

## Prevalence and determinants of postoperative deficiencies secondary to bariatric surgery among patients in king fahad general hospital in Jeddah 2019

Abeer Alhussaini<sup>1\*</sup>, Majedh Hakami<sup>2</sup>, Nouran Aleyeidi<sup>3</sup>, Mahmood Sadagah<sup>4</sup>, Osama Fida<sup>5</sup>

<sup>1,2</sup>Resident, <sup>3</sup>Consultant Community Medicine, <sup>5</sup>Consultant, <sup>1,2</sup>Joint Program of Saudi Board in Family Medicine, Jeddah, <sup>4,5</sup>Prince Sultan Center for Bariatric Surgery, Jeddah, Saudi Arabia

**\*Corresponding Author: Abeer Alhussaini**  
Email: abir.m.h20@gmail.com

### Abstract

**Introduction:** Presently, bariatric surgery is considered the most compelling treatment modality for morbid obesity patient and one of the most effective procedures. The study aimed to identify the prevalence and determinants of patients' compliance to the recommended vitamin and mineral supplements and to identify the prevalence and determinants of post-bariatric surgery nutritional deficiencies in King Fahad General Hospital in Jeddah city so as to improve the patients' health.

**Materials and Methods:** This is a cross-sectional study wherein a validated questionnaire was used to collect data and were encoded and analyzed using IBM SPSS version 23, (IBD Corp., Armonk, NY).

**Results:** The findings of the study showed that nutritional deficiency is more likely to happen to female gender who is working. The study also revealed that deficiencies are common in HB, Vit D, Vit B12, calcium, iron and folate. The longer the period of intensive fluid taken following surgery increases the risk of vitamin deficiency. Furthermore, there's low compliance to vitamins and supplements and patients who underwent bariatric surgery only become adherent to vitamins/minerals when they discover complications.

**Conclusion:** This study concluded that there are various factors causing and affecting nutritional deficiencies preoperatively and postoperatively such as gender, work status, complications, and vitamins and supplements compliance. Overall, the present study concluded that it is imperative for the patients to adhere to vitamins and supplements intake according to the recommendation of the clinicians and dieticians.

**Keywords:** Obesity, Bariatric surgery, Nutritional deficiency.

### Introduction

Being overweight or most commonly known as obesity has been a worldwide epidemic and an increasing problem ever since. World health organization has always mentioned obesity as a major new global epidemic.<sup>1</sup> Over ingesting of food and absence or lack of exercise or any physical activities were named as main risk factors why people become overweight.<sup>2</sup> In order to overcome obesity, procedures, surgical or non-surgical processes to lose body fats were initiated. However, due to energy homeostasis, non-surgical procedures are known particularly ineffective at accomplishing major and long-term weight drop. Generally, not more than 5-10% is being reduced over dieting, exercising, and other few anti-obesity medications.<sup>3-6</sup> Significantly, minor weight loss even deliberates uneven health benefits, in terms of bettering obesity-associated comorbidities.<sup>7</sup> Nonetheless, additional considerable and resilient weight reduction would mend these predicaments effectively and even reduce the stigmatization as well as emotional distress repeatedly suffered by obese folks.

Bariatric surgery is deliberated to be the most compelling treatment modality for morbid obesity patient who has "BMI > 40 kg/m, BMI > 35 kg/m with metabolic syndrome or diabetes mellitus. It has become the most operational procedure in the attainment of long-term weight loss.<sup>8,9</sup> Three types of surgery were applied in Saudi Arabia namely laparoscopic gastric sleeve, laparoscopic Roux-en-Y gastric bypass, mini gastric bypass. There are increasing trend of numbers of bariatric surgery and approximately 500,000 bariatric surgeries are and being performed in the world.<sup>10</sup>

