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Perioperative, functional, and oncologic outcomes in obese patients undergoing Da Vinci robot-assisted radical prostatectomy: a systematic review and meta-analysis

Chong-jian Wang[1†], Jiao Qin[2†], Yang Liu[1], Zhi Wen[1], Cai-xia Chen[1], Hong-yuan Li[1], Hao-tian Huang[1], Lin Yang[1] and Xue-song Yang[1*]

Abstract

Objective The influence of robot-assisted radical prostatectomy (RARP) in obese (OB) and non-obese (NOB) prostate cancer patients remains a topic of debate. The objective of this study was to juxtapose the perioperative, functional, and oncologic outcomes of RARP in OB and NOB cohorts.

Materials and methods We systematically searched the databases such as PubMed, Embase, Web of Science, and the Cochrane Library database to identify relevant studies published in English up to September 2023. Review Manager was used to compare various parameters. The study was registered with PROSPERO (CRD42023473136). Sixteen comparative trials were included for 8434 obese patients compared with 55,266 non-obese patients.

Results The OB group had a longer operative time (WMD 17.8 min, 95% CI 9.7,25.8; $p<0.0001$), a longer length of hospital stay (WMD 0.18 day, 95% CI 0.12,0.24; $p<0.00001$, a higher estimated blood loss (WMD 50.6 ml, 95% CI 11.7,89.6; $p=0.01$), and higher pelvic lymphadenectomy rate (RR 1.08, 95% CI 1.04,1.12; $p<0.0001$)and lower nerve sparing rate (RR 0.95, 95% CI 0.91,0.99; $p<0.01$), but there was no difference between unilateral (RR 1.0, 95% CI 0.8,1.3; $p=0.8$)and bilateral (RR 0.9, 95% CI 0.9,1.0; $p=0.06$)nerve sparing rate. Then, complication rates (RR 1.6, 95% CI 1.5,1.7; $p<0.00001$) were higher in the OB group, and both major (RR 1.4, 95% CI 1.1,1.8; $p=0.01$)and minor (RR 1.4, 95% CI 1.1,1.7; $p<0.01$)complication rates were higher in the OB group. Moreover, obese patients showed significantly higher probabilities of incontinence (RR 1.17, 95% CI 1.03,1.33; $p=0.01$) and impotency (RR 1.08, 95% CI 1.01,1.15; $p=0.02$) at 1 year. Last, the positive surgical margin (RR 1.2, 95% CI 1.1,1.3; $p<0.01$) was higher in the OB group.

Conclusion In the obese group, perioperative outcomes, total complications, functional outcomes, and oncologic outcomes were all worse for RARP. Weight loss before RARP may be a feasible strategy to improve the prognosis of patients.

Keywords Prostate cancer, Robot-assisted radical prostatectomy, Obese, Outcomes, Meta-analysis

†Chong-jian Wang and Jiao Qin share first authorship.

*Correspondence:
Xue-song Yang
Xuesongyang2022@163.com

[1]Department of Urology, Affiliated Hospital of North Sichuan Medical College, Nanchong, China
[2]Department of Anesthesiology, Affiliated Hospital of North Sichuan Medical College, Nanchong, China

Introduction

Globally, obesity has long been associated with the progression of prostate cancer and has emerged as a growing health concern due to the prevalence of global obesity [1]. Consequently, obesity is evolving into an increasingly significant factor. It is demonstrated to influence the efficacy of treatments, acceleration of cancer progression, the emergence of comorbidities, and survival rates [2]. Potential explanations could encompass the interaction of obesity-related comorbidities and the modulation of tumor biology in obesity, mediated by factors such as estrogens, testosterone, insulin, and insulin-like growth factor, among others [3, 4].

The da Vinci Surgical System was employed for the first time in the groundbreaking operation, the robot-assisted radical prostatectomy (RARP), by Jochen Binder in the year 2000 [5]. The RARP procedure has become internationally recognized and widely performed. Extensive research has highlighted the notable benefits of RARP compared to traditional surgery, particularly in reducing perioperative complications [6], enhancing recovery of erectile function [7], and improving urinary continence outcomes [8]. Moreover, in terms of oncological efficacy, RARP has been found to achieve results on par with those of established surgical techniques [9]. Considering these benefits, robot-assisted laparoscopic radical prostatectomy (robotic surgery) could theoretically improve patient outcomes more effectively [10]. However, in the study by Xu et al. [11], perioperative outcomes of RARP in the obese cohort were similar to those in the non-obese cohort. The purpose of the present study was to evaluate the outcomes of RARP in obese vs. non-obese patients.

Methods

This meta-analysis adheres to the standards set by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [12] and the Assessment of Multiple Systematic Reviews (AMSTAR 2) [13], and has been duly registered with the PROSPERO registry (ID: CRD42023473136).

Literature search strategy, study selection and data collection

We conducted a systematic search of the PubMed, Embase, Web of Science, and Cochrane Library databases through September 2023 to identify eligible studies. The following terms were produced by combining intervention and patient-related search terms: [(robot OR robotic OR robotics OR robot-assisted OR robotic-assisted) AND (prostatectomy) AND (obesity)]. Moreover, we manually searched and reviewed the relevant references to avoid any omissions. Only studies reported in English are included in the references. The PICOS approach was used to define the inclusion criteria. I. The patients were diagnosed with prostate cancer based on pathological findings; II. in the experimental group, patients had a history of OB and undergone RARP; III. in the control group, patients had no previous OB and were undergone RARP; IV.one or more of the following outcomes: perioperative, functional and oncologic outcomes; and V. cohort studies, case–control studies or randomized controlled trials (RCTs). Following are the exclusion criteria: I.non-comparative studies; II. editorial comments, meeting abstracts, case reports, unpublished studies, or reviews; III. studies with unavailable data for analysis. The data were independently extracted by the two reviewers, as follows: I.general information: This includes the first author, publication year, article type; II.population characteristics: This information encompasses the number of patients, age, body mass index (BMI), prostate-specific antigen (PSA), prostate size, pathological stage and outcomes; III. perioperative outcomes: These consist of the operative time, estimated blood loss, length of hospital stay, pelvic lymphadenectomy, nerve-sparing status; IV. complications: Complications: This refers to minor complications (defined as Clavien grade 1–2) and major complications (defined as Clavien grade≥3); V. functional outcomes: These involve continence recovery (defined as the use of no pad or one safety pad per day), and potency recovery (defined as erections sufficient for sexual intercourse without the use of phosphodiesterase 5 (PDE5) inhibitors); and VI. oncologic outcomes: These include positive surgical margins (PSM), and biochemical recurrence (BCR). Discrepancies were addressed through agreement or after discussing with a third reviewer.

Bias risk assessment

We included articles that were all cohort studies and no randomized cohort studies were identified. We utilized the ROBINS-I tool [14] to evaluate the quality of all included non-randomized controlled trials (non-RCTs), encompassing an assessment of bias across seven domains: (1) confounding factors; (2) selection of participants; (3) classification of exposure; (4) attrition from the intended exposure; (5) missing data; (6) measurement of outcomes; and (7) selection of reported results. (S-Fig. 1).

