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Systematic Review

Impact of Benign Prostatic Hyperplasia on Postoperative Complications and Periprosthetic Joint Infections After Total Joint Arthroplasty: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Total joint arthroplasty (TJA) is one of the most frequently performed surgical procedures each year, offering considerable cost-effectiveness and numerous benefits. However, certain postoperative complications can be observed following TJA. While the relationship between various comorbidities and these complications has been well-documented, this study aims to specifically investigate the impact of benign prostatic hyperplasia (BPH) on postoperative outcomes.

Methods: For this systematic review, we searched PubMed, Scopus, and Web of Science using terms like "total hip arthroplasty," "total knee arthroplasty," "BPH," and "benign prostatic hypertrophy." Screening of retrieved articles was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Studies comparing complications in TJA between patients with and without preexisting BPH were eligible for inclusion. Data extraction was performed on the included articles, and their quality was assessed using the Newcastle-Ottawa scale. A meta-analysis was conducted using the Mantel-Haenszel method.

Results: This systematic review encompassed 4 articles evaluating TJA outcomes in men with a history of BPH, involving a total of 75,222 male cases. Among these, 17,183 cases (23%) presented with symptomatic BPH. The meta-analysis revealed that the incidence rate of periprosthetic joint infection did not significantly differ between BPH and non-BPH groups across both total hip and knee arthroplasty cases (odds ratio [OR] (95% confidence interval [CI]) = 1.28 [0.92-1.79]). However, postoperative urinary retention was significantly higher among patients with BPH (OR [95% CI] = 3.43 [2.04-5.78]). Additionally, patients with BPH exhibited a notably elevated incidence of postoperative urinary tract infection (OR [95% CI] = 2.55 [2.33-2.79]), as well as sepsis (OR [95% CI] = 1.31 [1.09-1.58]).

Conclusions: It is noteworthy that while patients with BPH are prone to certain complications, meta-analysis indicate that BPH cannot be considered a comorbidity that increases the risk of periprosthetic joint infection.

Introduction

Total joint arthroplasty (TJA) stands as a remarkably effective treatment for severe joint conditions, offering pain relief and functional restoration to patients. As one of the most frequently conducted procedures annually, its utilization continues to rise due to the aging population and the escalating demand for joint replacements [1]. Despite its considerable cost-effectiveness and advantages, TJA may entail certain postoperative complications, including periprosthetic joint infection (PJI), pulmonary embolism, urinary tract infection (UTI), urinary retention, peripheral nerve injury, and others [2-4]. Typically, individuals of male gender, obesity, diabetes mellitus, prolonged operation time, and elderly patients are at a heightened risk of experiencing complications and

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achieving poorer outcomes following TJA compared to other patient groups [5,6].

Benign prostatic hyperplasia (BPH), characterized by the noncancerous enlargement of the prostate gland, affects millions of men and poses a potential risk factor for postoperative urinary retention by compressing the urethra and obstructing the bladder outlet. To avert this complication and bladder overdistension, urinary catheters are frequently employed in patients undergoing TJA [7,8]. However, prolonged catheterization, particularly exceeding 2 days, is associated with an increased risk of UTI, which is also recognized as a medical complication following TJA [9]. In a study, postoperative UTI has been shown to increase the risk of PJI. However, the current evidence is insufficient to draw definitive conclusions about the association between postoperative UTI and PJI [10]. Given the rising incidence of PJI, it is crucial to further investigate various factors that might contribute to the occurrence of this complication [11,12].

Hence, as elucidated, BPH might pose a potential risk factor for the onset of PJI and other complications subsequent to TJA, despite the apparent lack of direct correlation between these conditions. Recognizing the potential interplay between BPH and TJA complications, particularly those of paramount importance such as PJI, holds significant relevance for surgeons and healthcare providers. This understanding could lead to the development of more effective preventive strategies aimed at enhancing patient outcomes. Given the current dearth of knowledge on this subject, the primary objective of this systematic review is to meticulously evaluate the potential impact of BPH on postoperative complications following TJA, with a specific focus on PJI.

Material and methods

The research utilized the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram to conduct the study selection for this systematic review [13]. Additionally, the study protocol was registered on the International Prospective Register of Systematic Reviews PROSPERO (Registration code: CRD42024530645).

Search strategy

The search encompassed several databases, including PubMed, Scopus, and Web of Science, from their inception to December 10th, 2023. There were no restrictions on the search, except that the articles had to be in English. The search terms comprised synonyms and related terms for TJA and BPH, encompassing phrases such as "total hip arthroplasty," "total knee arthroplasty," "BPH," and "benign prostatic hypertrophy." The comprehensive search strategy file is provided in the supplementary material, Table S1.

Data collection employed 3 modalities to ensure inclusion of all available articles: electronic database tracking based on keywords, tracking based on the references of included studies, and tracking based on citations of included studies.

Study selection

The results from the databases, postremoval of duplicates, were uploaded onto the Rayyan online tool. Two authors (M.R., M.M.) independently conducted the initial screening of titles and abstracts to determine article eligibility. Subsequently, 2 reviewers (M.R., M.M.) independently assessed the full texts of the initially screened articles to ascertain definitive eligibility. In case of any discrepancies, a third reviewer (S.H.S.) was consulted.

For inclusion in this systematic review, studies had to be retrospective or prospective cohort studies, case-control studies, or randomized clinical trials that compared complications following TJA (including total hip arthroplasty [THA] and total knee arthroplasty [TKA]) between 2 groups: patients who had BPH before arthroplasty and those who did not.

Data extractions

Two authors (S.E., M.S.) independently extracted the data from each accepted study according to a pre-established protocol in Excel. In this study, we extracted characteristics of each study (first author name, publication year, country, study design, study population, and control population), characteristics of patients (age, body mass index, comorbidity), complications (PJI, urinary retention, UTI, asymptomatic bacteriuria (ASB), sepsis and others), type of arthroplasty, and history of symptomatic BPH before the procedure.