Nevertheless, studies showed a high prevalence of vitamins and minerals deficiencies post-surgery. The most frequent postsurgical paucities are iron (47%-66%), vitamin B12 (37%-50%), folic acid (15%-38%), vitamin D (15%-20%), and calcium (10%).<sup>11-27</sup> In order to decrease the prevalence of malnutrition and vitamin deficiency after surgery, multivitamins supplementation was deemed as the most important recommendation by clinicians. Moreover, the preoperative deficiency may contribute in increasing risk of vitamins deficiency postoperative, thus, vitamins deficiency should be treated even before surgery and an austere follow-up is dire essential to prevent vitamins deficiency.<sup>28</sup>

If the patient loses weight with vitamin deficiency, this will affect the patients future quality of life. Therefore, the authors are interested in studying and learning prevalence and determinant deficiencies subordinate to bariatric surgery because of the limitations of studies in Jeddah, moreover, a lot of patients come to Jeddah, as one of the largest city in Saudi Arabia, to do bariatric surgery. Bariatric surgery aspirants are always at risk of acquiring vitamin and mineral nutritional deficits in the post-operative stage caused by several factors, comprising of reduction in food consumption, vomiting, diminution of gastric secretions and bypass of absorption zone.<sup>29,30</sup> Thus, it is necessary to have daily multivitamins supplementation for optimal patient care following bariatric surgery,<sup>31,32</sup> and must be tailored to patients basing on their intermittent laboratory examinations and dietary necessities.<sup>33</sup>

For all patients going through bariatric surgery, edification and close follow-up to avert and identify nutritional insufficiencies are vital.

## Materials and Methods

### Profile of Respondents

All respondents were patients of both genders who came to Bariatric Clinic to follow up on their Post-Roux-en-Y Gastric Bypass, Sleeve Gastrectomy surgeries and mini gastric bypass after three, six months and one-year post-operation in King Fahad General Hospital in Jeddah. Within one month, all patients who underwent bariatric surgery after three, six months and one year and who agreed to volunteer with us were enrolled in the study and their total number was 101.

### Study Design

This study was performed using analytical cross-sectional study.

### Data Collection

The primary tool in this study was a validated questionnaire. The questionnaire comprised of leading three parts:

1. Socio-demographic data
2. Questions to measure prevalence of postoperative deficiencies secondary to Roux-en-Y Gastric Bypass and Sleeve Gastrectomy surgeries.
3. Questions to assess patients' compliance to the recommended vitamin and mineral supplementations and follow up after bariatric surgeries.

This was then tested during the pilot study.

Investigation results were done for patients routinely (pre-operative and post-operative after three, six months and one-year respectively).

We have interviewed and distributed the questionnaire to the post-bariatric surgeries patients in the waiting area, before they entered Bariatric clinics in King Fahad General Hospital, and was collected on the same day.

All information included in this study was treated with utmost confidentiality. Informed consent was distributed with the questionnaire and signed by the residents. Moreover, we have used the investigation results from the post-operative investigations done for those patients routinely.

The process was done for over a month. The data was confirmed by hand and was coded and encoded into a personal computer.

### Statistical Analysis

The study was analyzed using IBM SPSS version 23, (IBM Corp., Armonk, NY). A simple descriptive statistics were used to define the characteristics of the study variables through a form of numbers and percentages for the categorical and nominal variables while continuous variables are presented by mean and standard deviations. During the analysis of the data a group of variables are considered to be interrelated by doing a simple additive

method a domain namely "Vitamins and Supplement Compliance" was derived, these variables are the following:

1. Compliance with the recommendation of the medical team in the use of vitamins and supplements after the procedure (Converted to Yes/No where 100% is Yes and 75% and below is No)
2. Have you ever forgotten to take your vitamin supplements?
3. Have you ever had a problem remembering to take your vitamin supplements?
4. When you feel better, do you sometimes stop taking your vitamin supplements?
5. Sometimes if you feel worse when you take your vitamin supplements, do you stop taking them?
6. Did you have any problem with vitamin supplements such as nausea and vomiting?
7. Did you take herbs instead of vitamin supplements?
8. Do you always consult your doctor if you have a problem that hinders you from continuing to take your vitamins?