Statistical analysis

The meta-analysis was conducted utilizing the Review Manager (RevMan 5.3). The outcomes were presented with 95% confidence intervals (CIs) and relative risk (RR) for dichotomous variables, and the weighted mean difference (WMD) used for continuous variables. The Mantel-Haenszel methodology was utilized for the amalgamation of meta-analyses pertaining to dichotomous variables, whereas for continuous variables, the method of Inverse Variance was employed. The I^2 statistic was employed to quantify the degree of heterogeneity in the study [15]. The corresponding thresholds of low, medium, and high levels of heterogeneity were designated at I^2 values of 25%, 50%, and 75% respectively. Data were aggregated utilizing the fixed-effect model unless a statistically significant high level of heterogeneity (I^2>50%) was detected across the studies. In instances of noted heterogeneity, the random-effect model was engaged. $p<0.05$ was deemed to illustrate statistical significance. The representation of prostate size across the examined studies was denoted in terms of weight measures. This value may be estimated by assigning a correction factor of 1.2 to the volume, a method utilized in a handful of studies that only offered data on the prostate volume [16].

Sensitivity analysis

We implemented the leave-one-out method, systematically excluding each study from the cumulative effect to evaluate the integrity of our estimates. Nonetheless, performing sensitivity analyses becomes infeasible when faced with an examination of three or fewer studies.

Publication bias

Funnel plots were used to screen for potential publication bias.

Results

Baseline characteristics

A total of 642 studies were preliminarily searched, with 384 remaining after duplicates were removed. We excluded 356 studies after reviewing titles and abstracts and 12 articles after reading and screening the full texts (One article is not available in full). Finally, 16 [17–32] studies (non-RCTs) involving 63,700 patients (8434 OB vs. 55266 NOB) were included in the present study (Fig. 1). Seven of the studies were retrospective comparisons and the remaining nine were prospective comparisons. These studies were conducted in various countries, including the United States of America (USA), Germany, Canada, Australia, Austria.

Furthermore, (Table 1) summarizes the baseline characteristics and the preoperative variables of included patients (sample size, age, BMI, PSA and pathologic outcomes).

Outcome analysis

Perioperative outcomes

A meta-analysis of operative time [17–22, 24, 26, 27, 29, 32] showed that obese patients took longer compared to non-obese patients (eleven studies pooled; WMD 17.8 min, 95% CI 9.7,25.8; $p<0.0001$). The OB group was associated with longer length of hospital stay [17–22, 28, 32] than the NOB group (WMD 0.18 day, 95% CI 0.12,0.24; $p<0.00001$), including eight studies. Higher estimated blood loss [17–22, 24, 26, 27, 31] was also observed in the OB group (WMD 50.6 ml, 95% CI 11.7,89.6; $p=0.01$), including nine studies. Furthermore, a pooled analysis of four studies revealed that the OB group had higher pelvic lymphadenectomy rate [21, 22, 25, 28] than the NOB group (RR 1.08, 95% CI 1.04,1.12; $p<0.0001$). The meta-analysis demonstrated a decreased rate of nerve sparing rate [17, 19, 21, 22, 24, 26, 27, 31] in the obese group (RR 0.95, 95% CI 0.91,0.99; $p<0.01$), with nine studies included. But there was no difference between unilateral [17, 21, 22, 27] (RR 1.0, 95% CI 0.8,1.3; $p=0.8$)and bilateral [17, 19, 21, 22, 27] (RR 0.9, 95% CI 0.9,1.0; $p=0.06$)nerve sparing rate. (FIGURE 2)

Complications

Minor complications rates (Clavien grade 1–2) were 5.3% (162 out of 3041 cases) in the OB group and 5.4% (236 of 4399 cases) in the NOB group. A meta-analysis of minor complication rates [19, 21, 22, 26, 30–32] revealed higher in the obese group (seven studies; $p<0.01$). The major complication (Clavien grade ≥ 3) rates were 3.9% (119 out of 3041 cases) and 3.0% (132 of 4399 cases) in the OB and NOB groups, respectively. Similarly, a meta-analysis of major complication rates [19, 21, 22, 26, 30–32] revealed higher in the obese group (seven studies; $p=0.01$). The meta-analysis revealed a higher overall complication rate [17–22, 25, 28, 30–32](twelve studies; RR 1.6, 95% CI 1.5,1.7; $p<0.00001$)in the OB group compared to the NOB group, indicating an increased risk among individuals with obesity. (FIGURE 3)

Functional outcomes

The meta-analysis revealed that the obese group exhibited more unfavorable outcomes in terms of incontinence [19, 20, 22, 25, 30, 31] (six studies; RR 1.17, 95% CI 1.03,1.33; $p=0.01$) and impotency [20, 22, 25, 26, 31] (five studies; RR 1.08, 95% CI 1.01,1.15; $p=0.02$) at 1 year. (FIGURE 4)

Oncologic outcomes

The meta-analysis revealed that the OB group had higher rates of positive surgical margins [17–27, 29, 31, 32] (PSM) than the NOB group (fourteen studies; RR 1.2, 95% CI 1.1,1.3; $p<0.01$). Among the included articles, only two articles mentioned BCR. Due to insufficient data, no further analysis was performed. (FIGURE 5)

Subgroup analysis

To determine the heterogeneity of this meta-analysis, subgroup analyses were performed according to the characteristics among the included studies (e.g. publication date, study type, blood loss volume, Risk of Bias assessment, nerve sparing rate). (Tables 2 and 3) show the subgroup analyses of OT, EBL, respectively. In the

