

RESEARCH ARTICLE

Impact of age on postoperative complications following bariatric surgery

Anwar E. Ahmed^{1,2}, Wala R. Alanazi³, Bashayr I. ALMuqbil², Wijdan A. AlJohi⁵, Budor A. AlRasheed², Doaa A. AlBuraikan², Rayan A. Ahmed⁴

Address for Correspondence:

Anwar E. Ahmed

¹King Abdullah International Medical Research Center (KAIMRC), Riyadh, Saudi Arabia

²King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

³Al-Maarefa College for Science and Technology, Riyadh, Saudi Arabia

⁴Dar Al Uloom University, Riyadh, Saudi Arabia

⁵General Surgery Department, King Abdulaziz Medical City, Riyadh, Saudi Arabia

Email: ahmeda5@vcu.edu

<http://dx.doi.org/10.5339/qmj.2019.11>

Submitted: 4 April 2017

Accepted: 23 June 2019

© 2019 Ahmed, Alanazi, ALMuqbil, AlJohi, AlRasheed, AlBuraikan, Ahmed, licensee HBKU Press. This is an open access article distributed under the terms of the Creative Commons Attribution license CC BY 4.0, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

Cite this article as: Ahmed AE, Alanazi WR, ALMuqbil BI, AlJohi WA, AlRasheed BA, AlBuraikan DA, Ahmed RA. Impact of age on postoperative complications following bariatric surgery, Qatar Medical Journal 2019;11 <http://dx.doi.org/10.5339/qmj.2019.11>

كيوساينس
QSCIENCE

دار جامعة حمد بن خليفة للنشر
HAMAD BIN KHALIFA UNIVERSITY PRESS

ABSTRACT

Background: The impact of age on complications following bariatric surgery remains unclear. Research is therefore warranted among previously unstudied populations of bariatric surgery patients. The aim of the current study was to assess the impact of age on postoperative complications following bariatric surgery in Saudi Arabia.

Methods: This retrospective study included 301 patients who underwent bariatric surgery between January 2011 and July 2016. Patients were classified into three groups according to age: < 25 years; 25 – 36 years; and > 36 years. Primary outcomes were determined by identifying the number of complications reported during a period of 180 days. The negative binomial model was used to assess the relationship between age and the high rate of postoperative complications following adjustment for confounding variables.

Results: The incidence of overall complications was 10.1% in the < 25-year age group, 15% in the 25 – 36-year age group, and 24.2% in the > 36-year age group. After adjusting for confounding variables, it was discovered that the risk of postoperative complications increases with age. The risk was higher in the > 36-year age group than in the > 25-year age group [adjusted relative rate (aRR) = 2.35; 95% confidence interval (CI) = 1.046 – 5.290; $p = 0.039$]. Diabetes (aRR = 3.27), adjustable gastric bands (aRR = 3.40), and a more lengthy hospital stay (aRR = 1.23) were associated with increased rates of postoperative complications.

Conclusion: Age is independently associated with a high rate of postoperative complications following bariatric surgery. The results showed that patients with diabetes, those using adjustable gastric bands, and those with longer length of hospital stay had

significantly higher incidence of postoperative complications. These findings indicate the need for risk stratification tools to evaluate patients as candidates for bariatric surgery and to use as a guide for identifying optimal preoperative factors.

Keywords: age, morbid obesity, weight loss, postoperative complications, Saudi Arabia

INTRODUCTION

The prevalence of obesity is a growing global concern,¹ particularly in Saudi Arabia, where it remains a major public health issue.² In Saudi Arabia, the prevalence of obesity has increased from 22% in 1993 to 36% in 2005² and is projected to double by 2022.² Obesity has been noted in all age groups, and this trend appears to increase with age.²⁻⁵ Recently, bariatric surgery has been found to be the most effective intervention and long-term strategy for obtaining sustainable weight loss.⁶⁻⁸ Furthermore, two studies performed in Saudi Arabia revealed that laparoscopic gastric sleeve is effective for treating individuals with morbid obesity.^{9,10}

Several studies have assessed the risk factors contributing to complications in bariatric surgery patients.¹⁰⁻¹⁴ Although such complications may develop in any age group,¹⁵⁻¹⁸ the risk of postoperative complications tends to increase with age.¹⁶ Some studies affirm that postoperative complications are observed more frequently in elderly people over the age of 65 years.^{15,18} However, other reports conclude that bariatric procedures can be effective and safe for patients aged ≥ 60 years.¹⁹⁻²¹ Since there has been no conclusive evidence showing age as a risk factor for postoperative complications,^{22,23} all published results regarding the link between age and complications after bariatric surgery remain debatable.