This study used a chi-square test to establish an association amongst categorical variables. While comparing two group means and more than two groups, an independent t-test and One-way ANOVA, with Least Significant Difference (LSD) as a post hoc test, respectively was used. To correlate variables which both represented by means a Pearson's correlation coefficient was used. To compare the means of two variables for a single group and to compute the variances amongst values of the two variables for each case and tests whether the average varies from 0, a Paired-Samples T Test was used. These tests were made on the basis of normal distribution. Dependent variables of the study were defined as binary results. A Binary Logistic Regression Model (BLRM), with Backward Conditional Elimination with Enter Criteria=0.05 and Elimination=0.10 was used to determine the significant predictors of any given dependent study variables with 95% confidence intervals. Finally, the criteria for rejecting the null hypothesis were a conventional p-value <0.05.

### Results

The participants of this study were composed of 101 patients who went to the Bariatric surgery clinics for follow up after three, six months and one-year post-operation, with ages ranging from 21 to 54 years old, having a mean age of 33.40 (SD=8.1), as shown in Table 1. The participants have weight before operation (kg) ranging from 87.0kg to 154kg with a mean of 114.61 (SD=14.3) and their weight after operation ranges from 55.0kg to 138.6kg with a mean of 84.97(SD=14.1). The participants' height (cm) ranges from 149.0cm to 182.0cm with a mean of 163.71(SD=8.2) and a BMI (kg/m<sup>2</sup>) of 33.8 to 57.0 with a mean of 42.29(SD=4.1). Out of the 101 respondents, 42 (41.6%) were male while 59 (58%) were female wherein their number of births experienced ranges from 1 to 10 with mean of 3.66(SD=1.9) and years after last birth ranges from 2 to 23 with a mean of 5.90(SD=4.7). 45(44.6%) were single, 49 (48.5%) were

married, 5(5.0%) were divorced and 2 (2.0%) were widowed. 54(85.7%) has financial status of average with 5000 Saudi Riyals to 20000 Saudi Riyals, while 9 (14.3%) has financial status of low with less than 5000 Saudi Riyals and 38 missing data. With regards to the participants' level of education, 75(74.3%) are in university level, 19(18.8%) are in secondary level, 6(5.9%) are in intermediate level while 1(1.0%) is in MA level. The participants were also asked regarding their employment/working status. 63(62.4%) have work or employed while 38(37%) were not. Out of the 63 participants who were working, 17(28.3%) were teachers, 9(15.0%) worked in administration, 5(8.3%) were bank employees, 5(8.3%) were nurses, 4(6.7%) were private company employees, 3(5.0%) were physiotherapist, another 3 (5.0%) were working in security, 2 (3.3%) were airport employees, 1(1.7%) worked in a call center, 1(1.7%) worked as a dentist, 1(1.7%) was a doctor, 1(1.7%) was an engineer, 1(1.7%) was a lab technician, 1(1.7%) was a pharmacist, 1(1.7%) was a porter, 1(1.7%) was a radiology technician, 1(1.7%) worked in a salon, 1(1.7%) was a STC company employee, 1(1.7%) was a supervisor in a supermarket, while 1(1.7%) was a technician and 3 missing information. The working hours of the participants ranges from 6 to 12 hours with a mean of 8.07 (SD=0.9).