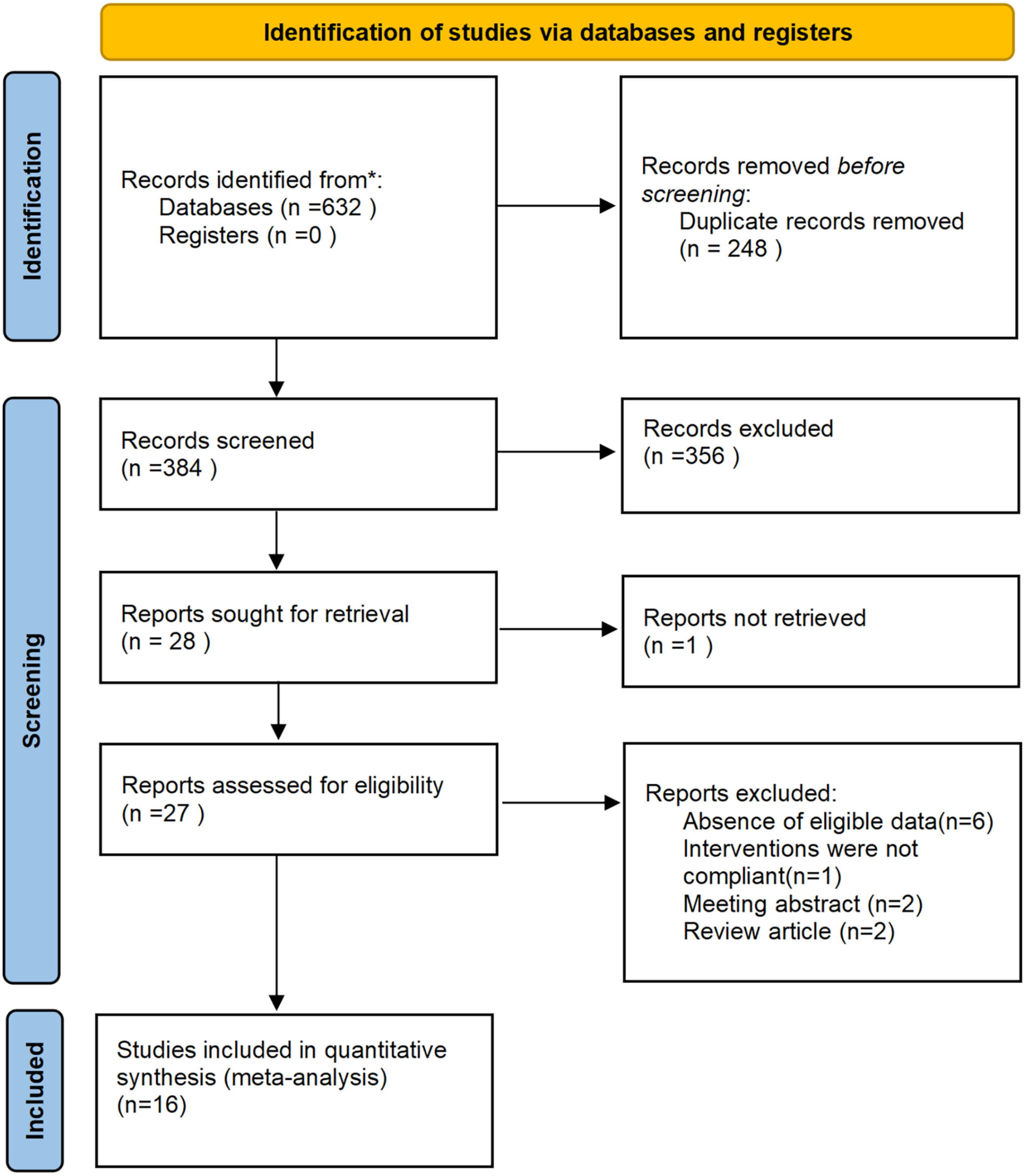

Fig. 1 Literature screening flowchart

subgroup analysis of OT, the subgroup with publication date≥2014(WMD,17.8 95%CI: 9.7–25.8; I^2= 41%) had less operative time than the subgroup with publication date <2014(WMD,30.0 95%CI: 14.5–44.1; I^2= 80%), and the heterogeneity was greatly reduced (Fig. 6-A). At the same time, the subgroup with a low Risk of Bias assessment (WMD,28.6 95%CI: 11.8–45.4; I^2= 85%) had a shorter operation time than the subgroup with a moderate Risk of Bias assessment (WMD,9.8 95%CI: 2.7–16.8; I^2= 67%), and the heterogeneity was obviously reduced (Fig. 6-B). However, Subgroup analysis revealed that study type, blood loss volume, and nerve sparing rate

Table 1 Table of basic information extracted from the literature

Reference	Type	Number of patients		Mean age(years)		Mean BMI(kg/m^2)		Mean initial PSA(ng/ml)		Mean prostate size(g)		pT3 stage(%)	
		OB	NOB	OB	NOB	OB	NOB	OB	NOB	OB	NOB	OB	NOB
Ahlering 2005	prospective	19	81	62.6(6.1)	62.3(7.2)	NA	NA	7.4(5.2)	8.1(8.1)	62.4(34.4)	49.5(21.6)	3/19	22/81
Khaira 2006	prospective	49	236	60.3(6.3)	60.7(4.3)	32.2	26.1	7.9(4.4)	7.9(7)	45.3(12.5)	47.3(23.8)	NA	NA
Herman 2007	retrospective	34	98	59(7)	61.4(4.7)	NA	NA	6.9(10.8)	7.6(9.8)	NA	NA	6/28	13/98
Boorjian 2008	retrospective	119	281	61(5.3)	60.8(5.5)	NA	NA	5(4.7)	4.9(5.1)	44.3(28)	45(24.4)	15/119	17/281
Castle 2008	retrospective	49	91	58.8(7.3)	59.6(6.8)	32.6	24.9	7.1(3.6)	7.3(4.8)	NA	NA	12/49	13/91
Wiltz 2009	prospective	265	680	59.4(6.2)	59.9(6.7)	33.7	26	6.4(4.3)	6.4(4.3)	54(25)	52(19.8)	61/265	127/680
Chalasani 2010	prospective	40	113	57.9	60.8	32.4	26.1	6.6	6.8	NA	NA	7/40	30/110
Zilberman 2011	prospective	169	386	59.8(6.7)	60.3(7.1)	NA	NA	4.9(2.4)	5.3(2.3)	48.2(15.9)	44(15.2)	28/174	65/403
Gu 2014	prospective	67	151	62.7(6.5)	62.8(6.6)	32.8	26.45	5.5(3.6)	6.56(4.99)	52.44(18.6)	50.72(15.2)	8/67	12/151
Kwon 2014	prospective	581	663	59(6)	60.2(6.8)	32.9	26.3	6.1(6.7)	6.5(8.2)	53.7(28.7)	51.2(28.8)	144/580	147/659
Garg 2017	retrospective	290	401	58.7(6.2)	59.5(6.4)	NA	NA	NA	NA	NA	NA	42/285	46/398
Knipper 2019	retrospective	4589	49,037	60.9(6.9)	61.7(7.1)	NA	NA	NA	NA	NA	NA	NA	NA
Goßler 2020	prospective	51	181	66.3(6.1)	65(7.47)	33.58	26.3	9.92(6.26)	NA	55.7((22.89)	NA	13/51	54/181
Mourão 2022	retrospective	247	830	61.35(6.71)	61.71(8.19)	NA	NA	NA	NA	NA	NA	69/247	191/820
Sarychev 2022	prospective	1701	1701	64(7.42)	64(7.42)	32.35	24	NA	NA	NA	NA	653/1701	660/1701
Farzat 2023	retrospective	164	336	66.93(8)	66.75(6.6)	NA	NA	15.6(26)	14.4(23.8)	68(29)	58(22.9)	79/164	124/336

BMI: body mass index, PSA: prostate specific antigen, OB: obese, NOB: nonobese

were not sources of heterogeneity in the outcomes of the studies. In the subgroup analysis of EBL, the blood loss in the subgroup of the retrospective study (WMD,56.5 95%CI: 14.1–98.9; I^2= 69%) was higher than that in the prospective study (WMD,47.3 95%CI: -7.3-101.9; I^2= 98%), and the heterogeneity was greatly reduced (Fig. 6-C). The remaining subgroup analyses also did not reduce the outcome heterogeneity.

Publication bias and sensitivity analysis

Funnel plots of the two outcome-Funnel plots of the two outcome (Fig. 6-D、E) indicators were roughly symmetric to the naked eye which indicated that the publication bias was not significant. After removing Sarychev 2022 data using a leave-one-out approach for estimated blood loss, heterogeneity decreased from I^2 = 97–77% (Fig. 6-F). This may be because patients in Sarychev 2022 did not distinguish between central vs. abdominal obesity, and abdominal obesity was major challenging for their physicians. The remaining results were found to be stable after exclusion using the leave-one-out method.

Discussion

The significant findings related to perioperative complications, functional outcomes, and oncologic outcomes in the current study warrant a thorough discussion.