Although several studies support the effectiveness of bariatric surgery in various age groups,¹⁹⁻²¹ no data regarding the impact of age on postoperative complications are available in Saudi Arabia. The findings of such research could benefit surgeons who perform weight loss surgeries by helping them develop strategies to prevent or minimize postoperative complications in patients undergoing such surgeries. A wider range of research from various countries is warranted to understand the link between age and postoperative complications. Furthermore, these studies could be used to assess whether

comparable results can be found to support findings that are reported in international bariatric surgery patients. This study reviewed the complications in a group of bariatric surgery patients. Patients were divided into three different age groups. The aim of the current study was to assess the impact of age on postoperative complications following bariatric surgery in Saudi Arabia. The hypothesis for this study stated that the rate of postoperative complications for bariatric procedures increases with age. This study also determined whether older age was an independent predictor for a high rate of postoperative complications in bariatric surgical patients.

METHODS

A cohort retrospective study was conducted on patients who underwent bariatric surgery at King Abdulaziz Medical City from January 2011 to July 2016. The study was approved by the Institutional Review Board of King Abdullah International Medical Research Center (Research Protocol #RSS/OO01). The records of all patients who underwent bariatric surgery during the study period were used. A total of 301 bariatric surgery patients were identified. The patients were consecutively enrolled, and no patients were excluded from this population.

Demographic data for all patients such as age, sex, and body mass index (BMI) was reviewed and recorded. For the purposes of analysis, patients were classified into three groups according to their age: < 25 years, 25 – 36 years, and > 36 years. BMI was divided into two groups: 1) overweight or class I obesity (BMI, 25 – 34.9) and 2) class II or III obesity (BMI ≥ 35).

Bariatric surgery and clinical data were also reviewed and recorded including: procedure type, number of procedures performed, procedure duration, length of hospital stay, history of prior bariatric surgery, hypertension, diabetes mellitus, asthma, kidney failure, dyslipidemia, heart disease, thyroid, obstructive sleep apnea, and gastroesophageal reflux disease.

Study outcome

The primary outcome of interest for this study was the number of bariatric surgery-related complications reported during a period of six months. Postoperative complications were recorded from the emergency department and hospital medical records following bariatric surgery. The postoperative complications

included were as follows: surgical site infection, abdominal pain, nausea/vomiting, wound infection, fever, obstruction/ileus, port site infection, discharge, bleeding, site leak, general pain, chest pain, blockage, infection, headache\dizziness, diarrhea, pulmonary embolism, collection\pseudomonas infection, and other complications. The sum of all postoperative complications was calculated for each patient.

Statistical analysis

All data analyses were conducted using IBM SPSS, version 23 (Chicago, IL). Descriptive statistics were

used to describe the sample studied (Table 1). Patient demographics and clinical characteristics across age groups were assessed using the chi-squared and Fisher’s exact tests for nonnumerical variables, while the Kruskal–Wallis test was used to assess numerical variables (Table 1). The negative binomial model was used to assess the relationship between age and the high rate of bariatric surgery-related complications after adjustment for confounders (Table 2). An alpha (α) value of ≤ 0.05 was considered significant for all analyses. We evaluated whether the negative binomial regression model fit the data. The deviance for the

Table 1. Patient demographics and clinical characteristics in each age group.

