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ORIGINAL CONTRIBUTIONS

Impacts of Bariatric Surgery on Improvement of Incontinence Among Obese Asian Women: A Prospective Study and Literature Review

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Abstract

Introduction Limited studies investigate bariatric surgery's role in improving UI status among Asians, specifically Middle Eastern Asian women. The aim of this study is to investigate the effect of bariatric surgery on the three most prevalent urine incontinence (UI).We also reviewed the current literature exploring the studies performed in Asian countries.

Materials and Methods A total of 77 women out of 200 who had UI and indications for bariatric surgery completed demographic information and the questionnaire (QUID) prior to surgery and 6 months after the surgery. For statistical analysis, the Mann–Whitney *U* test, Wilcoxon test, and Friedman test were utilized. We also performed a literature review with the aim of investigating studies performed in Asian countries.

Results Among the initial analysis of 200 participants, 50.5% reported UI symptoms before surgery. The average weight loss was 29 kg, with a standard deviation of 7 kg. The mean BMI dropped 11.2 kg/m^2, and the standard deviation was 2.5 after weight loss. Post-surgery, significant reductions in UI scores were observed across all severity levels, with a notable 44% achieving complete symptom resolution, indicating a substantial decrease in urinary incontinence. Stress, urine incontinence, and mixed urine incontinence symptoms had improved in 75%, 71%, and 30% of women, respectively. Notably, age and gynecological history were identified as critical factors influencing the extent of UI improvement.

Conclusion This study reveals significant improvements in urinary incontinence scores, with age and gynecological history playing pivotal roles in UI improvement.

Keywords Urinary incontinence · Bariatric surgery · Pelvic floor diseases · Age · Gynecological history

Key Points
- Bariatric surgery significantly improved urinary incontinence (UI) symptoms, with marked reductions across stress, urgency, and mixed UI types, indicating its effectiveness in managing UI.
- No significant correlation was found between UI improvement and various pre- and post-surgical factors, suggesting the multifaceted nature of UI resolution following bariatric surgery.
- Studies show variations in UI resolution rates post-bariatric surgery between Asian and Western populations, highlighting potential differences in surgical outcomes across regions.

Introduction

Obesity and overweight are widely recognized as prevailing health issues in the twenty-first century, characterized by an imbalanced body weight in proportion to height, resulting in an excessive accumulation of adipose tissue [1, 2]. According to the World Health Organization (WHO), individuals with a body mass index (BMI) ranging from 18.50

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to 24.99 kg/m^2 are considered average weight. Additionally, individuals with a BMI between 25.0 and 29.99 kg/m^2 fall into the overweight category, while those with a BMI of 30 kg/m^2 or higher are classified as obese [3]. Between 1999 and 2017, the percentage of adults with a BMI of ≥ 30 kg/m^2 increased from 30.5 to 41.9% and from 4.7 to 9.2% in cases with severe obesity [4]. Obesity, as a modifiable factor, is linked to various diseases such as cardiovascular disease, skeletal impairments (degenerative joint disease, osteoarthritis), diabetes mellitus type 2 (DM), the development of pelvic floor diseases and sexual dysfunction, and some types of cancer (colon, endometrium, and breast) [5–7].

One of the most significant pelvic floor diseases is urinary incontinence (UI), encompassing stress urinary incontinence, urge urinary incontinence, and mixed urinary incontinence. Notably, stress incontinence in women has been recognized as a prominent condition within this category [8, 9]. UI was 67% among severely obese women candidates for bariatric surgery, compared to 27% in the general population [10, 11]. The main reason for the high prevalence of incontinence among women with severe obesity remains poorly elucidated; however, increased abdominal fat, inducing intravascular pressure, detrusor instability caused by diabetic neuropathy, urethral hypermobility, and increased abdominal pressure, intervertebral disk herniation, impairing bladder innervation are some etiologies considered in various studies [9, 12, 13].