Perioperative outcomes

The primary perioperative parameters evaluated in the two groups included operative time, the length of hospital stay, estimated blood loss, pelvic lymphadenectomy rate and nerve sparing rate. The present study found significant increases in both operating time and EBL in obese men undergoing RARP. Similarly Mikhail et al. [33] noted in the study that OT and EBL were increased in the obese group. The following factors elucidate the complexities encountered when implementing the Robotic-Assisted Radical Prostatectomy (RARP) technique in obese patients. (I) Obese patients possess higher volumes of adipose tissue, which commonly results in a less discernible and distinguishable anatomical structure within the surgical area as compared to non-obese patients. This aspect poses a significant challenge to the surgeon in terms of isolating and excising the prostate, inherently extending the duration of the operation. (II) Within the abdominal cavity, the presence of amplified adipose tissue may lead to a constricted operative field, thereby complicating the maneuverability of the robotic arm during surgery [34]. (III) Patients with obesity, characterized by an enriched blood supply to adipose tissue, may necessitate extended time for hemorrhage control during surgical procedures. This factor contributes to the observed increase in blood loss in these individuals. Although the increases in blood loss (50.63 ml) and

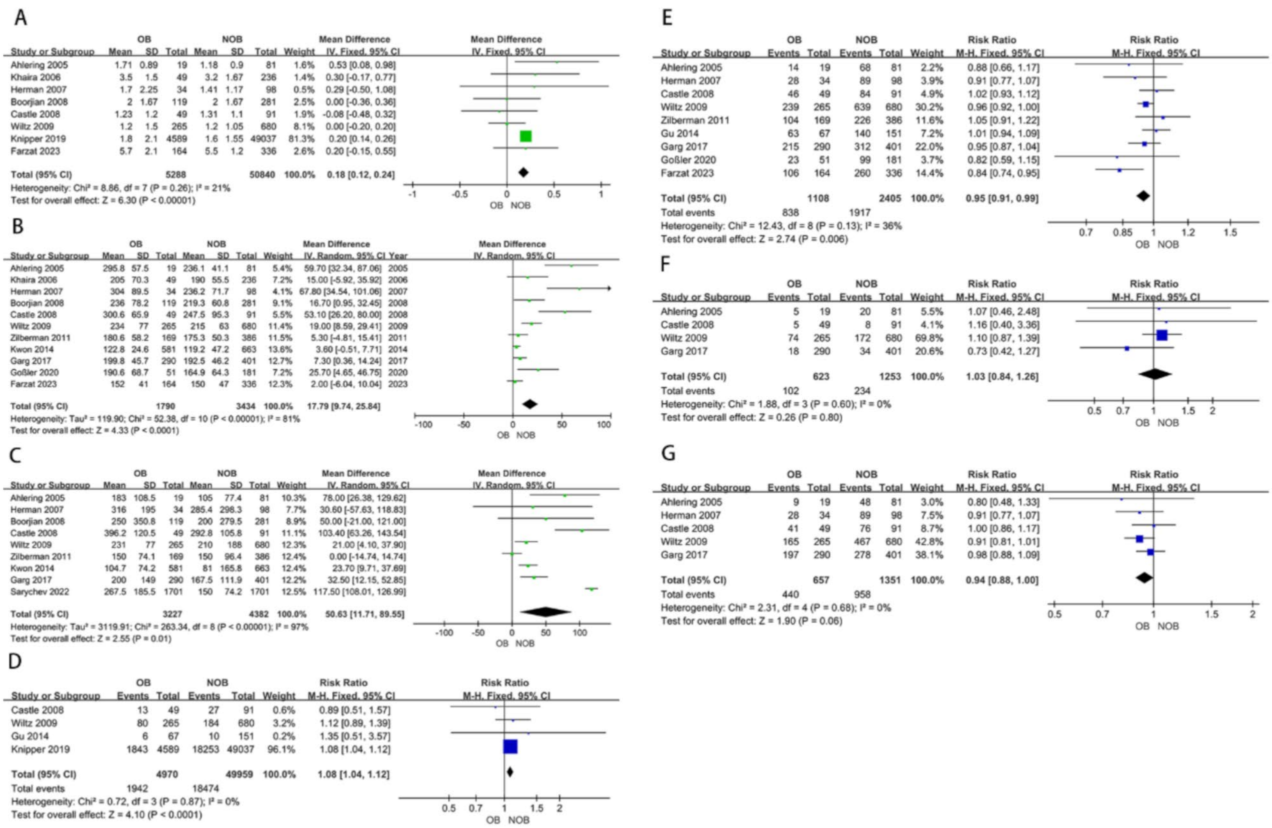

Fig. 2 Forest plots of perioperative outcomes. **A**. operative time **B**. length of hospital stay. **C**. length of hospital stay **D**. pelvic lymphadenectomy **E**. Nerve sparing status (Overall) **F**. Nerve sparing status (Unilateral) **G**. Nerve sparing status (Bilateral)

operative time (17.79 min) in obese men were statistically significant, these disparities may bear minimal clinical significance. Furthermore, in our meta-analysis, individuals with obesity demonstrated significantly larger prostate sizes. Obesity was similarly found to be associated with a larger prostate in the study by Mikhail et al. [33]. This could render the dissection of the anterior urethra more challenging and potentially complicate the process of cystourethral anastomosis for the surgeon [35].

The OB group was associated with longer length of hospital stay than the NOB group, possible reasons: (I) Patients with obesity often present with concomitant health conditions, such as cardiovascular disease and diabetes. These comorbidities can adversely impact postoperative recovery and subsequently extend the duration of their hospital stay. (II) Patients with obesity may experience an elevated incidence of postoperative complications [36], encompassing infections and deep vein thrombosis, necessitating extended periods for management and recuperation.

The obese group had a higher rate of pelvic lymphadenectomy and a lower rate of nerve sparing. In the study by Tafuri et al. [37], it was found that obese prostate cancer patients had a higher risk of lymph node metastasis. Studies have shown that prostate cancer in obese patients is more aggressive [38, 39], so in order to completely remove the cancer, it may be necessary to remove the related nerves and lymph nodes.

Complications

In respect of the safety of RARP, the OB group was higher for overall, major, or minor complications in comparison with nonobese group. But In the study by Xu et al. [11], there was no significant difference for overall, major, or minor complications in comparison with nonobese group. However, the results of the study by Cao et al. [40] were similar to our results. This can be elucidated from the subsequent viewpoints: (I) Obese patients have a higher amount of adipose tissue, leading to a compact operational space during surgery, thereby escalating the level of complexity in the procedure. (II) Obese patients have an increased cardiorespiratory load and are susceptible to airway obstructions, significantly heightening the risk associated with anesthesia [41]. (III) Obese patients also carry an elevated risk for wound infections.