Quality assessment

Subsequently, the quality of all included studies was evaluated using the Newcastle-Ottawa Scale. In this scale study is judged on 3 broad perspectives: the selection of the study groups; the comparability of the groups; and the ascertainment of either the exposure or outcome. Based on the score of this scale the studies were divided into 3 groups: The studies with score more than 6 were high quality, scores 5 or 6 were medium quality, and scores less than 5 were low quality [14].

Statistical analysis

The meta-analysis was conducted using the Review Manager 5.3 software (Cochrane Collaboration, Software Update, Oxford, United Kingdom). The odds ratio (OR) and 95% confidence intervals (CIs) for all categorical data were calculated using the Mantel-Haenszel method. A fixed-effect model was employed when low heterogeneity was detected, while a random-effects model was applied for high heterogeneity. Statistical heterogeneity was assessed through the Q-test and I^2 values, with I^2 values of 25%, 50%, and 75% indicating low, moderate, and high heterogeneity, respectively. If the I^2 was less than 50%, a fixed-effect model was used; otherwise, a random-effects model was applied [15]. If the I^2 was less than 50%, a fixed-effect model was used; otherwise, a random-effects model was applied. Statistical significance was defined as $P < .05$ for all analyses, except for heterogeneity. All tests were conducted as 2-sided. Shoulder arthroplasty studies were excluded from the meta-analysis, and instead, only a systematic review was conducted for this specific subset of studies.

Results

Study selection

A comprehensive search across databases yielded a total of 770 articles, following the removal of duplicates. Initial screening based on title and abstract led to the identification of 26 articles, which proceeded to the secondary screening stage involving thoroughly examining their full texts. Subsequently, 4 articles on the evaluation of TJA outcomes in men with a history of BPH met the eligibility criteria and were included in this systematic review [16-19]. To ensure exhaustiveness, the references of these included articles underwent careful examination, revealing no additional relevant studies. A graphical representation detailing the stages of article screening and inclusion can be found in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses chart (Fig. 1).

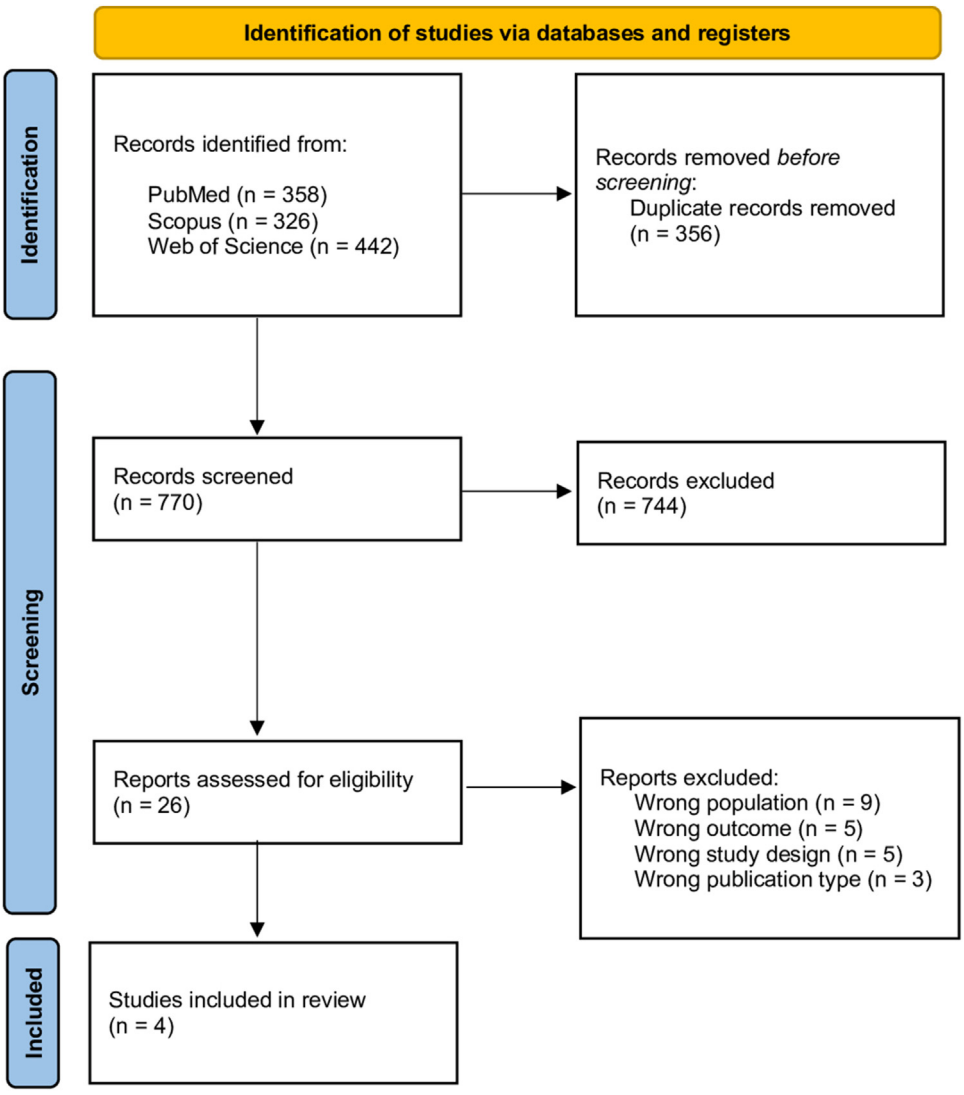

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

Quality of assessment

Based on the Newcastle-Ottawa scale, all included articles were of high quality. Detailed scores for each article were provided in Table 1.

