The Impact of Obesity on Surgical Outcome in Endometrial Cancer Patients: A Systematic Review

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Abstract

Background: Obesity is a significant public health problem in the United States, and many studies have established obesity as a significant risk factor for endometrial cancer. Surgery is the standard of care in staging and treatment of endometrial cancer, and obesity may influence surgical outcomes because of its attendant comorbid conditions. Therefore, assessment of the impact of obesity on surgical outcome is important for decreasing morbidity and improving survival in patients with endometrial cancer. **Objective:** The aims of this research were to evaluate and review epidemiologic data systematically on the impact of obesity on surgical outcomes and to assess safety and feasibility of newer surgical techniques in obese patients. **Materials and Methods:** A systematic search of PubMed was conducted to identify articles between 2004 and 2013 that focused on the impact of obesity on surgical outcome. Reference lists of retrieved articles were also used to identify other relevant articles. Thirteen relevant articles were reviewed. **Results:** Evidence from epidemiologic studies showed that obesity impacts surgical outcome adversely. On average, obese patients have worse surgical outcomes than their nonobese counterparts. In addition, surgical outcome worsens as level of obesity increases. However, surgical procedure also influences this association. Minimally invasive surgeries are more useful and are accompanied with fewer complications than conventional laparotomy and can be performed safely in obese patients. **Conclusions:** Obesity is a significant risk in the etiology, treatment, and surgical outcomes of patients with endometrial cancer. Future research will need more randomized controlled trials and prospective studies to identify the best procedures for maximal outcomes. (J GYNECOL SURG 32:149)

Introduction

ENDOMETRIAL CANCER is the cancer of the uterine corpus and is the fourth most common malignancy in females.¹ As of 2013, it was the most common gynecologic malignancy in the United States, with an estimated incidence of 54,560 new cases (6% of cancer incidence) and estimated deaths of 8190 (3% of cancer mortality).¹ Many studies have established the association between obesity and endometrial cancer.^{2–6} The biologic mechanism of the relationship between obesity and endometrial cancer has been attributed to alterations in endogenous hormone metabolism.^{7,8} Endometrial cancer is a hormone-dependent cancer, and obesity affects hormone metabolism by increasing aromatization of androstenedione to estrone in adipose tissues.^{8,9} In addition, obesity increases circulating levels of estrogen, which creates a conducive environment for tumor formation.^{4,9} Other risk

factors for endometrial cancer include physical inactivity, unopposed estrogen therapy, chronic hyperinsulinemia, tamoxifen, and early menarche, late onset of menopause, polycystic ovarian syndrome, and diabetes.^{6,10}

Obesity is a significant public health problem in the United States, and the prevalence of obesity is increasing at an alarming rate. Recent data from the National Health and Nutrition Examination Survey [NHANES] 2009–2010 showed that ~35% of women are obese.¹¹ Obesity is defined by using the body mass index cutoff point of >30 kg/m², which is calculated as weight in kg divided by height in meters squared (m²).¹² Although the measurement of BMI has been criticized because this measurement does not differentiate between lean or fat mass and does not account for central adiposity,^{13,14} the BMI is still of great public health importance because it correlates well with disease risk and mortality.⁸

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The standard of care for the proper management of endometrial cancer is surgery, which is necessary for both staging and treatment.^{15,16} The recommended surgical procedures for early stage endometrial cancer include hysterectomy, bilateral salpingo-oophorectomy, and, if applicable, lymphadenectomy (para-aortic or pelvic). These surgical procedures can be carried out via three major approaches: (1) laparotomy; (2) conventional laparoscopy; or (3) robotic-assisted laparoscopy.¹⁷ However, conventional laparoscopy and robotic-assisted surgery are usually grouped together as minimally invasive surgery. In the past, the standard surgical approach for staging was laparotomy which involves an abdominal midline incision, but, later on, laparoscopically assisted surgery became a better alternative for reducing complications.¹⁸ An obese patient is at a higher risk of operative and postoperative complications, a long hospital stay, and increased morbidity when laparotomy is performed.^{3,7} In 2011, the American Association of Gynecologic Laparoscopists published an article and stated that hysterectomies for benign diseases should be performed either vaginally or laparoscopically.¹⁹ However, within the past decade, minimally invasive surgeries have evolved and are often used to treat many gynecologic cancers.^{18,20}