Table 2. Shows the vitamins component of the patients through blood analysis before and after the operation and vitamins deficiencies present. Before operation, the HB level using blood analysis ranges from 10.90 to 16.90 with a mean difference of 13.40 (SD=1.4), calcium ranges from 8.30 to 10.49 with a mean of 9.34 (SD=0.4), Vit D ranges from 4.20 to 60.77 with a mean of 19.15 (SD=10.0), Vit B12 ranges from 142 to 581.70 with a mean of 248.48 (SD=59.8), folic acid ranges from 7.00 to 19.40 with a mean of 12.06 (SD=3.6), and iron ranges from 9.10 to 192.30 with a mean of 54.36 (SD=53.3). After operation, the HB level

using blood analysis ranges from 9.01 to 15.90 with a mean difference of 15.90 (SD=1.4), calcium intake ranges from 7.90 to 10.02 with a mean of 8.84 (SD=0.5), Vit D intake ranges from 2.01 to 61.35 with a mean of 14.60 (SD=11.4), Vit B12 ranges from 100.00 to 494.01 with a mean of 216.00 (SD=51.6), folic acid ranges from 4.49 to 15.19 with a mean of 9.70 (SD=3.2), and iron ranges from 6.95 to 174.60 with a mean of 41.35 (SD=48.2).

Deficiencies were confirmed in HB, calcium, Vit D, Vit B12, Folic Acid and iron with 65 (64.4%), 32 (31.7%), 52 (54.0%), 57 (58.2%), 19 (70.4%) and 45 (44.6%) participants respectively. While 36 (35.6%) responded no deficiencies in HB, 69 (68.3%) in calcium, 46 (46.0%) in vit D, 41 (41.8%) in vit B12, 8 (29.6%) in folic acid and 56 (55.4%) in iron. There were 1 missing information in vit D, 3 in Vit B12 and 74 in folic acid.

To determine the significant difference of before and after operation to the listed variables, this study used the paired sample t-test. It was found in Table 3 that HB level, calcium, Vit D, Vit B12, folic acid and iron (P<0.005) is significantly different to before and after bariatric operation. Furthermore, before operation is higher than after operation. Table 4 shows the significant effect of demographics presented as variables to vitamin deficiency. The study found that gender (P<0.013) and working patients (p<0.026) have a significant effect to vitamin deficiency. Furthermore, the effect is higher in female patients (78.0%) who are working. (60.3%) It was found in Table 5 that vitamins and supplements compliance has a significant effect to deficiency. Table 6 shows that the presence of complications after operations significantly affects vitamins and supplements compliance. It was found that those who have complications after the operation are more likely to comply with taking vitamins and supplements.

**Table 1:** Characteristics of the 101 Study Samples

Demographics	N	Min	Max	Mean	SD
Age	101	21	54	33.40	8.1
Weight before operation (kg)	101	87.0	154.0	114.61	14.3
Weight after operation (kg)	97	55.0	138.6	84.97	14.1
Height (cm)	99	149.0	182.0	163.71	8.2
BMI (kg/m <sup>2</sup> )	100	33.8	57.0	42.29	4.1
Number of Births (for female)	29	1	10	3.66	1.9
How many years after the last birth?	29	2	23	5.90	4.7
		<b>Number</b>		<b>%</b>	
Total		101		100.0	
Gender	Male	42		41.6	
	Female	59		58.4	
Marital Status	Single	45		44.6	
	Married	49		48.5	
	Divorced	5		5.0	
	Widow	2		2.0	
Marital Status	Single	45		44.6	
	Married Once(divorced/widow)	56		55.4	
Financial status	Low (less than 5000 SR)	9		14.3	
	Average (5000 SR - 20000 SR)	54		85.7	

	Missing	38			
Educational level	Intermediate	6		5.9	
	Secondary	19		18.8	
	University level	75		74.3	
	MA	1		1.0	
<b>Demographics of the participants occupation</b>		<b>Number</b>		<b>%</b>	
Do you work	Yes	63		62.4	
	No	38		37.6	
		<b>Number</b>		<b>%</b>	
Total		63		100.0	
Type of job	Administrative	9		15.0	
	airport employee	2		3.3	
	bank employee	5		8.3	
	call center	1		1.7	
	dentist	1		1.7	
	doctor	1		1.7	
	engineer	1		1.7	
	lab technician	1		1.7	
	nurse	5		8.3	
	pharmacist	1		1.7	
	physiotherapist	3		5.0	
	porter	1		1.7	
	private company employee	4		6.7	
	radiology technician	1		1.7	
	salon	1		1.7	
	security	3		5.0	
	STC company employee	1		1.7	
	supervisor in supermarket	1		1.7	
	Teacher	17		28.3	
	Technician	1		1.7	
Missing	3				
		<b>N</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>
Working hours		60	6	12	8.07
				<b>SD</b>	0.9