Study characteristics

The included studies exhibited diversity in their focus, with 1 study addressing primary or revision THA or TKA [16], 2 studies focusing on primary THA or TKA [17,19], 1 study concentrating on primary THA [18]. In total, the investigation encompassed 75,222 male cases, comprising 65,210 THA cases and 10,012 TKA cases. Among these, 17,183 cases (22.8%) presented with symptomatic BPH, while the remaining 58,039 cases (77.2%) constituted the control group. Regarding age distribution, 2 studies reported mean age ranges from 65-71 years [16,17]. Gu et al. provided a detailed breakdown across different age brackets, with the majority of patients being between 60 and 80 years old [19]. Jeong et al. did not provide any information about the patients' ages [18]. In all included studies, matching procedures were employed to align BPH and non-BPH groups. Minimum follow-up duration emerged as a pivotal inclusion criterion across all studies. Notably, 2 studies specified a minimum follow-up period of 12 months [16,17], while the remaining study stipulated a minimum of 24 months [18,19].

Table 1
Quality assessment of included studies.

Study	Newcastle-Ottawa scale (NOS)			Total score
	Selection	Comparability	Exposure/outcome	
Yazdi et al. 2020 [16]	4	4	2	8
Jiang et al. 2023 [17]	4	2	2	8
Jeong et al. 2023 [18]	4	2	3	9
Gu et al. 2020 [19]	4	2	3	9

Table 2
Characteristics of included studies.

Author, y	Country	Study design	Type of surgery	Matching or regression	Total population, n	Age, y	BMI, kg/m^2	Comorbidity	Follow-up
Yazdi et al. 2020 [16]	USA	Retrospective	Primary (n = 814) or revision (n = 144) THA (n = 474) & TKA (n = 484)	Matching	***THA*** **BPH:** 125 **Non-BPH:** 349 ***TKA*** **BPH:** 125 **Non-BPH:** 359	**BPH:** 70.9 ± 8.2 **Non-BPH:** 69.7 ± 8.5	**BPH:** 29.9 ± 4.9 **Non-BPH:** 30.0 ± 4.9	***ECI*** **BPH:** 1.5 ± 1.3 **Non-BPH:** 1.6 ± 1.2	60.5 (12-152.1)
Jiang et al. 2023 [17]	China	Retrospective	Primary unilateral TKA (n = 123) or THA (n = 193)	Matching	***THA*** **BPH:** 193 **Non-BPH:** 386 **Premedication BPH:** 83 **Nonpremedication BPH:** 110 ***TKA*** **BPH:** 123 **Non-BPH:** 246 **Premedication BPH:** 68 **Nonpremedication BPH:** 55	***THA*** **BPH:** 65 (38-88) **Non-BPH:** 65 (40-89) ***TKA*** **BPH:** 71 (46-90) **Non-BPH:** 70 (49-90)	No significant difference	***CCI ≥2*** ***THA*** **BPH:** 11.9% **Non-BPH:** 11.9% ***TKA*** **BPH:** 12.2% **Non-BPH:** 12.2%	59 (12-154)
Jeong et al. 2023 [18]	USA	Retrospective	Primary THA	Matching	**BPH:** 11,819 **Non-BPH:** 47,103	NA	NA	NA	≥24
Gu et al. 2020 [19]	USA	Retrospective	Primary THA or TKA	Matching	***THA*** **BPH:** 1745 **Non-BPH:** 3490 ***TKA*** **BPH:** 3053 **Non-BPH:** 6106	***THA*** **BPH:** <60: 191 (11%) 60-70: 567 (32.5%) 70-80: 955 (54.7%) >80: 32 (1.8%) **Non-BPH:** <60: 388 (11.1%) 60-70: 1134 (32.5%) 70-80: 1904 (54.6%) >80: 64 (1.8%) ***TKA*** **BPH:** <60: 249 (8.2%) 60-70: 977 (32.0%) 70-80: 1789 (58.6%) >80: 38 (1.2%) **Non-BPH:** <60: 498 (8.2%) 60-70: 1954 (32.0%) 70-80: 3578 (58.6%) >80: 76 (1.2%)	***BMI ≥30*** ***THA*** **BPH:** 391 (22.4%) **Non-BPH:** 782 (22.4%) ***TKA*** **BPH:** 811 (26.6%) **Non-BPH:** 1622 (26.6%)	***CCI ≥2*** ***THA*** **BPH:** 523 (30.0%) **Non-BPH:** 1046 (30.0%) ***TKA*** **BPH:** 893 (29.2%) **Non-BPH:** 1786 (29.2%)	≥24

BMI, body mass index; CCI, Charlson Comorbidity Index; ECI, elixhauser comorbidity index; n, number; NA, not available.