Characteristics	Levels	Overall N = 301		<25 years 69 (22.9%)		25–36 years 100 (33.2%)		>36 years 132 (43.9%)		P
		n	%	n	%	N	%	n	%	
Sex	Male	99	32.9	32	46.4	31	31.0	36	27.3	0.021*
	Female	202	67.1	37	53.6	69	69.0	96	72.7	
BMI	Overweight/ Class I obesity	21	7.0	2	2.9	8	8.0	11	8.3	0.327
	Class II/III obesity	279	93.0	66	97.1	92	92.0	121	91.7	
Procedure	Gastric Sleeve	228	75.7	55	79.7	82	82.0	91	68.9	0.042*
	Gastric bypass	31	10.3	3	4.3	7	7.0	21	15.9	
	Adjustable gastric band/removal	42	14.0	11	15.9	11	11.0	20	15.2	
Number of procedures	1 Procedure	92	38.0	22	38.6	31	37.8	39	37.9	0.995
	2 or more procedures	150	62.0	35	61.4	51	62.2	64	62.1	
Prior bariatric surgery	No	256	85.0	64	92.8	82	82.0	110	83.3	0.192
Hypertension	Yes	45	15.0	5	7.2	18	18.0	22	16.7	0.001*
	No	230	76.4	65	94.2	91	91.0	74	56.1	
Diabetes mellitus	Yes	71	23.6	4	5.8	9	9.0	58	43.9	0.001*
	No	244	81.1	63	91.3	94	94.0	87	65.9	
Asthma	Yes	57	18.9	6	8.7	6	6.0	45	34.1	0.175
	No	261	86.7	62	89.9	90	90.0	109	82.6	
Dyslipidemia	Yes	40	13.3	7	10.1	10	10.0	23	17.4	0.001*
	No	251	83.4	67	97.1	97	97.0	87	65.9	
Kidney failure	Yes	50	16.6	2	2.9	3	3.0	45	34.1	0.024*
	No	296	98.3	69	100.0	100	100.0	127	96.2	
Heart disease	Yes	5	1.7	0	0.0	0	0.0	5	3.8	0.005*
	No	291	96.7	69	100.0	99	99.0	123	93.2	
Obstructive sleep apnea	Yes	10	3.3	0	0.0	1	1.0	9	6.8	0.444
	No	273	90.7	60	87.0	91	91.0	122	92.4	
Thyroid	Yes	28	9.3	9	13.0	9	9.0	10	7.6	0.137
	No	275	91.4	66	95.7	93	93.0	116	87.9	
Gastroesophageal reflux	Yes	26	8.6	3	4.3	7	7.0	16	12.1	0.166
	No	280	93.0	67	97.1	94	94.0	119	90.2	
Complications	Yes	21	7.0	2	2.9	6	6.0	13	9.8	0.030*
	No	247	82.1	62	89.9	85	85.0	100	75.8	
Operation duration, median (25–75 h) percentiles		54	17.9	7	10.1	15	15.0	32	24.2	0.023#
Length of hospital stay, median (25–75 day) percentiles		2.3 (1.9–2.8)		2.2 (1.9–2.6)		2.2 (1.8–3)		2.3 (2.1–3.1)		0.006#

*Chi-Square/Fisher’s Exact test is significant at $\alpha = 0.05$, # Kruskal–Wallis test is significant at $\alpha = 0.05$.

Table 2. Predictors of high rate of postoperative complications after bariatric surgery.

Characteristics	Reference	B	SE	P	aRR	95% Wald Confidence Interval for aRR	
						Lower	Upper
(Intercept)		-3.29	1.00	0.001	0.04	0.005	0.263
Age 25 – 36 years	< 25 years	0.39	0.42	0.356	1.47	0.649	3.330
Age > 36 years	< 25 years	0.86	0.41	0.039*	2.35	1.046	5.290
Female	Male	0.69	0.36	0.059	1.99	0.975	4.051
Class II/III obesity	Overweight/ Class I obesity	-0.33	0.55	0.555	0.72	0.244	2.132
Adjustable gastric band/removal	Gastric Sleeve	1.22	0.52	0.018*	3.40	1.232	9.384
Gastric bypass	Gastric Sleeve	-0.35	0.82	0.673	0.71	0.141	3.540
Two or more procedures	1 Procedure	0.45	0.33	0.172	1.56	0.823	2.974
Prior bariatric surgery		-2.03	0.76	0.007*	0.13	0.030	0.580
Hypertension		-1.24	0.55	0.024*	0.29	0.099	0.849
Diabetes mellitus		1.18	0.44	0.007*	3.27	1.384	7.709
Asthma		-0.93	0.56	0.094	0.39	0.132	1.172
Dyslipidemia		0.59	0.49	0.229	1.80	0.691	4.690
Kidney failure		1.48	0.98	0.131	4.37	0.645	29.671
Heart disease		-1.12	1.04	0.281	0.33	0.043	2.496
Obstructive sleep apnea		0.53	0.50	0.289	1.70	0.637	4.526
Thyroid		-0.91	0.73	0.214	0.40	0.097	1.686
Gastroesophageal reflux		-0.69	0.89	0.443	0.50	0.087	2.903
Operation duration		0.20	0.21	0.339	1.23	0.807	1.867
Length of hospital stay		0.21	0.09	0.014*	1.23	1.044	1.457