**Table 2:** Vitamins analysis before and after the operation and deficiency

Variables		N	Min	Max	Mean	SD
Before operation	Hb level	101	10.90	16.90	13.40	1.4
	Calcium	99	8.30	10.49	9.34	0.4
	Vit D	100	4.20	60.77	19.15	10.0
	Vit B12	91	142.00	581.70	248.48	59.8
	Folic acid	20	7.00	19.40	12.06	3.6
	Iron	101	9.10	192.30	54.36	53.3
After operation	Hb level	101	9.01	15.90	11.57	1.4
	Calcium	101	7.90	10.02	8.84	0.5
	Vit D	101	2.01	61.35	14.60	11.4
	Vit B12	98	100.00	494.01	216.00	51.6
	Folic acid	27	4.49	15.19	9.70	3.2
	Iron	100	6.95	174.60	41.35	48.2
			<b>Number</b>		<b>%</b>	
Total			101		100.0	
Deficient	Hb	Yes	65		64.4	
		No	36		35.6	
	Calcium	Yes	32		31.7	
		No	69		68.3	
	Vit D	Yes	54		54.0	

	Vit B12	No	46	46.0
		Missing	1	
		Yes	57	58.2
	Folic acid	No	41	41.8
		Missing	3	
		Yes	19	70.4
	Iron	No	8	29.6
		Missing	74	
		Yes	45	44.6
			No	56

**Table 3:** Vitamin vs before and after operation

Variables		N	Mean ± SD	Mean Difference	95% C.I of the Difference		p-value
					Lower	Upper	
Hb level	before operation	101	13.40 ± 1.4	1.83	1.61	2.05	<0.001 <sup>a</sup>
	after operation	101	11.57 ± 1.4				
Calcium	before operation	99	9.34 ± 0.4	0.52	0.44	0.61	<0.001 <sup>a</sup>
	after operation	99	8.82 ± 0.5				
Vit D	before operation	100	19.15 ± 10.0	4.60	2.99	6.21	<0.001 <sup>a</sup>
	after operation	100	14.55 ± 11.5				
Vit B12	before operation	91	248.48 ± 59.8	28.75	20.84	36.67	<0.001 <sup>a</sup>
	after operation	91	219.73 ± 50.6				
Folic acid	before operation	20	12.06 ± 3.6	1.89	1.09	2.68	<0.001 <sup>a</sup>
	after operation	20	10.17 ± 3.0				
Iron	before operation	100	54.39 ± 53.5	13.04	10.67	15.42	<0.001 <sup>a</sup>
	after operation	100	41.35 ± 48.2				

<sup>a</sup>-significant using Paired-Sample t-test @<0.05 level.

**Table 4:** Deficiency in relation to demographics

Variables		Total	Deficient		p-value
			No	Yes	
Age		101	33.66 ± 7.8	33.28 ± 8.4	0.828
BMI (kg/m2)		100	42.47 ± 4.2	42.20 ± 4.0	0.756
Working hours		60	8.05 ± 0.7	8.08 ± 0.9	0.886
Gender	Male	42	19(45.2%)	23(54.8%)	0.013 <sup>a</sup>
	Female	59	13(22.0%)	46(78.0%)	
Marital Status	Single	45	11(24.4%)	34(75.6%)	0.161
	Married Once(divorced/widow)	56	21(37.5%)	35(62.5%)	
Financial status	Low (less than 5000 SR)	9	4(44.4%)	5(55.6%)	0.752
	Average (5000 SR - 20000 SR)	54	21(38.9%)	33(61.1%)	
Educational level	Intermediate	6	2(33.3%)	4(66.7%)	0.355
	Secondary	19	4(21.1%)	15(78.9%)	
	University level	75	25(33.3%)	50(66.7%)	
	MA	1	1(100.0%)	0(0.0%)	
Do you work	Yes	63	25(39.7%)	38(60.3%)	0.026 <sup>a</sup>
	No	38	7(18.4%)	31(81.6%)	