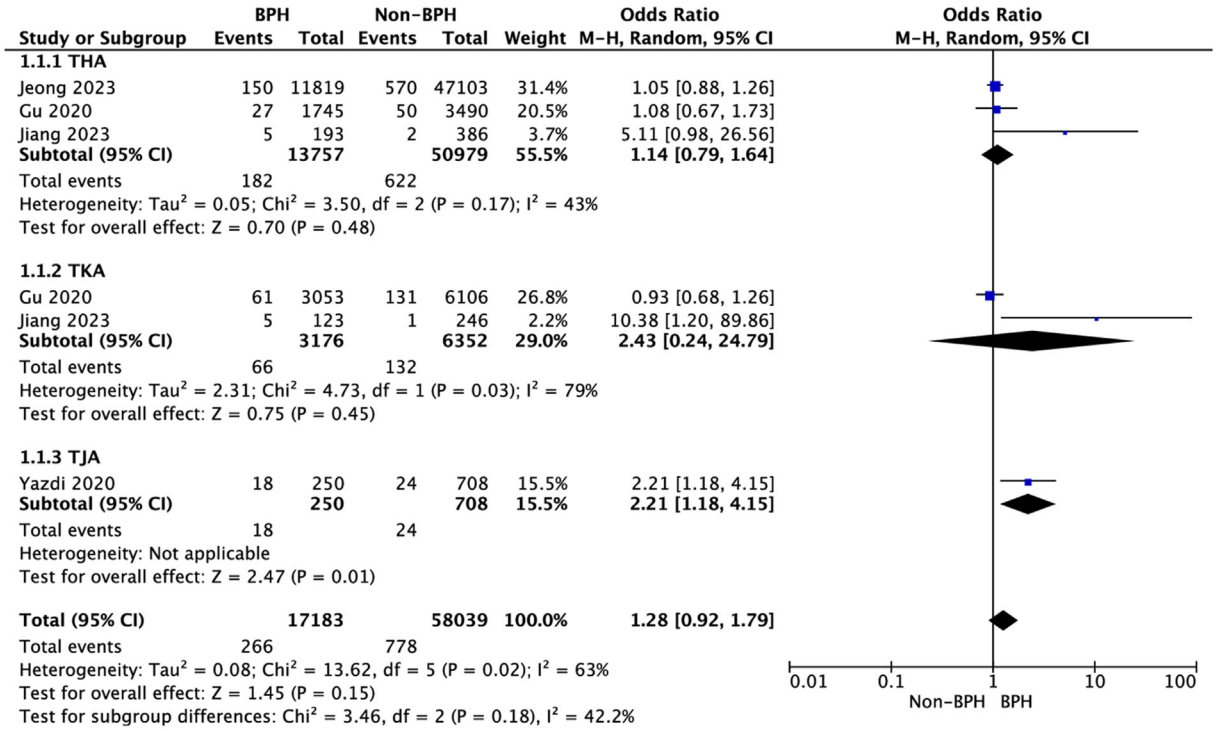

Figure 2. Forest plot illustrating the incidence of PJI following total joint arthroplasty (TJA) in BPH and non-BPH groups.

Additional details, including body mass index and comorbidity data, were provided in Table 2.

PJI

The meta-analysis indicates that the incidence rate of PJI between BPH and non-BPH groups did not exhibit a significant difference across both THA and TKA cases (OR [95% CI] = 1.28 [0.92-1.79], I^2 = 63%; Fig. 2). Subgroup analysis based on the type of joint operated yielded similar results (THA, OR [95% CI] = 1.14 [0.79-1.64], I^2 = 43%; TKA, OR [95% CI] = 2.43 [0.24-24.79], I^2 = 79%; Fig. 2). However, in the study conducted by Yazdi et al., where PJI occurrences were not separately reported by the operated joint, a higher rate of PJI was observed within the BPH group (OR [95% CI] = 2.21 [1.18-4.15]; Fig. 2) [16].

Furthermore, in Jeong et al.'s study, no difference was found in the survival rates, without the need for revision related to PJI, 5 years after primary THA among patients with and non-BPH (98.3% [95% CI] = [98.1%-98.6%] vs 98.1% [95% CI] = [98.1%-98.2%]; *P* value = .10) [18]. Jiang et al. reported results from bacterial cultures, indicating that the majority of joint bacterial cultures were gram-positive (8 out of 13), with only 2 patients showing negative results (no growth on culture) [17]. Additionally, they categorized patients with BPH into 2 groups based on whether they initiated anti-BPH medication before undergoing TKA or THA. This treatment regimen typically included a1-adrenal blockers alone or in combination with 5a-reductase inhibitors. Among symptomatic patients with BPH, those who commenced anti-BPH medication prior to primary TKA demonstrated a significantly reduced incidence of PJI compared to those who did not (0% vs 9.1%; *P* value = .016). However, similar results were not observed among THA patients (Table 3) [17].

Urinary retention

Postoperative urinary retention showed a significantly higher incidence among patients with BPH compared to non-BPH group, as indicated by both pooled analysis of THA and TKA (OR [95% CI] = 3.43 [2.04-5.78], I^2 = 82%; Fig. 3), as well as subgroup analyses for THA (OR [95% CI] = 3.80 [1.88-7.68], I^2 = 88%; Fig. 3) and TKA (OR [95% CI] = 2.69 [1.63-4.43]; Fig. 3) separately.

In the study by Jiang et al., patients with BPH in the premedication group exhibited a lower incidence of postoperative urinary retention in both THA (24.1% vs 41.8%; *P* value = .010) and TKA (16.2% vs 58.2%; *P* value <.001) compared to nonpremedication group (Table 3) [17].

UTI and ASB

The occurrence of postoperative UTI demonstrated a notably elevated rate in patients with BPH in contrast to non-BPH group. This was evident in both the combined analysis of THA and TKA (OR [95% CI] = 2.55 [2.33-2.79], I^2 = 0%; Fig. 4), as well as in separate subgroup analyses for THA (OR [95% CI] = 2.56 [2.30-2.85], I^2 = 0%; Fig. 4) and TKA (OR [95% CI] = 2.52 [2.09-3.03], I^2 = 41%; Fig. 4).

In Jiang et al.'s study, over 50 percent of patients with BPH who experienced PJI following primary arthroplasty also presented with UTI or ASB, totaling 6 out of 10 cases. However, unlike UTI, the incidence rate of ASB was not significantly different between the BPH and non-BPH groups in this study (THA, 3.1% vs 1.8%, *P* value = .321; TKA, 6.5% vs 2.4%, *P* value = .054). Additionally, they found that patients with BPH who underwent THA and received premedication had a lower incidence of UTI (1.2% vs 9.1%; *P* value = .043) compared to those who did not receive premedication (Table 3) [17].

Sepsis

The incidence of sepsis among patients with BPH who underwent THA (OR [95% CI] = 1.38 [1.11-1.71], I^2 = 0%; Fig. 5), as well as among the combined group of THA and TKA patients (OR [95% CI] = 1.31 [1.09-1.58], I^2 = 0%; Fig. 5), was higher compared to patients non-BPH. However, in Gu et al.'s study focusing on patients who

Table 3
Postoperative outcomes following joint arthroplasty in BPH and non-BPH groups.