*significant at $\alpha = 0.05$. B, parameter estimate; SE, Standard errors; P, P-value; aRR, adjusted rate ratio.

negative binomial model was almost 1.0 (0.991), whereas for the Poisson model, it was 1.669. The log likelihood value was smaller for the Poisson model than for the negative binomial regression model (-206.650 vs. -166.973). These findings indicated that the negative binomial regression model fits the data well.

RESULTS

Of the 301 patients who underwent bariatric surgery, 69 (22.9%) were aged < 25 years, 100 (33.2%) were aged between 25 and 36 years, and 132 (43.9%) were aged > 36 years. The mean patient age at the time of surgery was 34.9 (12–64) years, and the mean BMI was 45.6 (26–85 kg/m²). The median length of hospital stay was four days (interquartile range: 3–5 days). Gastric sleeve surgery was the most commonly performed procedure in the hospital (75.7% of patients). Descriptive statistics for the patient population were recorded (Table 1).

There were more female patients in the > 36-year age group than in the other two groups (53.6%

patients in the < 25-year age group, 33.2% patients in the 25–36-year age group, and 72.7% patients in the 36-year age group, $p = 0.021$). According to unadjusted analyses (Table 1), the prevalence of hypertension increased significantly with age in the patients (5.8% in the < 25-year age group, 9% in the 25–36-year age group, and 43.9% in the > 36-year age group, $p = 0.001$). Similarly, the prevalence of diabetes mellitus, dyslipidemia, and kidney failure was significantly increased with age. The three age groups were comparable in their BMI distribution. Bariatric surgery-related complications increased incrementally with age (10.1% in the < 25-year age group, 15% in the 25–36-year age group, and 24.2% in the > 36-year age group, $p = 0.03$).

The number of postoperative complications during a period of six-months ranged between 0 and 12 complications per patient. Out of the 301 patients studied, 17.9% had at least one postoperative complication, while 82.1% had no postoperative complications. A multivariate negative binomial regression model was constructed to assess the

independent relationship between the rate of postoperative complications and age, while adjusting for demographic and clinical characteristics (Table 2). Advanced age remained a significant predictor for the risk of postoperative complications. The incidence of postoperative complications was significantly higher in the > 36-year age group than in the > 25-year age group (adjusted relative rate (aRR) = 2.35; 95% confidence interval (CI) = 1.046 – 5.290; $p = 0.039$). Adjustable gastric band/removal surgeries were associated with a higher rate of postoperative complications than gastric sleeve surgeries (aRR = 3.40; 95% CI = 1.232 – 9.384; $p = 0.018$). Among gastric sleeve surgery patients, those with diabetes had a higher incidence of postoperative complications than those without diabetes (aRR = 3.27; 95% CI = 1.384 – 7.709; $p = 0.007$). For every one-day increase in the length of hospital stay, the rate of postoperative complications increased by 23% (aRR = 1.23; 95% CI = 1.044 – 1.457; $p = 0.014$). Patients who had undergone prior bariatric surgery showed an 87% decrease in the rate of postoperative complications (aRR = 0.13; 95% CI = 0.030 – 0.580; $p = 0.007$). According to adjusted analyses (Table 2), patients with hypertension showed a 71% decrease in the rate of postoperative complications (aRR = 0.29; 95% CI = 0.099 – 0.849; $p = 0.024$).