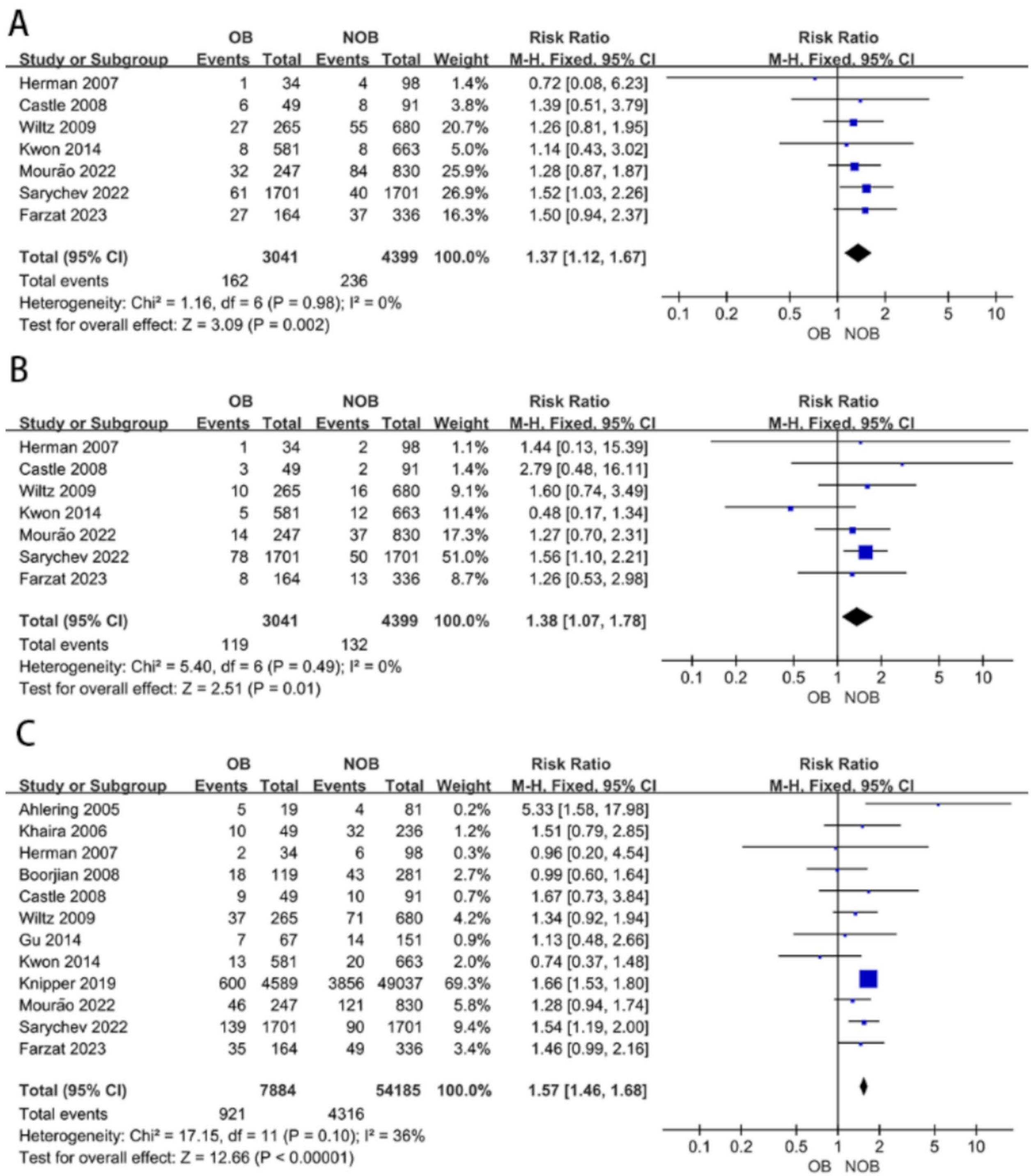

Fig. 3 Forest plots of complication. **A**. Minor complications **B**. Major complications **C**. Overall complications

Functional outcomes

Functional outcomes were also analyzed in the current meta-analysis. Continence recovery defined as the use of no pad or one safety pad per day, and potency recovery defined as erections sufficient for sexual intercourse without the use of phosphodiesterase 5 (PDE5) inhibitors. In the first year after surgery, we identified that obese patients had poorer functional outcomes compared to their nonobese counterparts. This differs from the study by Carbin et al. [42]. In their study, men with BMI ≥ 35 achieved continence rates and equivalent to men with BMI < 35 within 1 year. However, some critical

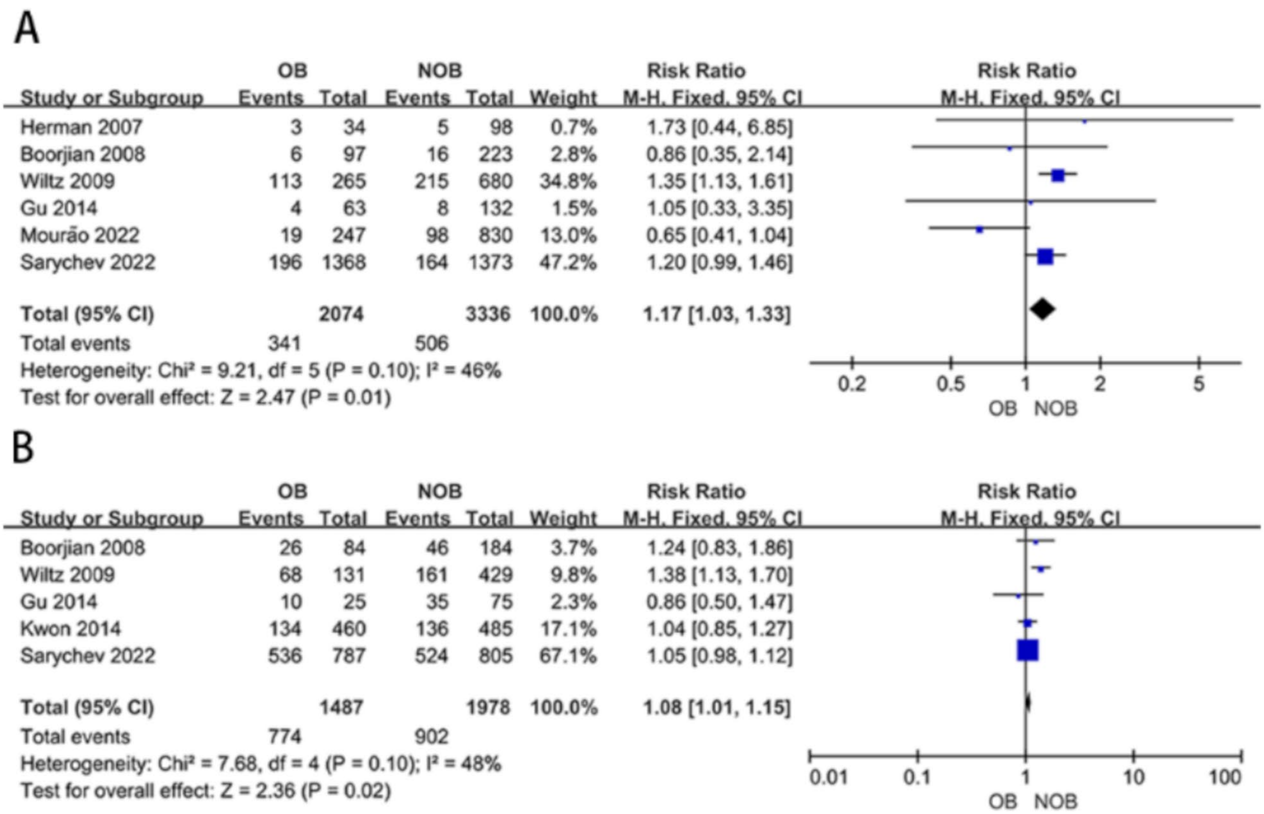

Fig. 4 Forest plots of functional outcomes. **A**. Incontinence at 1 year **B**. Impotency at 1 year