Author, y	PJI	Urinary retention	UTI	ASB	Sepsis	Postoperative length of stay	Blood transfusion	Readmission
Yazdi et al. 2020 [16]	**BPH:** 18 (7.2%) **Non-BPH:** 24 (3.4%) *P* value: .01	NA	NA	NA	NA	NA	NA	NA
Jiang et al. 2023 [17]	***THA*** **BPH:** 5 (2.6%) **Non-BPH:** 2 (0.5%) *P* value: .08 ***TKA*** **BPH:** 5 (4.1%) **Non-BPH:** 1 (0.4%) *P* value: .029	***THA*** **BPH:** 66 (34.2%) **Non-BPH:** 64 (16.6%) *P* value: <.001 ***TKA*** **BPH:** 43 (35.0%) **Non-BPH:** 41 (16.7%) *P* value: <.001	***THA*** **BPH:** 10 (5.2%) **Non-BPH:** 4 (1.0%) *P* value: .006 ***TKA*** **BPH:** 5 (4.1%) **Non-BPH:** 1 (0.4%) *P* value: .029	***THA*** **BPH:** 6 (3.1%) **Non-BPH:** 7 (1.8%) *P* value: .321 ***TKA*** **BPH:** 8 (6.5%) **Non-BPH:** 6 (2.4%) *P* value: .054	NA	***THA*** **BPH:** 3.6 ± 2.9 **Non-BPH:** 3.0 ± 2.1 *P* value: 0.018 ***TKA*** **BPH:** 3.9 ± 1.9 **Non-BPH:** 3.0 ± 1.7 *P*-value: <.001	NA	NA
Jeong et al. 2023 [18]	2-y **BPH:** 150 (1.3%) **Non-BPH:** 570 (1.2%) *P* value: .60	**BPH:** 112 (0.9%) **Non-BPH:** 84 (0.2%) *P* value: <.001	**BPH:** 455 (4%) **Non-BPH:** 728 (2%) *P* value: <.001	NA	**BPH:** 82 (0.7%) **Non-BPH:** 229 (0.5%) *P* value: .003	NA	NA	NA
Gu et al. 2020 [19]	2-y ***THA*** **BPH:** 27 (1.5%) **Non-BPH:** 50 (1.4%) *P* value: .745 Unmatched non-BPH: 4535 (1.64%) *P* value: .746 ***TKA*** **BPH:** 61 (2.0%) **Non-BPH:** 131 (2.1%) *P* value: .642 Unmatched non-BPH: 6581 (1.2%) *P* value: <.001	NA	***THA*** **BPH:** 168 (9.6%) **Non-BPH:** 141 (4.0%) *P* value: <.001 Unmatched non-BPH: 16,027 (5.1%) *P* value: <.001 ***TKA*** **BPH:** 251 (8.2%) **Non-BPH:** 213 (3.5%) *P* value: <.001 Unmatched non-BPH: 28,110 (5.0%) *P* value: <.001	NA	***THA*** **BPH:** 34 (2.0%) **Non-BPH:** 55 (1.6%) *P* value: .325 Unmatched non-BPH: 3777 (1.2%) *P* value: .003 **TKA** **BPH:** 54 (1.8%) **Non-BPH:** 92 (1.5%) *P* value: .345 Unmatched non-BPH: 5178 (0.9%) *P* value: <.001	NA	***THA*** **BPH:** 104 (6.0%) **Non-BPH:** 113 (3.2%) *P* value: <.001 Unmatched non-BPH: 13,805 (4.35%) *P* value: .001 ***TKA*** **BPH:** 161 (5.3%) **Non-BPH:** 170 (2.8%) *P* value: <.001 Unmatched non-BPH: 18,796 (3.4%) *P* value: <.001	NA

NA, not available.

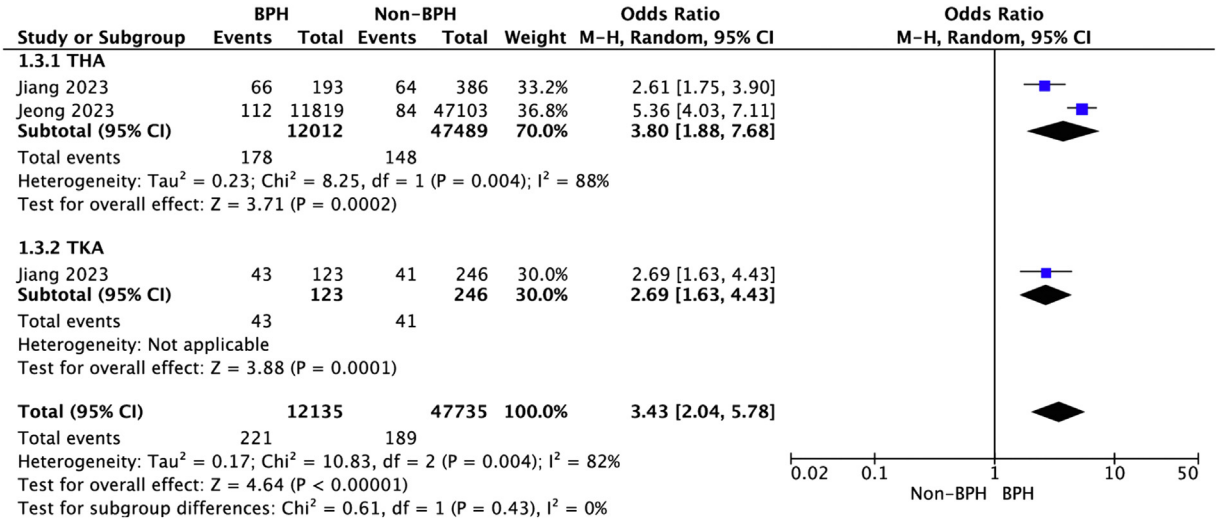

Figure 3. Forest plot illustrating the incidence of urinary retention following TJA in BPH and non-BPH groups.

underwent TKA, this difference was not found to be statistically significant (OR [95% CI] = 1.18 [0.84-1.65]; Fig. 5) (Table 3).

