heterogeneity: Chi² = 3.99, df = 5 (P = 0.55); I² = 0%
Test for overall effect: Z = 2.80 (P = 0.005)



infection of 0.64 %, a superficial infection rate of 0.04 %, and a deep infection rate of 0.60 % in obese and non-obese patients as well as rates of 0.63, 0 and 0.63 %, respectively, in morbidly obese and non-obese patients. This study accounted for large weight because of its large population, and it might have introduced bias into the meta-analysis and influenced the results. If this study were ignored, the deep infection result in obese patients would be reversed, with an I^2 of 0 % and an odds ratio of 1.71 % (95 % CI 1.04–2.82), suggesting that deep infection occurred more frequently in obese patients. However, the results for the rates of any infection, superficial infection and DVT would not have fundamentally changed.

Kerkhoffs et al. [26] published a systematic review and meta-analysis regarding the effect of obesity on the complication rates and outcomes of TKA. It included 20 studies published before 2010. A comparison of obese and non-obese patients was performed, and statistically significant differences were observed. However, a few of the studies included in the meta-analysis might be inappropriate, such as those of Amin et al. [1] and Krushell et al. [27] who reported only the outcomes of morbidly obese and non-obese patients following primary TKA and those of Miric et al. [28] and Namba et al. [30], who reported the outcomes of highly obese and non-highly obese patients. Bias might be introduced if these data were included in the comparison of obese and non-obese patients. In comparison with the previous study, this study has included the latest literature and accurately evaluated the effect of the BMI at different cutoff values on the outcomes of primary TKA, and the results differ somewhat from those of the previous study.

This study also has some limitations. It is difficult to design high-quality studies on the effect of the BMI on the outcomes of TKA because the participants could not be randomly assigned to exposure groups, and blinding is only partially possible. Because obtaining Level I evidence is difficult, we tried to capture all the comparative studies, including cohort (Level II and Level III) and case–control studies (Level III), which, at present, provide the best source of information regarding the effect of the BMI on the outcomes of TKA. Other confounding factors, such as the diagnosis, comorbidities, activity level, operative side, population heterogeneity and surgical technique variations within the included studies might have affected the results. Despite these limitations, we were able to include and analyze 28 studies published in the past 16 years, and all the studies had NOS scores of five or more stars, suggesting that these studies are comparable and that pooling them is advisable.

This evidence-based study suggests that a BMI ≥ 30 kg/m^2 have a negative influence on outcomes of primary TKA, and it would appear to be reasonable that obese patients should be encouraged to lose weight before selective TKA. However, should patients who fail to lose weight undergo TKA or have bariatric surgery, or are there other options? Parvizi et al. [31] reported that bariatric surgery was successful in reducing the BMI of morbidly obese patients before TKA, and the cumulative KSS had an excellent outcome with an acceptable complication rate. Severson et al. [35] concluded that patients who undergo bariatric surgery and TKA experienced increased rates of perioperative complications regardless of the temporal relationship between the bariatric surgery and TKA. Therefore, it is important to determine in the future whether weight loss prior to TKA as well as the weight loss method used would improve the outcomes of TKA in obese patients.

Conclusions

A BMI ≥ 30 kg/m^2 might have a negative influence on the outcomes of primary TKA, and patients with a BMI ≥ 30 kg/m^2 are at higher risk of lower functional scores and the development of complications. It appears reasonable that obese patients should be encouraged to lose weight before selective TKA, and further high-quality studies to provide more evidence on this topic are required.

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