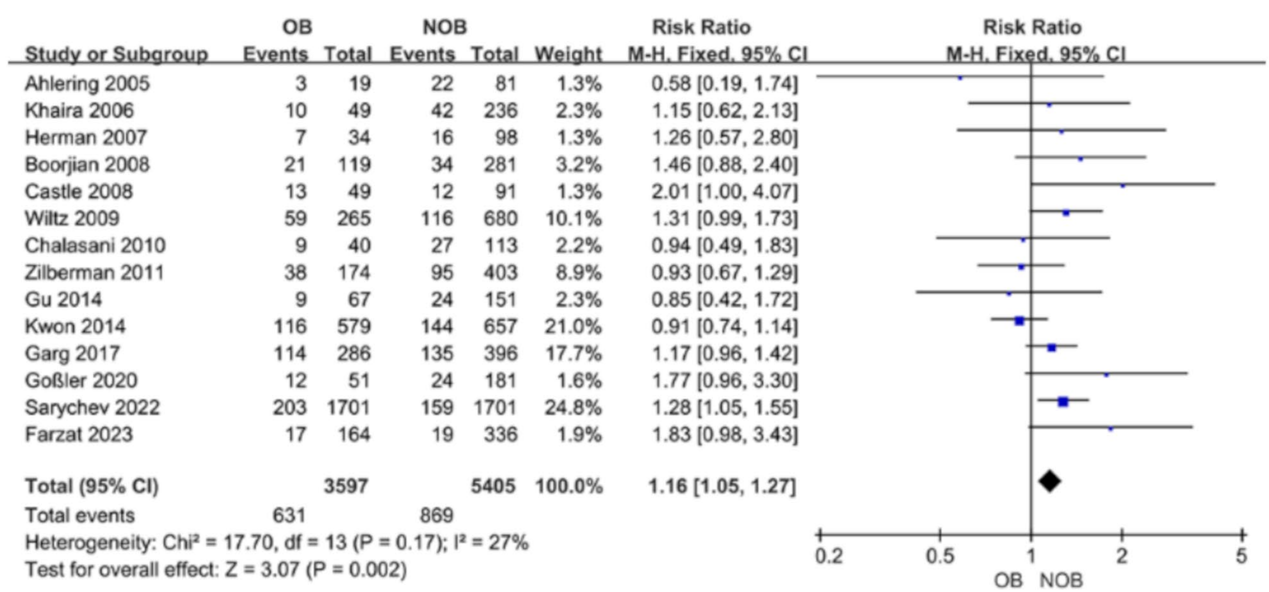

Fig. 5 Forest plots of oncologic outcomes. A Positive surgical margins

issues must be addressed before discussing the functional results. Firstly, the nerve-sparing technique and pelvic lymphadenectomy could potentially influence the restoration of continence and potency. Secondly, in patients with obesity, excess adipose tissue and constrained surgical space could restrict the surgeon's field of vision. This visual clarity is crucial for preserving the urethral sphincter and nerves. Thirdly, obese patients often present with

Table 2 Subgroup analysis of operative time

Stratified	No.of studies	I^2	WMD (95%CI)	*P* value
Publication date				
<2014	7	80%	29.3 (14.5,44.1)	*P* = 0.0001
≥ 2014	4	41%	17.8 (9.7, 25.8)	*P* = 0.03
Study type				
prospective	6	81%	17.0(5.8, 28.2)	*P* = 0.003
retrospective	6	85%	22.0(6.7, 37.3)	*P* = 0.005
Blood loss volume				
≤ 200	4	81%	10.6(0.6, 20.6)	*P* = 0.04
>200	4	77%	34.3(14.4, 54.1)	*P* = 0.0007
Never sparing				
<80%	5	79%	13.7(2.5, 25.0)	*P* = 0.02
≥ 80%	3	83%	43.8(11.8, 75.9)	*P* = 0.007
Risk of Bias assessment				
Moderate	7	85%	28.6(11.8, 45.4)	*P* = 0.0009
Low	4	67%	9.8(2.7, 16.8)	*P* = 0.007

Table 3 Subgroup analysis of estimated blood loss

Stratified	No. of studies	I^2	WMD (95%CI)	*P* value
Publication date				
<2014	6	83%	43.6(11.4, 75.8)	*P* = 0.008
≥ 2014	3	99%	58.2(-10.0, 126.3)	*P* = 0.09
Study type				
prospective	5	98%	47.3(-7.3, 101.9)	*P* = 0.09
retrospective	4	69%	56.5(14.1, 98.9)	*P* = 0.009
Never sparing				
<80%	3	84%	29.6(-5.4, 64.6)	*P* = 0.10
≥ 80%	3	85%	52.9(-9.6, 115.4)	*P* = 0.10
Risk of bias assessment				
Moderate	4	89%	52.8(-9.9, 115.6)	*P* = 0.10
Low	5	98%	49.1(-2.1, 100.3)	*P* = 0.06

heightened abdominal pressure [43], placing undue stress on the function of the urethral sphincter, potentially exacerbating incontinence. Consequently, it is crucial that we exercise careful judgment when evaluating the functional outcomes in both groups following robot-assisted radical prostatectomy (RARP). Furthermore, Checcucci and colleagues [44] have investigated the pivotal role of anatomical reconstruction in facilitating continence recovery post-RARP. Their study reveals that the total reconstruction technique (TR) enhances the rate and velocity of continence restoration when compared to the conventional approach or isolated posterior (PR) or anterior (AR) reconstruction methods. This insight holds substantial significance for the management of continence recovery following RARP.

Oncologic outcomes

In a recent paper published by Porcaro et al. [45] showed a statistically significant inverse association between BMI and PSMs in patients. In our study, the OB group had higher rates of PSM than the NOB group. This may be due to the fact that adipose tissue secretes a variety of cytokines and hormones, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) [46–48]. These substances could potentially stimulate tumor growth and invasiveness, obscure the delineation of tumor boundaries, and as a result, impede the thorough excision of all malignant cells during surgical treatments. Lastly, we did not perform the analysis of BCR, so it still needs to be validated in high-quality, multicenter studies.

Compared to the previous meta-analysis [11], our article has the advantage of incorporating more data and increasing the rates of Pelvic lymphadenectomy and nerve sparing. We conducted a more in-depth analysis and obtained different results in terms of surgical complications and length of hospital stay. Nonetheless, the study exhibits certain limitations. The meta-analysis conspicuously lacked the incorporation of any Randomized Controlled Trials (RCTs). In the context of these two unique cohorts (obese versus nonobese), the execution of randomization and blinding within RCTs is practically unrealistic. Besides, there was inconsistency in the employed surgical techniques and a noticeable absence of standardized definitions for outcome measures across