According to the literature, possible treatments for managing UI, including muscle training of Kegel, pharmacologic medications, fluid restriction, weight loss, and surgery, may be considered depending on the type of incontinence [14–16]. Antimuscarinic drugs are the primary choices for urge urinary incontinence (UUI), while surgical procedures such as mid-urethral sling implantation are often utilized for stress urinary incontinence (SUI). Mixed urinary incontinence (MUI) is challenging to treat, requiring surgery and pharmacotherapy based on the primary symptoms [8, 17]. According to the National Institute of Health, patients with severe obesity-related complications that could be improved by significant weight loss are possible candidates for further bariatric surgery [18]. When it comes to severe obesity, bariatric surgery has been shown to be both more effective and safer than medical treatment for achieving long-term weight loss and managing comorbidities [19–22]. The two most popular methods of bariatric surgery are the Roux-en-Y gastric bypass (RYGB) and the sleeve gastrectomy (SG). The safety and beneficial effects of RYGB and SG at 1 year were equivalent [23].

There is a limited number of studies investigating the role of bariatric surgery on the improvement of incontinence status among Asians, specifically Middle Eastern Asian women. Moreover, most of the recent review studies focused on the studies published by Western countries. The main aim of this prospective study is to investigate the effect of bariatric surgery on the three most prevalent UI types in severely obese women and evaluate the effect of parameters such as BMI change, surgical approach, parity, type of delivery, diabetes, and hypertension on women who underwent these two types of surgical procedures at a private medical center. Both RYGB and SG are among the most commonly performed bariatric surgeries at our facility. This choice reflects our aim to provide insights that are directly applicable to the surgical practices and patient outcomes in our specific clinical setting. The present study can contribute to modifying bariatric surgery techniques and help healthcare providers predict the adverse effects of bariatric surgeries and how to deal with the complications. Besides, we reviewed the current literature exploring the studies performed in Asian countries.

Materials and Methods

This prospective study was conducted through convenient sampling; 200 patients with severe obesity who were satisfied to participate were recruited from the Tehran Obesity Center. Sampling was done between August 2019 and August 2020. Patients followed up prior to the surgery and 6 months after surgery. Participants completed a demographic information questionnaire and a diagnostic urinary incontinence questionnaire (QUID). The demographic questionnaire included age, marital status, education, weight, height, number of pregnancies, childbirth method, history of gynecological surgeries, diabetes, hypertension, and current treatment status. Patients underwent the RYGB and the SG surgical methods under anesthesia. Over 6 months, 24 individuals dropped out due to various reasons. Finally, patients were analyzed for weight loss and severity of UI following surgery with a comprehensive assessment. Women between 18 and 60 years of age, those with severe obesity, and candidates for bariatric surgery were included in the study. Exclusion criteria were the history of surgery for treating urinary incontinence or pelvic organ prolapse, consumption of new medicine for treating urinary incontinence during 1 year prior to and after surgery, and any neurologic defect affecting the urinary system's innervation.

Diabetes was defined as having a fasting blood sugar level greater than 126 mg/ dl, HbA1c higher than 7%, and using diabetes treatments. Previous gynecological surgeries included hysterectomy, oophorectomy, and ovarian cyst surgery. The QUID assessed the presence of SUI and UUI, containing six questions and two domains. The questionnaire consists of three items focusing on SUI and three other items addressing UUI. Each item includes a Likert scale ranging from scale of 0 to 5, which corresponds to the following values: never (0), rarely (1), sometimes (2), often (3), most of the time (4), and always (5). Responses for items one, two, and three contribute to the SUI score, while responses for items four, five, and six contribute to the UUI score. The scores from these two domains are summed

together. Compared to standard clinical approaches, this questionnaire is considered a reliable and consistent method for assessing UI. The research objective was thoroughly explained to the patients.