Other outcomes

In Jiang et al.'s study, no significant differences were observed in the Harris Hip Score (*P* value = .54), Hospital for Special Surgery Score (*P* value = .28), or pain Visual Analog Scale scores (THA, *P* value = .44; TKA, *P* value = .78) between BPH and non-BPH group following THA or TKA. However, the postoperative length of stay was significantly longer in the BPH group following both THA (3.6 ± 2.9 vs 3.0 ± 2.1; *P* value = .018) and TKA (3.9 ± 1.9 vs 3.0 ± 1.7; *P* value <.001) in this study (Table 3) [17].

Gu et al. found that the need for blood transfusion was higher in the BPH group for both THA (6.0% vs 3.2%; *P* value <.001) and TKA (5.3% vs 2.8%; *P* value <.001). Furthermore, they reported that in patients underwent THA, the incidence of anemia (11.12% vs 7.42%; *P* value <.001) and in patients underwent TKA, the incidence of anemia (10.81% vs 6.11%; *P* value <.001), cellulitis (3.47% vs 2.54%; *P* value = .023), and renal failure (4.26% vs 3.36%; *P* value = .030) was significantly higher in the BPH group. In contrast, BPH was associated with a decreased incidence of heart failure following TKA compared to the control cohort (3.54% vs 4.19%; *P* value = .029) (Table 3) [19].

Discussion

In this systematic review, our objective was to explore the existing literature to investigate the correlation between a history of BPH and the incidence of postoperative complications following TJA. Pooled analysis revealed that male patients with BPH experienced higher rates of urinary retention and UTI following THA and TKA compared to non-BPH group. Additionally, Sepsis following THA was elevated in the BPH group. However, there was no significant difference in the incidence rate of PJI between patients with and non-BPH in either THA or TKA.

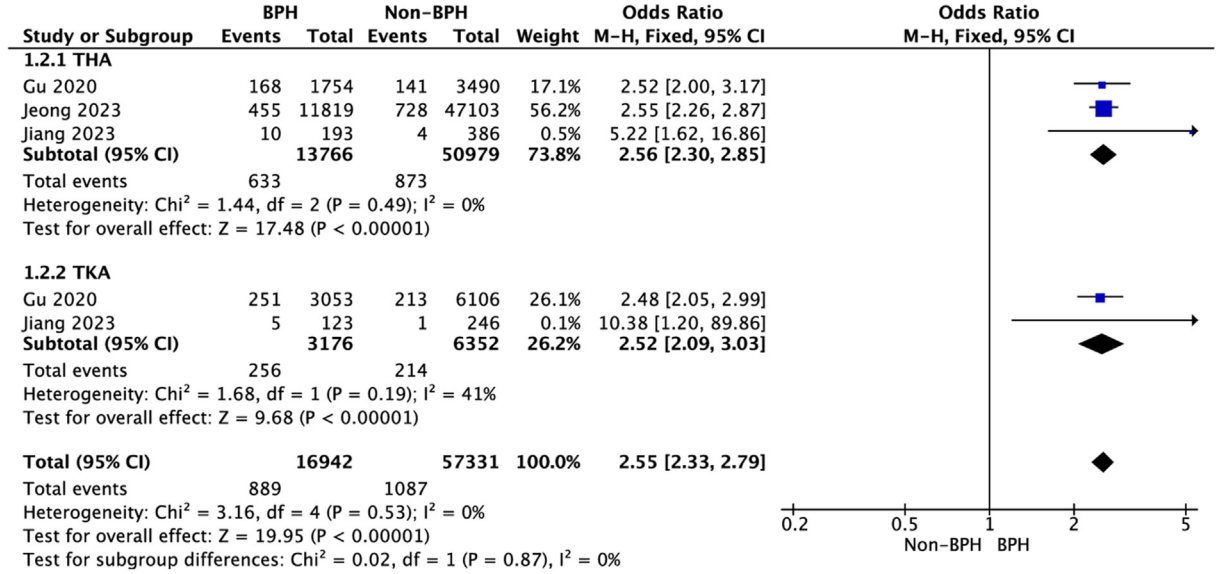

Figure 4. Forest plot illustrating the incidence of UTI following TJA in BPH and non-BPH groups.