Obesity plays a central role in the etiology of, management options for, and treatment outcomes of endometrial cancer. Management of an obese patient is quite challenging, and the goal in management is to reduce morbidity and mortality, and improve survival. As the incidence of obesity is increasing, physicians are tending towards performing minimally invasive surgeries to lessen intra- and postoperative complications.¹⁷ Apart from the higher risk of endometrial cancer in obese patients, they also have a higher incidence of cardiovascular, respiratory, gastrointestinal, metabolic, and neurologic disease.²¹ In addition, obesity is also considered to be a relative contraindication to general anesthesia. The increased risk of other comorbid disease makes surgical treatment and management of obese patients technically difficult. Many studies have examined the association between obesity and surgical outcomes, but results have been mixed. The aim of this review is to investigate how obesity affects or impacts surgical outcome such as blood loss, operating time, length of hospital stay, and complication rates. In addition, the safety and efficacy of newer surgical techniques are assessed and compared with respect to managing endometrial cancer in obese patients.

Materials and Methods

A literature search was conducted through privileges of the University of South Carolina Library, and articles were accessed through PubMed for articles published in scientific journals. Searches were made for articles published in English not later than 10 years ago and for studies performed in humans. The following search terms and combinations were used: endometrial cancer, neoplasm, obesity, BMI, body weight, surgery, and surgical outcome. Reference lists of articles were reviewed to identify other relevant articles.

The initial search yielded 42 articles, and titles were screened for relevant information. Based on this information, 22 potential articles were reviewed, and 9 articles were removed because they were either case reports, did not focus on the operationalized terms—such as surgical outcome or

obesity—or were not specific to endometrial cancer. Surgical procedures of interest included laparotomy, minimally invasive surgery (vaginal, laparoscopic and robotic), para-aortic lymphadenectomy, and pelvic lymphadenectomy. The surgical outcomes of interest in this review were estimated blood loss (EBL), operating room time (ORT), the length of hospital stay (in days), and postoperative complications.

Selection of studies

Any study found that looked at surgical outcomes, such as EBL, ORT, and postoperative complications and included any or all of the operationalized terms related to obesity was included in this review.

Review methods

Data on the measurements of obesity that were associated with surgical outcome were extracted and summarized. Original studies ($N=13$) were selected, based on the inclusion of the predetermined measurements of BMI in the publications.

Results

A review of 13, mostly retrospective studies was conducted. A summary of the articles is shown in Table 1. Twelve studies defined obesity using BMI; one study did not state a BMI cutoff but assessed women whose weight was >100 kg (220 lbs.).²² Most studies examined the following outcomes of interest: EBL; ORT; length of hospital stay; and postoperative complications. All studies reviewed used a statistical significance level of $p < 0.05$.

There were ten retrospective studies,^{3,4,7,15,22–27} three prospective studies,^{28–30} and no randomized clinical trials (RCTs) in this review. The sample size of the retrospective studies and prospective studies ranged between 42 and 655 women and 86 and 233 women, respectively. Seven studies compared surgical outcome according to BMI. The peri-operative outcomes are summarized in Table 2. Five studies compared the efficacy and safety of minimally invasive surgeries versus laparotomy in the management of obese patients.^{15,22,25,26,29}

There were mixed results in the findings of the retrospective studies. A retrospective study in Turkey, conducted by Akbayir et al.,⁴ assessed the influence of BMI on surgical morbidity and outcome in normal-weight, overweight, and obese patients. The surgical procedure performed on all 370 women in the study was total abdominal hysterectomy, bilateral oophorectomy, and peritoneal cytology. Findings from this retrospective study showed no significant difference in length of hospital stay, blood loss, and complications among the groups. However, obese patients had significantly longer ORTs. In addition, the researchers found that the risk of hypertension and diabetes increased with increasing BMI. The researchers' conclusion was that obesity is not considered an obstacle for surgical staging and that surgical staging in obese patients is not risky. In addition, mortality rates were not affected by BMI.