All participants provided written informed consent. The ethical committee reviewed and approved the study protocol for biomedical research at the Research Ethics Committees of Mashhad Medical Science Islamic Azad University by the number of IR.IAU.MSHD.REC.1399.195. All surgeries were performed by a single surgeon with more than ten years of experience in bariatric surgeries. Furthermore, the pros and cons of each technique were comprehensively described for the patients, and each individual decided on the technique applied for the surgery with no coercion from the researchers.

Statistical analysis was performed using SPSS version 26.0 (SPSS Inc., Chicago, IL, USA). Data were shown as mean ± standard deviation (SD) and number (percent). A *P*-value less than 0.05 was considered a significant threshold. Descriptive statistics such as frequency and proportion were used for qualitative data, while measures such as mean and SD were employed for quantitative data. In data analysis, the normality of the data was assessed using the Shapiro–Wilk test. For non-normally distributed data, the Mann–Whitney *U* test, Wilcoxon test, and Friedman test were utilized. For normally distributed data, the Student *t*-test was employed.

Results

Among the initial 200 participants, 101 individuals (50.5%) reported symptoms of UI prior to surgery. Out of the initial cohort, 77 participants completed the study and were reevaluated 6 months following the surgery. The mean age of the participants was 40.82 ± 11.63 years. The participants exhibited a preoperative mean BMI of 43.24 ± 4.67. Remarkably, 6 months after surgery, the participants demonstrated a significant weight reduction, with an average loss of 29 ± 7.0. This weight loss corresponded to a mean BMI decrease of 11.2 kg/m^2, with a 2.5 kg/m^2 standard deviation. Analyzing UI type revealed that at the outset, 21 individuals (27%) experienced urgency UI, four individuals (5%) experienced stress UI, and 52 individuals (67%) suffered from mixed UI, encompassing both urgency and stress incontinence. Following bariatric surgery, there was a notable reduction in UI scores for each level of UI severity compared to the preoperative scores. The study's findings investigated the association between UI scores and various factors, including BMI changes, age, surgical technique, gynecological history, pregnancies, delivery type, blood sugar status, diabetes medication usage, and hypertension. Notably, no significant correlation emerged between postoperative UI scores and BMI before or after surgery (*P*-values of 0.894 and 0.379, respectively). The study also examined the correlation between UI scores and changes in BMI post-surgery, with a resulting *P*-value of 0.157, indicating a lack of significant correlation.

Moreover, a noteworthy finding was the significant difference in the percentage change of UI scores among participants under 40 (*P*-value = 0.007). Regarding the surgical technique used, no significant difference in overall UI scores was observed (*P*-value = 0.195). In contrast, a history of gynecological surgery was associated with a significant difference in overall UI scores (*P*-value = 0.026). Conversely, the number of pregnancies and the type of delivery (Cesarean, vaginal, or both) did not yield significant differences in the changes in UI scores (*P*-value = 0.227 and *P*-value = 0.896, respectively). Furthermore, the study explored the impact of blood sugar status and consumption of diabetes medications on UI scores, which were found to have no significant influence on UI score changes (*P*-values of 0.873 and 0.526, respectively).

Similarly, hypertension had no significant effect on UI score changes (*P*-value = 0.801). We showed that 44% of the women in the study reported a complete improvement in the symptoms of urinary incontinence. According to the types of incontinence, 75% of women with symptoms of stress incontinence, 71% of women with symptoms of emergency incontinence, and 30% of women with symptoms of mixed urinary incontinence have improved their symptoms ($P < 0.001$) (Table 1).

The data analysis revealed distinct patterns of change before and 6 months after the surgical procedures. For SUI, the mean score registered a notable decrease from 2.47 ± 2.09 before surgery to 0.55 ± 0.85 post-surgery, and similarly, for UUI, the mean score transitioned from 5.17 ± 3.03 to 0.84 ± 1.58. Meanwhile, MUI displayed a substantial decline, with the mean score shifting from 7.64 ± 3.99 before surgery to 1.39 ± 2.12 6 months after the surgical intervention. The assumption of normality was rejected across all incontinence types, underscoring the non-normal distribution of the data. Moreover, the Wilcoxon test consistently highlighted the presence of significant differences in incontinence scores before and after surgery, substantiated by remarkably low *P*-values of < 0.0001 for all three types, affirming the effectiveness of the surgical procedures in mitigating urinary incontinence symptoms (Table 2).