DISCUSSION

Currently, bariatric surgery is the most prevalent method for treating morbid obesity, and the number of Saudis with morbid obesity is increasing. As a result, there has been a widespread increase in the rate of postoperative complications. These complications were reported in a previous study based on a review of patients who visited the emergency department and/or were readmitted to the hospital.¹⁰ In our study population, 75.7% of the bariatric surgeries performed during the study period were gastric sleeve surgeries, indicating that gastric sleeve surgery is the most popular procedure in Saudi Arabia. Furthermore, this is a procedure that has also become popular worldwide.^{24–26} The demographic characteristics of our study population are similar to those reported in other international bariatric surgery populations.^{27,28} Our population was predominantly female (67.1%), severely obese (BMI ≥ 35) (93%), and relatively young (mean patient age, 34.9 years). In our study, older patients were more likely to have hypertension,

diabetes mellitus, dyslipidemia, kidney failure, and heart disease than younger patients.

According to the analyses of patient subgroups, the current study demonstrates that postoperative complications occur more in older patients than in younger patients. Also, the rate of complications tends to gradually decline in younger patients. While 24.2% of postoperative complications were noted in the > 36-year age group, 15% were reported in the 25–36-year age group and 10.1% in the < 25-year age group. This finding was confirmed after adjusting for confounders using the negative binomial regression model, which showed that age was independently associated with postoperative complications. The > 36-year age group had more than twice the rate of postoperative complications compared with the < 25-year age group (aRR = 2.35). A wider range of studies have documented associations between age and postoperative complication rates in other international bariatric surgery populations.^{15–18} These findings warrant further investigation to reduce postoperative complications by targeting high-risk individuals and older patients (> 36 years).

Data suggests that the type of procedure may also impact the rate of postoperative complications. In our study, the type of procedure was independently associated with complication rates. High rates of postoperative complications were observed among patients who underwent adjustable gastric band/removal (aRR = 3.40). Similar findings were noted in previous studies.^{20,29} Similar to findings among other bariatric surgery populations,^{30–32} the adjusted rate of postoperative complications was significantly higher in patients with diabetes (aRR = 3.27). The current study confirms the findings of Garg et al.,³² in which our adjusted analyses suggested a positive trend between the length of hospital stay and postoperative complications, where a higher rate of postoperative complications was found in patients with longer length of hospital stay. Unlike other studies,^{33–36} the current study is considered to be the first investigation on the link between patient age and postoperative complications in Saudi Arabia.

This study has several noteworthy limitations. The rate of postoperative complications was higher in patients aged 36 years; in addition, these patients had more comorbidities than patients aged < 36 years. The postoperative complications for these patients according to emergency department and hospital

records were retrospectively identified. Also, while this study occurred at King Abdulaziz Medical City in Riyadh, chart reviews not have captured complications that were reported at different institutions.

CONCLUSIONS

The unadjusted and adjusted rates demonstrated that postoperative complications were higher in bariatric surgery patients aged > 36 years. This confirms the findings demonstrated in other international populations of bariatric surgery patients. Older patients may not be denied bariatric surgery, although other risk factors may have contributed to the higher rate of complications. The results suggest that diabetes, adjustable gastric band/removal, and longer length of hospital stay were significantly associated with higher incidence of postoperative complications. These findings indicate the need for risk stratification tools to assess patients as candidates for bariatric surgery and to identify optimal preoperative factors. The results may also offer useful information for surgeons and clinicians who handle postoperative care for bariatric surgery patients.

Abbreviations

ED: emergency department; BMI: Body mass index; CI: Confidence interval; aRR: adjusted relative risk

Acknowledgements

The authors would like to thank King Abdullah International Medical Research Center for approving this study.

Authors' contributions

AEA conceived and designed the study, performed the data analysis, and prepared the manuscript. DAA, BIA, WAA, WRA, BAA, and RAM helped in data collection and entry. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable as the manuscript does not contain any identifiable individual's data.

Availability of data and materials

The data are not publicly available because of confidentiality concerns due to the nature of the study. However, all relevant and supporting data are contained within the manuscript.

Ethics approval and consent to participate

The study received ethical approval from the Institutional Review Board of King Abdullah International Medical Research Center.