However, Pavelka et al.²⁴ who also conducted a retrospective study in the United States, found that patients with BMI >40 kg/m² had longer ORTs and greater mean EBLs than patients with BMI <30 kg/m². There were also

TABLE 1. EPIDEMIOLOGIC STUDIES ON THE IMPACT OF OBESITY ON SURGICAL OUTCOME IN PATIENTS WITH ENDOMETRIAL CANCER

<i>First author & reference</i>	<i>Year</i>	<i>Study design</i>	<i>Location</i>	<i>Sample size</i>	<i>Exposure assessment/ BMI group</i>	<i>Confounders adjusted</i>	<i>Findings</i>
Giugale ²³	2012	Retrospective study assessing the effect of obesity classifications on hysterectomy outcomes for uterine cancer/hyperplasia	Virginia, USA	659 women: 261 obese; 271 morbidly obese; & 123 super obese	<i>Patient notes</i> BMI groups: 30–39 kg/m ² ; 40–49 kg/m ² ; ≥ 50 kg/m ²	Not specified; however, outcomes were assessed based on BMI & surgical procedure	Women with BMI ≥40 kg/m ² have worse surgical outcomes than their less-obese counterparts.
Akbayır ⁴	2012	Retrospective study examining the influence of BMI on surgical morbidity & outcome	Istanbul, Turkey	370 normal-weight, overweight, & obese women	<i>Patient notes</i> BMI groups: < 25 kg/m ² ; 25–29.9 kg/m ² ; ≥ 30 kg/m ²	Age >60, BMI, comorbid conditions, smoking, HRT use, stage of disease, nonendometrioid histology, tumor grade, myometrial invasion, LN involvement, or radiation	There were no differences in hospital stay, blood loss & complications. However, patients with BMI ≥30 kg/m ² had significantly longer operating times.
Fambrini ³	2012	Retrospective study comparing minilaparotomy vs. vaginal surgery in obese patients with early stage endometrial cancer	Firenze, Italy	74 women: Class II & Class III obese patients	<i>Medical charts, operative records & pathology reports</i> BMI groups: 30–39.9 kg/m ² ; > 40 kg/m ²	Not specified; however, baseline characteristics except nulliparity & previous laparotomy were similar between groups	No significant difference in ORT, EBL, length of hospital stay & postoperative complications. The researchers concluded that obese patients could be managed safely with minilaparotomy if unfit for vaginal surgery.
Bernardini ²⁹	2012	Prospective cohort study comparing surgical outcome of robotic-assisted surgery vs. laparotomy in morbidly obese patients (BMI >35)	Ontario, Canada	86 women with a BMI of ≥35 kg/m ²	<i>Patient notes</i> BMI assessed prospectively	Age, comorbid conditions, stage, grade, prior abdominal surgery	No statistically significant difference in operative complications. However, postoperative complications & length of hospital stay were higher in the laparotomy group
Santos ²⁸	2012	Prospective cohort study examining the impact of obesity on perioperative outcomes	Memphis, TN, USA	233 women: 42 normal weight; 53 overweight; 50 obese; & 88 morbidly obese	<i>Medical records collected prospectively</i> BMIs: < 25 kg/m ² ; 25 to <30 kg/m ² ; 30 to <35 kg/m ² ; & > 35 kg/m ²	Not stated; outcomes assessed according to 4 BMI groups	No difference in length of hospital stay or number of LNs harvested, or perioperative complications. However, EBL & length of hospital stay were greater as BMI increased (continued)