Lastly, the literature review retrieved six studies investigating incontinence following bariatric surgeries with different techniques among the Asian population. Aggarwal indicated higher resolution rates than Western countries, along with maximal effect after three months of follow-up. However, Leshem believed the maximal effects were observed during the first 6 months after surgeries. Another study advocated a more substantial cure rate for SUI than UI after bariatric surgeries. Although Aggarwal found no association between post-surgical improvement and comorbidities, Bulbuller showed enhanced UI among

Table 1 Comparison of percentage changes in urinary incontinence score

	Corresponding values	Lowest	Highest	Mean	SD	*P*-value
BMI before surgery	Class 2 obesity (BMI:35–40)	− 100.00	0.00	− 78.95	32.31	0.894
	Class 3 obesity (BMI > 40)	− 100.00	− 43.4	− 87.37	13.72	
BMI after surgery	Overweight	− 100.00	0.00	− 86.78	22.33	0.379
	Obese	− 100.00	0.00	− 84.54	19.66	
Changes in BMI	Less than 10 kg	− 100.00	0.00	− 74.00	32.97	0.157
	More than 10 kg	− 100.00	− 50.00	− 88.85	12.36	
Age	Younger than 40	− 100.00	0.00	− 89.56	19.35	0.007
	40 years old and older	− 100.00	0.00	− 80.92	20.60	
Surgery technique	Bypass	− 100.00	0.00	− 80.51	24.22	0.195
	Sleeve	− 100.00	0.00	− 87.56	17.83	
History of gynecological surgery	Yes	− 100.00	0.00	− 87.41	18.22	0.026
	No	− 100.00	0.00	− 74.22	26.82	
Number of children	0	− 100.00	− 75.00	− 94.92	8.99	0.227
	1	− 100.00	0.00	− 80.15	28.48	
	2	− 100.00	0.00	− 81.37	24.03	
	3	− 100.00	− 43.48	− 81.62	20.31	
Type of delivery	Cesarean section	− 100.00	0.00	− 82.24	24.33	0.896
	Vaginal delivery	− 100.00	0.00	− 79.55	25.62	
	Both	− 100.00	− 50.00	− 81.57	19.63	
Blood sugar	Normal (BS < 95)	− 100.00	0.00	− 85.49	20.73	0.873
	Prediabetic (BS:96–125)	− 100.00	− 77.78	− 87.89	9.08	
	Diabetic (BS > 126)	− 100.00	− 43.48	− 78.89	24.79	
Treatment for diabetes mellitus	Yes	− 100.00	0.00	− 85.49	20.73	0.526
	No	− 100.00	− 43.48	− 83.11	18.31	
Hypertension	Yes	− 100.00	0.00	− 86.21	21.18	0.081
	No	− 100.00	− 43.48	− 80.94	16.33	

Table 2 Effect of bariatric surgery on urinary incontinence score

Incontinence type	Pre-surgery Mean ± SD	Post-surgery Mean ± SD	*P*-value
SUI	2.47 ± 2.09	0.55 ± 0.85	0.0001
UUI	5.17 ± 3.03	0.84 ± 1.58	0.0001
MUI	7.4 ± 3.99	1.39 ± 2.12	0.0001

diabetic individuals. Similar to Kim, Uruc, and colleagues, Shimonov found significant improvement in incontinence, quality of life, and pelvic organ prolapse symptoms; however, they advocated no changes in sexual parameters.

Discussion

Obesity is a common health issue affecting an individual's well-being [2]. Urinary incontinence (UI) has emerged as a prominent concern within a category of medical conditions associated with obesity, leading to decreased quality of life [13].