REFERENCES

- Seidell JC. Obesity: a growing problem. *Acta Paediatrica*. 1999 Feb;88(428):46–50.
- Al-Quwaidhi AJ, Pearce MS, Critchley JA, Sobngwi E, O'Flaherty M. Trends and future projections of the prevalence of adult obesity in Saudi Arabia, 1992–2022. *East Mediterr Health J*. 2014 Oct;20(10):589–595.
- Al-Ghamdi SH. The association between watching television and obesity in children of school-age in Saudi Arabia. *J Family Community Med*. 2013 May;20(2):83–89.
- Al-Qahtani DA, Imtiaz ML, Shareef MM. Obesity and cardiovascular risk factors in Saudi adult soldiers. *Saudi Med J*. 2005 Aug;26(8):1260–1268.
- Abalkhail B. Overweight and obesity among Saudi Arabian children and adolescents between 1994 and 2000. *East Mediterr Health J*. 2002 Jul-Sep;8(4-5):470–479.
- Hansen EN, Torquati A, Abumrad NN. Results of bariatric surgery. *Annu Rev Nutr*. 2006;26:481–511.
- Shikora SA, Kim JJ, Tarnoff ME. Nutrition and gastrointestinal complications of bariatric surgery. *Nutr Clin Pract*. 2007 Feb;22(1):29–40.
- Smith BR, Schauer P, Nguyen NT. Surgical approaches to the treatment of obesity: bariatric surgery. *Med Clin North Am*. 2011 Sep 1;95(5):1009–1030.
- Aldaqa SM, Sehlo MG. Self-esteem and quality of life in adolescents with extreme obesity in Saudi Arabia: the effect of weight loss after laparoscopic sleeve gastrectomy. *Gen Hosp Psychiatry*. 2013 May-Jun;35(3):259–264.
- Ahmed A, AlBuraikan D, ALMuqbil B, AlJohi W, Alanazi W, AlRasheed B. Readmissions and emergency department visits after bariatric surgery at Saudi Arabian hospital: the rates, reasons, and risk factors. *Obes Facts*. 2017;10(5):432–443.