TABLE 1. (CONTINUED)

<i>First author & reference</i>	<i>Year</i>	<i>Study design</i>	<i>Location</i>	<i>Sample size</i>	<i>Exposure assessment/ BMI group</i>	<i>Confounders adjusted</i>	<i>Findings</i>
Rabischong ⁷	2011	Retrospective cohort study comparing surgical outcomes of laparoscopic treatment in obese vs. nonobese patients	Clermont-Ferrand, France	52 obese & 155 non-obese women	<i>Medical records</i> BMIs: < 30 kg/m ² & ≥ 30 kg/m ²	Not specified; participants were similar in terms of age, nulliparity, menopausal status, stage & grade of tumor	No differences were found between BMI groups in terms of mean ORT, hospital stay, & perioperative complications. Laparoscopic approach had similar survival & complication rates in obese patients, compared to nonobese patients
Subramaniam ²⁵	2011	Retrospective cohort study comparing surgical outcomes in robotic-assisted & laparotomy surgery in obese women	Birmingham, AL, USA	177 women (BMI ≥30 kg/m ²): 73 women had robotic-assisted surgery & 104 had laparotomy	<i>Medical records (retrospective chart review)</i> Mean BMIs (SD): 39.8 (9.3) & 41.9 (9.3) for women who had robotic-assisted surgery & laparotomy, respectively	Not specified; participants were significantly different according to age & number of vaginal deliveries	Robotic-assisted surgeries yielded improved surgical outcomes in obese women.
Lau ³⁰	2011	Prospective cohort study assessing the relationship between BMI & robotic-assisted surgery	Montreal, Canada	108 women: 52 nonobese; 33 obese; & 23 morbidly obese	<i>Patients' notes collected prospectively</i>	Age, comorbid conditions, parity, smoking, previous abdominal surgeries & ASA score	Surgical ORT, EBL, length of hospital stay & postoperative complications were not statistically different among BMI groups.
Santi ¹⁵	2010	Retrospective cohort study comparing the safety & efficacy of laparoscopy & laparotomy for early endometrial cancer, particularly in obese women	Bern, Switzerland	240 women: 120 had laparotomy & 120 had laparoscopy	<i>Medical records</i> BMI groups not stated but BMI was not significantly different between groups; mean BMIs were 29.6 kg/m ² & 31.6 kg/m ² in laparotomy & laparoscopy groups, respectively	Patients were age- & tumor-matched (tumor stage & grade with histology)	Laparoscopy was associated with less ORT, EBL & hospital stay. This approach can be used to treat obese patients effectively. ORT for patients whose BMI were <30 kg/m ² was statistically shorter than patients whose BMI were >30 kg/m ²
Eisenhauer ²⁶	2007	Retrospective study, comparing laparotomy, laparoscopy & laparotomy with panniculectomy in obese women	New York, NY, USA	154 women had laparotomy, 24 had laparoscopy, 27 had laparotomy with panniculectomy	<i>Medical records</i> BMI: >35 kg/m ²	Surgical procedure & comorbid conditions	Both laparoscopy & laparotomy+panniculectomy were associated with lower rate of incisional complications. There was lower blood loss with laparoscopy, compared with laparotomy & laparotomy+panniculectomy. However, there was significantly lower ORT in the laparotomy group.

(continued)

TABLE 1. (CONTINUED)