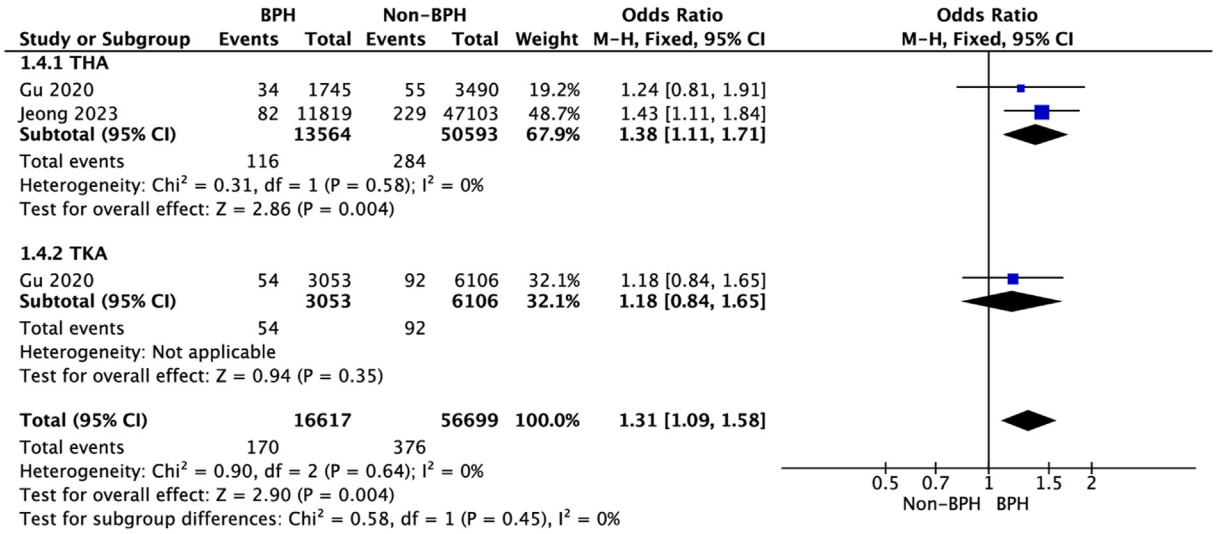

Figure 5. Forest plot illustrating the incidence of sepsis following TJA in BPH and non-BPH groups.

While prevention and diagnosis have seen notable advancements, PJI persists as a prevalent cause of failure among patients who have undergone THA or TKA [20]. Several research studies have shown a link between various health conditions such as congestive heart failure, hypothyroidism, renal disease, liver disease [21-23], preoperative anemia [24], rheumatologic disease [25], and diabetes mellitus [26-28] and the occurrence of PJI following elective arthroplasty. Additionally, having an American Society of Anesthesiologists score greater than 2, which serves as a scoring system for comorbidities, has been identified as a risk factor for PJI [29,30]. These observations have prompted researchers to investigate additional comorbidities, such as BPH, to identify further risk factors for PJI. Given that, as age increases, there is a noticeable rise in the prevalence of BPH, with around 80% of men being affected by the age of 70 [31]. Several studies suggest that male gender is a significant risk factor for PJI [6,32,33]. It is hypothesized that sex hormones may exert different influences on the immune system in males and females, though additional research is necessary to confirm these findings [34,35]. Symptomatic BPH was identified as an independent risk factor for PJI among men undergoing primary TKA, as demonstrated by Jiang et al [17]. Additionally, Yazdi et al. [16] found that symptomatic BPH remained a significant risk factor for PJI following primary or revision THA and TKA, even after adjusting for several known confounders. However, despite these findings, our meta-analysis, along with the other included studies, did not reveal a significant association between BPH and PJI. It should be noted that the 2 studies demonstrating the association between BPH and PJI had a shorter minimum follow-up duration for their patients compared to other studies (12 vs 24 months). Furthermore, in the study by Yazdi et al. [16], the inclusion of patients undergoing revision procedures and oncologic reconstructions may have contributed to the positive findings. As Gu et al. [19] speculates, it is conceivable that BPH may have a more pronounced association with PJI in complex cases, such as revision procedures. One possible explanation for this is that patients undergoing more complex surgeries may need indwelling urinary catheters due to longer procedure durations. After removing the catheter, patients with symptomatic BPH are more likely to fail void trials compared to those non-BPH. In those with BPH, this heightened risk of recatheterization could lead to UTIs and subsequent PJI [36,37]. This scenario might be less common in primary THA or TKA surgeries, where routine indwelling catheter use during surgery has decreased, even with spinal anesthesia. Additionally, patients undergoing revision surgery often have more health issues, and catheter placement in those with more comorbidities is associated with a greater UTI risk [19]. Future research could focus exclusively on revision procedures to explore the potential correlation between BPH and the risk of PJI among recipients of revision THA or TKA.

BPH has been associated with an increased risk of UTI and renal failure [38]. While perioperative UTI may not be definitively linked to PJI, postoperative UTI can heighten the risk of PJI [39,40]. Patients with symptomatic BPH often require frequent urinary catheterization, further increasing the risk of UTI [41]. The meta-analysis revealed a higher incidence of UTI, as well as urinary retention, among patients with symptomatic BPH, with an OR of 2.55. As demonstrated in previous research on hip and knee arthroplasty, this elevated occurrence of UTI did not distinctly result in a significantly higher rate of PJI [42-44].

Postoperative urinary retention, a painful and disruptive complication following TKA and THA, often necessitates intermittent or indwelling urethral catheterization [45]. The increased incidence of indwelling catheterization due to urinary retention, potential urethral trauma from frequent catheterization, and subsequent rise in UTI risk in arthroplasty patients [46]. Garbarino et al. conducted a retrospective analysis using data from 15 hospitals on patients who underwent TKA. Within this patient group, they reported that urinary bladder catheterization heightened the risk of both PJI and UTI. The study specifically found that indwelling catheterization, as opposed to intermittent catheterization, was linked to a higher risk of PJI. They recommended that surgeons should limit the duration of catheterization to lower the risk of PJI [37].

Perioperative medical treatment may be helpful for patients with BPH. Jiang et al. divided patients into premedication and nonpremedication groups and found that perioperative medical treatment with alpha-adrenergic blockers and/or 5-alpha reductase inhibitors improved bladder function, leading to a notable decrease in the need for catheterization secondary to postoperative urinary retention. This decreased incidence of urinary obstruction symptoms and reduced need for indwelling catheterization lowers the likelihood of urethral trauma and the risk of UTI, consequently mitigating the risk of PJI caused by transient bacteremia due to UTI. Prospective follow-up studies with larger sample sizes would be beneficial for corroborating the effectiveness [17].