This study aimed to investigate the prevalence and severity of UI among women candidates for bariatric surgery, evaluating the efficacy of bariatric surgeries in reducing the prevalence of UI, being among the first studies of the East of Asia according to the literature (Table 3). Of the 200 participants, 50.5% reported UI symptoms before undergoing bariatric surgery. Similar to our findings, evidence from studies like O'Boyle et al. [19] and Subak et al. [24] demonstrates that incontinence is experienced by over half of all obese women who need bariatric surgery. Following bariatric surgery, all severity levels of UI demonstrated a significant reduction in UI scores compared to preoperative scores. Notably, 44% of women reported a complete cure for UI symptoms, which is consistent with the findings of Leshem et al. [25] and Bulbuller et al. [26]. Overall, 48% and 38% of UI patients (respectively) reported complete resolution of UI after 6 months of follow-up. Improvement was seen across UI types, including SUI, MUI, and UUI.

Similarly, this contrasts with the remission percentage of 67% reported by Subak et al. [24], which may be attributed to differences in follow-up duration and sample size. The current study depicts the largest rate of UI improvement for SUI, which was

Table 3 Bariatric surgery literature review in Asian countries

Study (year)	Country	Sample size of UI patients	Surgical technique	BMI (Mean)	Change in UI	Weight loss at 6 months	Main findings
Aggarwal (2021)	India	41	RYGB: 6 LSG: 30 OAGB: 5	45.62	UUI: 75% SUI: 96.5% MUI: 50%	25.5%	The maximal effect was observed following 3 months of surgery. Despite to the female sex, no significant association between post-surgical improvement and age, diabetes, hypothyroidism, and hypertension. Moreover, surgical technique showed no significant effect. The maximum effect was seen on SUI. Bariatric surgery of Asian patients may have higher resolution rates than western population
Leshem (2018)	Israel	101	RYGB: 0 LSG: 93 OAGB: 8	41.6	UUI: 14% SUI: 67% MUI: 14%	22%	Maximal effects were seen during the first 6 months following surgery and the results remained constant for the rest of the study follow-up. Significant sexual parameters changed mainly during the first 6 months after surgery. However, these variables did not show significant changes in the second 6 months of follow-up
Bulbuller (2017)	Turkey	72	RYGB: 0 LSG: 72 OAGB: 0	46.17	UUI: 39% SUI: 61% MUI: 25%	70.33%	Post-surgical significant decrease of UI among all and specifically diabetic patients. Besides to the significant decrease in prevalence of UI after the surgery, cure rate of patients with SUI was the most
Shimonov (2017)	Israel	29	RYGB: 0 LSG: 29 OAGB: 0	42.2	-	-	51.7% of women experienced total resolution of UI. Significant changes of incontinence score, quality of life score, pelvic organ prolapse symptoms, and colorectal-anal symptoms following the surgery was yielded. However, changes in sexual parameters did not reach statistical significance
Kim (2017)	South Korea	57	RYGB: 57 LSG: 0 OAGB: 0	37.5	UUI: - SUI: 54.5% MUI: -	-	Quality of life, patient perception of bladder condition, and beck depression inventory were significantly improved following the surgery. They showed significant changes of SUI and lower urinary tract symptoms after surgery

Table 3 (continued)

Study (year)	Country	Sample size of UI patients	Surgical technique	BMI (Mean)	Change in UI	Weight loss at 6 months	Main findings
Uruç (2016)	Turkey	22	RYGB: 0 LSG: 22 OAGB: 0	49.57	-	62.8%	Despite other studies, participants were male patients. Beck depression inventory, international prostate symptom score, and international consultation on incontinence questionnaire—short form were significantly decreased following the surgery

in line with previous studies; however, O'Boyle et al. [19] found MUI to be the most improved factor. The study also explored factors that could influence postoperative UI outcomes, including age and gynecological history. These factors significantly impacted the outcomes of UI, improving UI scores, which were most noticeable among participants younger than 40 and those with no history of gynecology surgery, suggesting that younger participants experienced more pronounced improvements in UI scores. Moreover, there was no statistically significant relationship between UI scores before and after surgery and BMI change, surgical approach, pregnancy history, and type of delivery. Furthermore, blood sugar levels, use of diabetes and hypertension medications, and hypertension did not show significant effects. Contrary to the results established by O'Boyle et al. [19], there was no significant association between the resolution of urinary symptoms in SUI and UUI and parity, type of delivery, and preoperative BMI. These findings underscore the importance of considering patient age and gynecological history in the preoperative assessment and counseling of women undergoing bariatric surgery for UI management.