<i>First author & reference</i>	<i>Year</i>	<i>Study design</i>	<i>Location</i>	<i>Sample size</i>	<i>Exposure assessment/ BMI group</i>	<i>Confounders adjusted</i>	<i>Findings</i>
Erkamli ²⁷	2006	Retrospective study assessing the impact of morbid obesity in surgical management of endometrial cancer	Adana, Turkey	42 women, divided into 3 groups based on BMI <30, 30–40 & >40 kg/m ²	<i>Medical records</i> BMI groups: <30 kg/m ² ; 30–40 kg/m ² ; >40 kg/m ²	Not specified, but prevalence of comorbid conditions were significantly different according to BMI group	Patients with BMI >40 had significantly longer ORT. However, mean EBL & length of hospital stay were not statistically significant among the groups.
Obermair ²²	2005	Retrospective study comparing TLH vs. TAH in morbidly obese women; cutoff for morbidly obese category not stated.	Australia	78 morbidly obese women: 47 had TLH, 31 had TAH	<i>Medical records</i> BMI not stated but surgery performed among women with weight >100 kg	Age, stage, grade, histology type, ASA score	Mean ORT & EBL were similar in both groups. TLH had significantly lower length of hospital stay.
Pavelka ²⁴	2004	Retrospective study assessing surgical, clinical & pathologic outcomes of patients managed with primary surgery	Columbus, OH, USA	356 women: 136 normal-weight women; 128 obese women; & 40 morbidly obese women	<i>Medical records</i> BMI groups: <30 kg/m ² 30–40 kg/m ² > 40 kg/m ²	Not specified; however, outcomes were assessed according to BMI groups	Patients with BMI >40 had longer ORTs & greater mean EBL than patients with BMI <30. There were also significant differences in rates of wound infection.

BMI, body mass index; TLH, total laparoscopic hysterectomy; TAH, total abdominal hysterectomy; HRT, hormone replacement therapy; LN, lymph node; ASA, American Society of Anesthesiologists; ORT, operating room time; EBL, estimated blood loss.

TABLE 2. INTRAOPERATIVE & POSTOPERATIVE OUTCOMES ACCORDING TO BMI GROUPS

First author & reference	BMI group	EBL (mL)	ORT (min)	Hospital stay (days)	Perioperative complications n (%)
Akbayir ⁴	<25 kg/m ²	300.6 ± 74.7	126.4	7.1	9 (17%)
	25–29.9 kg/m ²	299.1 ± 92.2	124.7	8.01	24 (20%)
	≥30 kg/m ²	301.7 ± 36.9	135.5	8.6	44 (13%)
Giugale ²³	30–39 kg/m ²	242.8	209	2.87	Number of complications unclear but postoperative factors were similar between groups
	40–49 kg/m ²	280.8	193	3.13	
	≥50 kg/m ²	377.7	188	3.66	
Pavelka ²⁴	<30 kg/m ²	331	177	4.00	30 (27%)
	30–40 kg/m ²	576	184	4.11	35 (30%)
	>40 kg/m ²	570	205	4.80	34 (47%)
Rabischong ⁷	<30 kg/m ²	Not stated; however, transfusion rates were similar	172.2	4.97	15 (10%)
	≥30 kg/m ²		187.5	5.20	7 (13%)
Santos ²⁸	<25 kg/m ²	206	98	3.00	3 (7%)
	25 to <30 kg/m ²	237	96	3.10	3 (6%)
	30 to <35 kg/m ²	275	108	3.30	5 (10%)
	≥ 35 kg/m ²	346	117	3.50	11 (12.5%)
Lau ³⁰	<30 kg/m ²	64.1	237	1	9 (17%)
	30–39.9 kg/m ²	95.9	255	2	22 (41%)
	≥ 40 kg/m ²	94.0	257	2	5 (21%)
Erkanil ²⁷	<30 kg/m ²	325	186	6.3	Numbers not specified, but intraoperative complications were similar among BMI groups
	30–40 kg/m ²	430	207	5.5	
	> 40 kg/m ²	447	234	7.1	

BMI, body mass index; EBL, estimated blood loss; ORT, operating room time.

significant differences in the rates of wound infection. A possible reason for the difference seen in the result may be a result of the classification of the BMI groups. Pavelka et al.²⁴ assessed obese and morbidly obese women separately and found increasing risk of poor surgical outcomes while Akbayir et al.⁴ only assessed obese (BMI >30 kg/m²) versus overweight and normal-weight patients. The classification in the latter study might have resulted in misclassification.