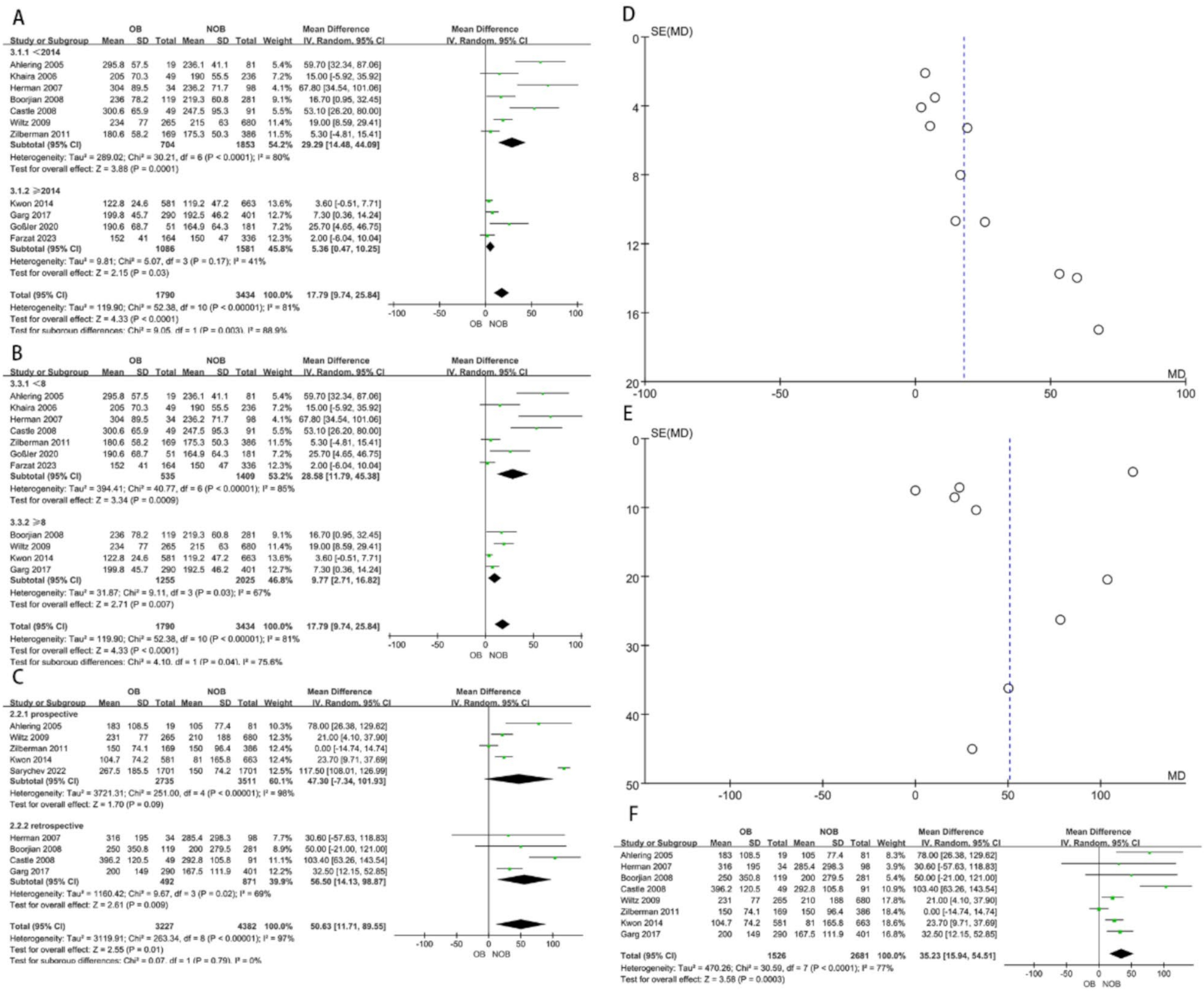

Fig. 6 **A**. Subgroup analysis of Publication date for operative time **B**. Subgroup analysis of Risk of Bias assessment for operative time **C**. Subgroup analysis of Study type for estimated blood loss **D**. Funnel plot of operative time **E**. Funnel plot of estimated blood loss **F**. The leave-one-out method of EBL

different institutions. Lastly, some outcomes were reliant on data derived solely from three or four studies, thus compromising the reliability of these outcomes.

Conclusions

Based on the current meta-analysis, the perioperative outcomes, total complications, functional outcomes, and oncologic outcomes of RAPA in the obese group were worse than those in the non-obese group. This may suggest that we should have a healthy lifestyle and control our weight. Further studies should be performed to evaluate the oncologic outcomes for obese patients undergoing RARP.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12894-024-01595-5.

Supplementary Material 1

Author contributions

All authors contributed to the study's conception and design. WCJ and QJ conducted data collection, while data organization was carried out by LY and WZ. Data analysis was performed by CCX, LHY, HHT, and YL. WCJ authored the initial draft of the manuscript, with YXS completing the review and revision. All authors read and granted approval for the final manuscript.