11. Wills CE Jr. Early postoperative complications in bariatric surgery. *J Med Assoc Ga.* 1986 May;75(5): 267 – 269.
12. Kuchinka J, Nawacki Ł, Bryk P, Matykiewicz J, Wawrzycka I, Kozieł D, et al. Reoperations in bariatric surgery – indications and initial evaluation of post-operative complications. *Pol Przegl Chir.* 2016 Mar 1; 88(2):87 – 92.
13. García-García ML, Martín-Lorenzo JG, Lirón-Ruiz R, Torralba-Martínez JA, García-López JA, Aguayo-Albasini JL. Failure of the Obesity Surgery Mortality Risk Score (OS-MRS) to Predict Postoperative Complications After Bariatric Surgery. *A Single-Center Series and Systematic Review. Obes Surg.* 2017 Jun; 27(6):1423 – 1429.
14. Wrzesinski A, Correa JM, Fernandes TM, Monteiro LF, Trevisol FS, Nascimento RR. Complications requiring hospital management after bariatric surgery. *Arq Bras Cir Dig.* 2015;28(1):3 – 6.
15. Pajecki D, Santo MA, Joaquim HD, Morita F, Riccioppo D, Cleva RD, et al. Bariatric surgery in the elderly: results of a mean follow-up of five years. *Arq Bras Cir Dig.* 2015 Dec;28(Suppl 1):15 – 18.
16. Sanni A, Perez S, Medbery R, Urrego HD, McCready C, Toro JP, et al. Postoperative complications in bariatric surgery using age and BMI stratification: a study using ACS-NSQIP data. *Surg Endosc.* 2014 Dec;28(12): 3302 – 3309.
17. Scozzari G, Passera R, Benvenga R, Toppino M, Morino M. Age as a long-term prognostic factor in bariatric surgery. *Ann Surg.* 2012 Nov 1;256(5): 724 – 729.
18. Qin C, Luo B, Aggarwal A, De Oliveira G, Kim JY. Advanced age as an independent predictor of perioperative risk after laparoscopic sleeve gastrectomy (LSG). *Obes Surg.* 2015 Mar 1; 25(3):406 – 412.
19. Peraglie C. Laparoscopic mini-gastric bypass in patients age 60 and older. *Surg Endosc.* 2016 Jan 1; 30(1):38 – 43.
20. Quebbemann B, Engstrom D, Siegfried T, Garner K, Dallal R. Bariatric surgery in patients older than 65 years is safe and effective. *Surg Obes Relat Dis.* 2005 Jul-Aug;1(4):389 – 392.
21. Nelson LG, Lopez PP, Haines K, Stefan B, Martin T, Gonzalez R, et al. Outcomes of bariatric surgery in patients ≥ 65 years. *Surg Obes Relat Dis.* 2006 May-Jun;2(3):384 – 388.
22. Quirante FP, Montorfano L, Rammohan R, Dhanabalsamy N, Lee A, Szomstein S, et al. Is bariatric surgery safe in the elderly population? *Surg Endosc.* 2017 Apr 1;31(4):1538 – 1543.
23. Bergeat D, Lechaux D, Ghaina A, Thibault R, Bouygues V. Postoperative outcomes of laparoscopic bariatric surgery in older obese patients: a matched case-control study. *Obes Surg.* 2017 Jun 1;27(6): 1414 – 1422.
24. Frezza EE, Barton A, Herbert H, Wachtel MS. Laparoscopic sleeve gastrectomy with endoscopic guidance in morbid obesity. *Surg Obes Relat Dis.* 2008 Sep-Oct;4(5):575 – 579.
25. Frezza EE, Reddy S, Gee LL, Wachtel MS. Complications after sleeve gastrectomy for morbid obesity. *Obes Surg.* 2009 Jun;19(6):684 – 687.
26. Bellanger DE, Greenway FL. Laparoscopic sleeve gastrectomy, 529 cases without a leak: short-term results and technical considerations. *Obes Surg.* 2011 Feb;21(2):146 – 150.
27. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA.* 2004 Oct 13; 292(14):1724 – 1737.
28. Poulouse BK, Griffin MR, Moore DE, Zhu Y, Smalley W, Richards WO, et al. Risk factors for postoperative mortality in bariatric surgery. *J Surg Res.* 2005 Jul 1; 127(1):1 – 7.
29. Shitrit AB, Magen A, Swartz E, Chen B, Matveychuk A, Talker O, et al. Long-term reflux-related symptoms after bariatric surgery: comparison of sleeve gastrectomy versus laparoscopic adjustable gastric banding. *Lung.* 2013 Jun;191(3):289 – 293.
30. Masoomi H, Reavis KM, Smith BR, Kim H, Stamos MJ, Nguyen NT. Risk factors for acute respiratory failure in bariatric surgery: data from the Nationwide Inpatient Sample, 2006-2008. *Surg Obes Relat Dis.* 2013 Mar-Apr; 9(2):277 – 281.
31. Masoomi H, Rimler J, Wirth GA, Lee C, Paydar KZ, Evans GR. Frequency and Risk Factors of Blood Transfusion in Abdominoplasty in Post-Bariatric Surgery Patients: Data from the Nationwide Inpatient Sample. *Plast Reconstr Surg.* 2015 May 1;135(5): 861e – 868e.
32. Garg T, Rosas U, Rivas H, Azagury D, Morton JM. National prevalence, causes, and risk factors for bariatric surgery readmissions. *Am J Surg.* 2016 Jul;212(1):76 – 80.
33. Algahtani HA, Khan AS, Khan MA, Aldarmahi AA, Lodhi Y. Neurological complications of bariatric surgery. *Neurosciences (Riyadh).* 2016 Jul;21(3):241.

34. Al-Shurafa H, Elzaafarany AH, Albenmoussa A, Balata MG. Primary experience of bariatric surgery in a newly established private obesity center. *Saudi Med J*. 2016 Oct;37(10):1089 – 1095.
35. Alqout O, Reynolds F. Experiences of obesity among Saudi Arabian women contemplating bariatric surgery: An interpretative phenomenological analysis. *J Health Psychol*. 2014 May;19(5):664 – 677.
36. Al Akwaa A, El Zubier A, Al Shehri M. Pattern of liver function tests in morbidly obese Saudi patients undergoing bariatric surgery. *Saudi J Gastroenterol*. 2011 Jul-Aug;17(4):252 – 255.