Of the studies that assessed safety and feasibility of minimally invasive surgeries, a prospective study by Rabischong et al.⁷ assessed long-term follow-up after laparoscopic management in obese women compared to nonobese women. The researchers found no difference between BMIs <30 kg/m² and ≥30 kg/m², in terms of mean ORT, hospital stay, and perioperative complications. Overall survival and disease-free 5-year survival were not different. This finding leans toward safety and efficacy of laparoscopy in obese patients.

Obermair et al.²² compared total laparoscopy hysterectomy (TLH) with total abdominal hysterectomy (TAH) in morbidly obese patients in terms of ORT, EBL, length of hospital stay, and conversion to laparotomy. Efficacy of the two techniques was also assessed. Among 47 patients, TAH was completed in 42 patients (89.4%) successfully but was converted to laparotomy in 5 patients (10.6%). The conversions were attributed to failed access because of severe adhesions in 2 patients and heavy bleeding in 3 patients. There were no significant differences in mean ORT and EBL. However, length of hospital stay was significantly lower in the TLH group.

Table 3 summarizes findings from studies that compared perioperative outcomes according to surgical approach in

obese patients. From the studies that compared type of surgical approach (laparotomy versus laparoscopy), one consistent finding was that laparoscopy produces better surgical outcomes and fewer complications. Another study by Fambrini et al. which compared outcomes of mini laparotomy with vaginal surgery among obese patients, did not find significant difference in intra- and post-operative complications.

Discussion

Findings from this review showed that, on average, obese patients have worse surgical outcomes than their less-obese counterparts. There were significant differences in EBL (mL), ORT (minutes), hospital stay (days), and perioperative complications by BMI groups. BMIs of <30 kg/m² typically had lower EBLs, shorter ORTs, and shorter hospital stays, compared to women with BMIs >30 kg/m². Furthermore, perioperative complications were higher among groups with higher BMIs. These findings were consistent after adjusting for confounders. Surgical outcomes worsened as the level of obesity (≥30 kg/m²) increased. It appears that minimally invasive surgeries are more useful and produce fewer complications than conventional laparotomy, and some studies have shown that minimally invasive surgeries can be performed safely and adequately in obese patients.^{7,8,27} Surgical technique can also influence morbidity and mortality in endometrial cancer.

However, evidence from this review suggests that surgical staging is safe and feasible in a morbidly obese patient when using a minimally invasive approach. In addition, this approach is associated with lower EBL, length of hospital stay, and fewer perioperative complications.

TABLE 3. INTRA- & POSTOPERATIVE OUTCOMES IN OBESE WOMEN ACCORDING TO SURGICAL APPROACH

First author & reference/ surgical approach	EBL (mL)	ORT (min)	Hospital stay (days)	Perioperative complications	Findings
Eisenhauer ²⁶					
Laparotomy	200 (40–2200)	164	6	54 (35%)	Both laparoscopy & laparotomy+panniculectomy surgeries were associated with lower rates of wound complications ($p \leq 0.01$). There was also less blood loss with laparoscopy, although this was not significant ($p = 0.07$).
Laparotomy+panniculectomy	250 (50–700)	265	6	3 (11%)	
Laparoscopy	150 (50–500)	215	3	2 (8%)	
Santi ¹⁵				Not assessed	Laparoscopy, in comparison to laparotomy, was associated with less ORT, EBL & length of hospital stay ($p < 0.05$)
Laparoscopy	240	165	5.6		
Laparotomy	580	150	13.2		Robotic-assisted surgery, in comparison to laparotomy, was associated with less ORT, EBL, length of hospital stay, & wound complications ($p < 0.05$).
Subramaniam ²⁵					
Robotic-assisted surgery	95.9	246.2	2.73	3 (4.1%)	
Laparotomy	408.9	138.2	5.07	21 (20.2%)	Operative complications were similar between robotic surgery patients & laparotomy patients. However, the laparotomy group had significantly longer lengths of hospital stay & higher postoperative complications ($p < 0.05$).
Bernadini ²⁹					
Robotic surgery	300	165	4	18 (44%)	
Laparotomy	200	270	2	8 (17.7%)	Mean ORT & EBL were not significantly different between women who had TAH or TLH. However, women who had TLH had significantly less length of hospital stay & wound infection, compared to women who had TAH ($p < 0.01$).
Obermair ²²					
All morbidly obese ^a					
TLH	278.5	139.3	4.4	10 (21.3%)	
TAH	319.8	126.8	7.9	18 (58%)	