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Data availability

The original contributions presented in the study are included in the article material, further inquiries can be directed to the corresponding author/s.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Alshaker H, Sacco K, Alfraidi A, Muhammad A, Winkler M, Pchejetski D. Leptin signalling, obesity and prostate cancer: molecular and clinical perspective on the old dilemma. Oncotarget. 2015;6(34):35556–63.
2. Jaspan V, Lin K, Popov V. The impact of anthropometric parameters on colorectal cancer prognosis: a systematic review and meta-analysis. Crit Rev Oncol Hematol. 2021;159:103232.
3. van Roermund JG, Witjes JA. The impact of obesity on prostate cancer. World J Urol. 2007;25(5):491–7.
4. Schnoeller T, Jentzmik F, Rinnab L, Cronauer MV, Damjanoski I, Zengerling F, Ghazal AA, Schrader M, Schrader AJ. Circulating free testosterone is an independent predictor of advanced disease in patients with clinically localized prostate cancer. World J Urol. 2013;31(2):253–9.
5. Binder J, Kramer W. Robotically-assisted laparoscopic radical prostatectomy. BJU Int. 2001;87(4):408–10.
6. Novara G, Ficarra V, Rosen RC, Artibani W, Costello A, Eastham JA, Graefen M, Guazzoni G, Shariat SF, Stolzenburg JU, et al. Systematic review and meta-analysis of perioperative outcomes and complications after robot-assisted radical prostatectomy. Eur Urol. 2012;62(3):431–52.
7. Ficarra V, Novara G, Ahlering TE, Costello A, Eastham JA, Graefen M, Guazzoni G, Menon M, Mottrie A, Patel VR, et al. Systematic review and meta-analysis of studies reporting potency rates after robot-assisted radical prostatectomy. Eur Urol. 2012;62(3):418–30.
8. Ficarra V, Novara G, Rosen RC, Artibani W, Carroll PR, Costello A, Menon M, Montorsi F, Patel VR, Stolzenburg JU, et al. Systematic review and meta-analysis of studies reporting urinary continence recovery after robot-assisted radical prostatectomy. Eur Urol. 2012;62(3):405–17.
9. Novara G, Ficarra V, Mocellin S, Ahlering TE, Carroll PR, Graefen M, Guazzoni G, Menon M, Patel VR, Shariat SF, et al. Systematic review and meta-analysis of studies reporting oncologic outcome after robot-assisted radical prostatectomy. Eur Urol. 2012;62(3):382–404.
10. Autorino R, Zargar H, Kaouk JH. Robotic-assisted laparoscopic surgery: recent advances in urology. Fertil Steril. 2014;102(4):939–49.
11. Xu T, Wang X, Xia L, Zhang X, Qin L, Zhong S, Shen Z. Robot-assisted prostatectomy in obese patients: how influential is obesity on operative outcomes? J Endourol. 2015;29(2):198–208.
12. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015;350:g7647.
13. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, Moher D, Tugwell P, Welch V, Kristjansson E, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ. 2017;358:j4008.
14. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;355:i4919.
15. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ. 2003;327(7414):557–60.
16. Sajadi KP, Terris MK, Hamilton RJ, Cullen J, Amling CL, Kane CJ, Presti JC Jr., Aronson WJ, Freedland SJ. Body mass index, prostate weight and transrectal ultrasound prostate volume accuracy. J Urol. 2007;178(3 Pt 1):990–5.
17. Ahlering TE, Eichel L, Edwards R, Skarecky DW. Impact of obesity on clinical outcomes in robotic prostatectomy. Urology. 2005;65(4):740–4.
18. Khaira HS, Bruyere F, O'Malley PJ, Peters JS, Costello AJ. Does obesity influence the operative course or complications of robot-assisted laparoscopic prostatectomy. BJU Int. 2006;98(6):1275–8.
19. Herman MP, Raman JD, Dong S, Samadi D, Scherr DS. Increasing body mass index negatively impacts outcomes following robotic radical prostatectomy. JSLS: J Soc Laparoendoscopic Surg / Soc Laparoendoscopic Surg. 2007;11(4):438–42.
20. Boorjian SA, Crispen PL, Carlson RE, Rangel LJ, Karnes RJ, Frank I, Gettman MT. Impact of obesity on clinicopathologic outcomes after robot-assisted laparoscopic prostatectomy. J Endourol. 2008;22(7):1471–6.
21. Castle EP, Atug F, Woods M, Thomas R, Davis R. Impact of body mass index on outcomes after robot assisted radical prostatectomy. World J Urol. 2008;26(1):91–5.
22. Wiltz AL, Shikanov S, Eggener SE, Katz MH, Thong AE, Steinberg GD, Shalhav AL, Zagaja GP, Zorn KC. Robotic Radical Prostatectomy in overweight and obese patients: oncological and validated-functional outcomes. Urology. 2009;73(2):316–22.
23. Chalasani V, Martinez CH, Lim D, Bareeq RA, Wignall GR, Stitt L, Pautler SE. Impact of body mass index on perioperative outcomes during the learning curve for robot-assisted radical prostatectomy. Can Urol Assoc J. 2010;4(4):250–4.
24. Zilberman DE, Tsivian M, Yong D, Albala DM. Surgical steps that elongate operative time in robot-assisted radical prostatectomy among the obese population. J Endourol. 2011;25(5):793–6.
25. Gu X, Araki M, Wong C. Does elevated body mass index (BMI) affect the clinical outcomes of robot-assisted laparoscopic prostatectomy (RALP): a prospective cohort study. Int J Surg. 2014;12(10):1055–60.
26. Kwon YS, Leapman M, McBride RB, Hobbs AR, Collingwood SA, Stensland KD, Samadi DB. Robotic-assisted laparoscopic prostatectomy in men with metabolic syndrome. Urol Oncol: Seminars Original Investigations. 2014;32(1):40.e49–40.e16.
27. Garg T, Young AJ, Kost KA, Park AM, Danella JF, Kirchner HL. Patient-reported quality of life recovery curves after robotic prostatectomy are similar across body mass index categories. Invest Clin Urol. 2017;58(5):331–8.
28. Knipper S, Mazzone E, Mistretta FA, Palumbo C, Tian Z, Briganti A, Saad F, Tilki D, Graefen M, Karakiewicz PI. Impact of obesity on Perioperative outcomes at robotic-assisted and open radical prostatectomy: results from the National Inpatient Sample. Urology. 2019;133:135–44.
29. Goßler C, May M, Rosenhammer B, Breyer J, Stojanoski G, Weikert S, Lenart S, Ponholzer A, Dreissig C, Burger M, et al. Obesity leads to a higher rate of positive surgical margins in the context of robot-assisted radical prostatectomy. Results of a prospective multicenter study. Cent Eur J Urol. 2020;73(4):1–9.
30. Mourão TC, de Oliveira RAR, Favaretto RDL, Santana TBM, Sacomani CAR, Bachega W, Guimarães GC, Zequi SDC. Should obesity be associated with worse urinary continence outcomes after robotic-assisted radical prostatectomy? A propensity score matching analysis. Int Braz J Urol. 2022;48(1):122–30.
31. Sarychev S, Witt JH, Wagner C, Oelke M, Schuette A, Liakos N, Karagiotis T, Mendrek M, Kachanov M, Graefen M, et al. Impact of obesity on perioperative, functional and oncological outcomes after robotic-assisted radical prostatectomy in a high-volume center. World J Urol. 2022;40(6):1419–25.
32. Farzat M, Sharabaty I, Tanislav C, Alsaid Y, Wagenlehner FM. BMI impact on readmissions for patients undergoing robot-assisted radical prostatectomy: a monocentric, single-surgeon serial analysis of 500 cases. J Clin Med. 2023;12(12).
33. Mikhail AA, Stockton BR, Orvieto MA, Chien GW, Gong EM, Zorn KC, Brendler CB, Zagaja GP, Shalhav AL. Robotic-assisted laparoscopic prostatectomy in overweight and obese patients. Urology. 2006;67(4):774–9.
34. Hu MB, Xu H, Bai PD, Jiang HW, Ding Q. Obesity has multifaceted impact on biochemical recurrence of prostate cancer: a dose-response meta-analysis of 36,927 patients. Med Oncol. 2014;31(2):829.
35. O'Connor E, Koschel S, Bagguley D, Sathianathen NJ, Cumberbatch MG, Thangasamy IA, Moon D, Murphy DG. Robotic prostatectomy after abandoned open radical prostatectomy-technical aspects and outcomes. BJUI Compass. 2020;1(5):174–9.
36. Murphy DG, Bjartell A, Ficarra V, Graefen M, Haese A, Montironi R, Montorsi F, Moul JW, Novara G, Sauter G, et al. Downsides of robot-assisted laparoscopic radical prostatectomy: limitations and complications. Eur Urol. 2010;57(5):735–46.
37. Tafuri A, Amigoni N, Rizzetto R, Sebben M, Shakir A, Gozzo A, Odorizzi K, De Michele M, Gallina S, Bianchi A, et al. Obesity strongly predicts clinically undetected multiple lymph node metastases in intermediate- and high-risk prostate cancer patients who underwent robot assisted radical prostatectomy and extended lymph node dissection. Int Urol Nephrol. 2020;52(11):2097–105.
38. Price RS, Cavazos DA, De Angel RE, Hursting SD, deGraffenried LA. Obesity-related systemic factors promote an invasive phenotype in prostate cancer cells. Prostate Cancer Prostatic Dis. 2012;15(2):135–43.

39. Zhang Q, Sun LJ, Qi J, Yang ZG, Huang T. Influence of adipocytokines and periprostatic adiposity measurement parameters on prostate cancer aggressiveness. Asian Pac J Cancer Prev. 2014;15(4):1879–83.
40. Cao Y, Ma J. Body mass index, prostate cancer-specific mortality, and biochemical recurrence: a systematic review and meta-analysis. Cancer Prev Res (Phila). 2011;4(4):486–501.
41. De Jong A, Verzilli D, Chanques G, Futier E, Jaber S. [Preoperative risk and perioperative management of obese patients]. Rev Mal Respir. 2019;36(8):985–1001.
42. Carbin Joseph DD, Dranova S, Harrison H, Papanikolou D, Uribe S, Broe M, Adamou C, Whiting D, Frajkoulis G, Moschonas D, et al. Functional and oncological outcomes of robot-assisted radical prostatectomy in obese men: a matched-pair analysis. J Robot Surg. 2023;17(5):2027–33.
43. Wilson A, Longhi J, Goldman C, McNatt S. Intra-abdominal pressure and the morbidly obese patients: the effect of body mass index. J Trauma. 2010;69(1):78–83.
44. Checcucci E, Pecoraro A, S DEC, Manfredi M, Amparore D, Aimar R, Piramide F, Granato S, Volpi G, Autorino R, et al. The importance of anatomical reconstruction for continence recovery after robot assisted radical prostatectomy: a systematic review and pooled analysis from referral centers. Minerva Urol Nephrol. 2021;73(2):165–77.
45. Porcaro AB, Sebben M, Corsi P, Tafuri A, Processali T, Pirozzi M, Amigoni N, Rizzetto R, Cacciamani G, Mariotto A, et al. Risk factors of positive surgical margins after robot-assisted radical prostatectomy in high-volume center: results in 732 cases. J Robot Surg. 2020;14(1):167–75.
46. Kojta I, Chacińska M, Błachnio-Zabielska A. Obesity, bioactive lipids, and adipose tissue inflammation in insulin resistance. Nutrients. 2020;12(5).
47. Fantuzzi G. Adipose tissue, adipokines, and inflammation. J Allergy Clin Immunol. 2005;115(5):911–9. quiz 920.
48. Coppack SW. Pro-inflammatory cytokines and adipose tissue. Proc Nutr Soc. 2001;60(3):349–56.

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