Concerning upper extremity procedures and BPH, Gordon et al.'s study on primary total shoulder arthroplasty patients indicated that the incidence of PJI (0.49% vs 0.32%), UTI (7.12% vs 1.78%), need for blood transfusion (1.89% vs 0.04%), and postoperative length of stay (3 vs 2 days) were all significantly higher in the BPH group compared to the non-BPH group. However, the readmission rate did not differ significantly between the 2 groups [47]. Although Gordon et al. conducted a similar study on reverse shoulder arthroplasty, the findings revealed a distinct pattern. Among variables including PJI (2.3% vs 2.2%), UTI (9.3% vs 3.1%), need for blood transfusion (2.1% vs 1.9%), length of stay (1.96 vs 1.99 days), and readmission rate (1.88% vs 2.11%), only the incidence of UTI showed a statistically significant difference between the BPH and non-BPH groups. Additionally, the overall rate of medical complications was significantly higher in the BPH group (34.3% vs 21.2%) [48].

Aligned with the discussion regarding TJA in males with BPH, it is noteworthy to reference the work of Moverman et al., who conducted an economic analysis to evaluate the cost-effectiveness of standard voiding optimization in this population. Their study aimed to determine the break-even point. Their results indicated that medical optimization was preferable, suggesting that surgical intervention was not justified unless considering the long-term financial implications of PJI [49].

Our systematic review has several limitations that should be considered when interpreting the findings. All included articles were retrospective, which inherently carry a higher risk of bias compared to prospective studies due to reliance on historical data that may be incomplete or inaccurately recorded, and the inability to establish causality. Additionally, the geographical scope of the studies was limited to the United States and China, reducing the generalizability of the findings to populations outside these regions, as cultural, genetic, and health care system differences could affect outcomes. Furthermore, the lack of comprehensive data in the original articles prevented us from conducting a meta-analysis to measure the effect of preoperative treatment for patients with BPH on postoperative outcomes, limiting our ability to provide a detailed understanding of how preoperative management strategies might influence medical intervention success.

Conclusions

In conclusion, our systematic review highlights that male patient with BPH experienced higher rates of urinary retention, UTI, and sepsis following THA and TKA compared to their non-BPH counterparts. However, there was no significant difference in the incidence rate of PJI. It is noteworthy that while patients with BPH are prone to certain complications, our findings indicate that BPH cannot be considered a comorbidity that increases the risk of PJI.

Conflicts of Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2024.101552.

CRediT authorship contribution statement

Sina Esmaeili: Writing – original draft, Project administration, Methodology, Data curation, Conceptualization. **Hannaneh Razaghi:** Writing – original draft, Data curation, Conceptualization. **Mahda Malekshahi:** Methodology, Data curation. **Mohammad Soleimani:** Methodology. **Seyyed Hossein Shafiei:** Writing – review & editing. **Mohammadreza Golbakhsh:** Writing – review & editing, Supervision, Conceptualization.

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Appendix

Table S1
Complete search strategy.

Database	Search string
PubMed	(BPH[Title/Abstract] OR "benign prostatic hyperplasia"[Title/Abstract] OR "benign prostatic hypertrophy"[Title/Abstract] OR prostate[Title/Abstract] OR prostatic[Title/Abstract] OR "Prostatic Hyperplasia"[Mesh]) AND ("total joint replacement"[Title/Abstract] OR "total joint arthroplasty"[Title/Abstract] OR TJA [Title/Abstract] OR TJR[Title/Abstract] OR “total hip arthroplasty"[Title/Abstract] OR "total hip replacement"[Title/Abstract] OR THA[Title/Abstract] OR THR[Title/Abstract] OR "total knee arthroplasty"[Title/Abstract] OR TKA[Title/Abstract] OR "total knee replacement"[Title/Abstract] OR TKR[Title/Abstract] OR "arthroplasties"[Title/Abstract] OR "joint replacement"[Title/Abstract] OR "total shoulder replacement"[Title/Abstract] OR "total shoulder arthroplasty"[Title/Abstract] OR "total ankle replacement"[Title/Abstract] OR "total ankle arthroplasty"[Title/Abstract] OR arthroplasty[Title/Abstract] OR arthroplasties[Title/Abstract] OR “joint replacement"[Title/Abstract] OR arthroplasty[Mesh])
Scopus	(TITLE-ABS(BPH) OR TITLE-ABS("benign prostatic hyperplasia") OR TITLE-ABS("benign prostatic hypertrophy") OR TITLE-ABS(prostate) OR TITLE-ABS(prostatic)) AND (TITLE-ABS("total joint replacement") OR TITLE-ABS("total joint arthroplasty") OR TITLE-ABS(TJA) OR TITLE-ABS(TJR) OR TITLE-ABS(“total hip arthroplasty") OR TITLE-ABS("total hip replacement") OR TITLE-ABS(THA) OR TITLE-ABS(THR) OR TITLE-ABS("total knee arthroplasty") OR TITLE-ABS(TKA) OR TITLE-ABS("total knee replacement") OR TITLE-ABS(TKR) OR TITLE-ABS("arthroplasties") OR TITLE-ABS("joint replacement") OR TITLE-ABS("total shoulder replacement") OR TITLE-ABS("total shoulder arthroplasty") OR TITLE-ABS("total ankle replacement") OR TITLE-ABS("total ankle arthroplasty") OR TITLE-ABS(arthroplasty) OR TITLE-ABS(arthroplasties) OR TITLE-ABS(“joint replacement"))
Web of Science	(TS="total joint arthroplasty" OR TS=TJA OR TS="total joint replacement" OR TS=TJR OR TS="total hip arthroplasty" OR TS="total hip replacement" OR TS=THA OR TS=THR OR TS="total knee arthroplasty" OR TS="total knee replacement" OR TS=TKA OR TS=TKR OR TS="total shoulder arthroplasty" OR TS="total shoulder replacement" OR TS="total ankle arthroplasty" OR TS="total ankle replacement" OR TS=arthroplasty OR TS=arthroplasties OR TS="joint replacement") AND (TS=BPH OR TS="benign prostatic hyperplasia" OR TS="benign prostatic hypertrophy" OR TS=prostate OR TS=prostatic)