^aBody mass index was not specified but researchers stated that the patients were all morbidly obese.

EBL, estimated blood loss; ORT, operating room time; min, minutes; TLH, total laparoscopic hysterectomy; TAH, total abdominal hysterectomy.

Mean EBL ranged between 64.1 to 331 mL in nonobese women and between 94 to 570 mL for obese and morbidly obese patients. This difference was significant in three studies.^{23,24,28} It was also significant in four studies that compared laparotomy versus minimally invasive surgeries.^{15,25,26,29} Mean ORT ranged from 98 to 237 minutes in nonobese women and from 108 to 270 in obese and morbidly obese patients. This difference was also statistically significant in four studies.^{4,23,24,28} Complication rates were statistically different in four studies that compared safety and efficacy of laparotomy versus minimally invasive surgery in obese patients.^{7,23,26,29} Of the studies that assessed surgical outcome according to BMI, five studies found that obesity (> 30 kg) was significantly associated with longer ORT. This is noteworthy because the longer obese patient spends on an anesthetic agent or lying down, the higher the risk of cardiopulmonary complications and deep venous thrombosis. These are life-threatening situations and have an impact on survival. Although this review did not evaluate survival, a future literature review should assess the effect of obesity on long-term complications.

The results of these various studies should be considered with caution because surgical outcomes, such as ORT, EBL, and length of hospital stay, do not depend on patient attributes or characteristics alone, but also depend on surgeons' experience and speed, and type of equipment available. Outcomes may also be related to types of hospitals (i.e., if a hospital has resident training); this may influence ORT and EBL if some time is set aside to train doctors.

One of the limitations of this review is the lack of RCTs available. Most of the studies available were retrospective studies. However, recall bias may not be an issue because exposure assessment of most studies was done objectively and abstracted from existing medical records/patient notes. In the few prospective studies, the comparison groups were historical cohorts from the same hospitals. To strengthen the existing body of literature, more RCTs and prospective studies are needed. In addition, most of the studies reviewed were conducted internationally, and only 5 studies were conducted in the United States.

Most of the studies did not state clearly what the confounding variables were and how this was controlled. Although it was discussed that information on variables was collected, statistical analysis or method of controlling was not mentioned. Confounders could bias study results and distort the true association between obesity and surgical outcome. It is also important to note the variability or bias that could result from different surgeons performing the intervention. In the Santi et al. study,¹⁵ different surgeons performed the surgeries and this could have resulted in interobserver variability. An important variable to assess or adjust for in future research would be surgeon skills, experience, or years of practice.

Conclusions/Implication for Practice

Obesity is a significant risk with respect to the incidence, treatment, and surgical outcomes in patients with endometrial

cancer. As the prevalence of obesity is increasing in the United States, surgeons should be aware of obesity's impact on endometrial cancer surgical outcomes. Efforts to reduce or prevent obesity, such as through regular physical activity or healthier eating, may have beneficial effects on endometrial cancer surgical outcomes. Some studies have shown that physical activity may help decrease the risk of endometrial cancer and improve survival even among high-risk women,^{21,31–33} possibly through changes in adipokines, leptin, insulin resistance, and estrogen production.³⁴ Thus, healthy lifestyle interventions to reduce obesity should be recommended to improve surgical outcomes for endometrial patients.

Author Disclosure Statement

No competing financial conflicts exist.

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