Bulbuller et al. [26] showed that diabetic patients, regardless of whether they were controlled, experienced notable UI score reductions following the surgery that was incompatible with our findings. Nevertheless, the current discrepancy may have been attributed to the smaller sample size of diabetics in our study (5% compared to 30%). Moreover, they concluded that patients with three or more gravidities experienced higher UI scores than those with two or fewer, similar to the findings of O'Boyle et al. [19] and contrary to our findings. Inconsistency observed can be due to various factors, including the differences in the questionnaire and score system and differences within the race of the patients studied.

Like any other study, our study has its strengths and weaknesses. The limitations of our study were the absence of a control group, a small number of participants, a short-term follow-up period, a lack of urodynamic tests, and no quantitative measurement of incontinence. A significant limitation in our study is the inability to control for the participants' utilization of anti-diabetic medications, such as Glucagon-like peptide 1 receptor agonists that promote weight loss and insulin that can result in weight gain. These medications could have a substantial impact on weight management and obesity-related outcomes, which could potentially influence the study's findings. Another limitation of our study is the potential lack of cultural and linguistic validation of the QUID for our specific study population. On the other hand, the prospective performance of the study, blinding the investigators and data analyst, thoroughly followed-up patients, and performing a thorough literature review of Asian populations were the strengths of our study. Although we included findings from other Asian studies regarding the discrepancies between studies, including the definition of incontinence, the severity of obesity, and the criteria for selecting candidates for bariatric surgeries, we cannot draw a definite conclusion, and further studies with more homogenous strategies are still needed.

Conclusion

This prospective study of 200 obese Asian women undergoing bariatric surgery highlights the significant impact of surgery on UI scores across various severity levels. Notably, age and gynecological history appeared to influence UI improvement. At the same time, factors such as surgical technique, pregnancy, delivery type, blood sugar status, diabetes medication, and high blood pressure had limited impact on postoperative UI outcomes. The findings emphasize the importance of considering individual characteristics when assessing the potential benefits of bariatric surgery in managing urinary incontinence. Further research may elucidate the nuances of this relationship and refine our understanding of surgical interventions for obesity treatment/weight management rather than just surgical interventions.

Abbreviations *UI*: Urinary incontinence; *BMI*: Body mass index; *WHO*: World Health Organization; *DM*: Diabetes mellitus; *RYGB*: Roux-en-Y gastric bypass; *SG*: Sleeve gastrectomy; *SUI*: Stress urinary incontinence; *UUI*: Urge urinary incontinence; *MUI*: Mixed urinary incontinence; *QUID*: Questionnaire for Urinary Incontinence Diagnosis.

Author Contribution Reza Valipour, Behzad Narouie, and Mehdi Dadpour: conception of the study, project administration, development and supervision, and critical review. Parham Torabinavid, Hamidreza Momeni, Negar Radpour, Mohadese Ahmadzade, Hamidreza Rouientan, Hoseinali Danesh, and Mohammad Aref Emami: data collection, investigation, methodology, critical review, manuscript drafting, and editing.

Data Availability The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Declarations

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The ethical committee reviewed and approved the study protocol for biomedical research at the Islamic Azad University of Medical Science by the number of IR.IAU.MSHD.REC.1399.195.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Consent for Publication All human subjects provided written informed consent with guarantees of confidentiality.

Conflict of Interest The authors declare no competing interests.

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