<sup>a</sup>-significant using Chi-Square Test @<0.05 level.

**Table 5:** Deficiency in relation to vitamins and supplement compliance

Variables		Total	Deficient		p-value
			No	Yes	
Vitamins and Supplement Compliance		101	3.16 ± 1.0	3.64 ± 0.9	0.019 <sup>a</sup>
Percentage of your commitment to the doctor's appointment after the operation and the necessary blood tests	50%	5	1(20.0%)	4(80.0%)	0.551
	75%	56	16(28.6%)	40(71.4%)	
	100%	40	15(37.5%)	25(62.5%)	

Compliance with the recommendation of the medical team in the use of vitamins and supplements after the procedure	<75%	9	2(22.2%)	7(77.8%)	0.738
	75%	73	23(31.5%)	50(68.5%)	
	100%	19	7(36.8%)	12(63.2%)	
Have you ever forgotten to take your vitamin supplements?	Yes	94	28(29.8%)	66(70.2%)	0.133
	No	7	4(57.1%)	3(42.9%)	
Have you ever had a problem remembering to take your vitamin supplements?	Yes	16	3(18.8%)	13(81.3%)	0.225
	No	85	29(34.1%)	56(65.9%)	
When you feel better, do you sometimes stop taking your vitamin supplements?	Yes	39	9(23.1%)	30(76.9%)	0.140
	No	62	23(37.1%)	39(62.9%)	
Sometimes if you feel worse when you take your vitamin supplements, do you stop taking them?	Yes	78	22(28.2%)	56(71.8%)	0.166
	No	23	10(43.5%)	13(56.5%)	
Did you have any problem with vitamin supplements such as nausea and vomiting?	Yes	94	29(30.9%)	65(69.1%)	0.510
	No	7	3(42.9%)	4(57.1%)	
Did you take herbs instead of vitamin supplements?	Yes	3	2(66.7%)	1(33.3%)	0.186
	No	98	30(30.6%)	68(69.4%)	
Do you always consult your doctor if you have a problem that hinders you from continuing to take your vitamins?	Yes	9	1(11.1%)	8(88.9%)	0.165
	No	92	31(33.7%)	61(66.3%)	

<sup>a</sup>-significant using Independent *t*-test@<0.05 level.

**Table 6:** Correlations of vitamins and supplement compliance to patients categorical variables

Variables		Total	Vitamins and Supplement Compliance	p-value
Did you have any complications after the operation?	Yes	12	4.33 ± 1.1	0.001 <sup>a</sup>
	No	88	3.36 ± 0.9	
Did you exercise after the operation?	Yes	75	3.40 ± 0.9	0.108
	No	25	3.76 ± 1.0	
Did health education include the types of blood tests needed after the operation?	Yes	64	3.45 ± 1.0	0.512
	No	32	3.59 ± 1.0	
Transparent liquids	A week	7	3.00 ± 1.0	0.480
	Ten (10) days	51	3.45 ± 1.0	
	Two (2) weeks	39	3.62 ± 1.0	
	More than that	2	3.50 ± 0.7	
Intensive fluids	A week	4	2.75 ± 1.3	0.070
	Ten (10) days	37	3.30 ± 0.9	
	Two (2) weeks	59	3.64 ± 1.0	
Mashed Food	Ten (10) days	18	3.39 ± 0.9	0.909
	Two (2) weeks	74	3.50 ± 1.0	
	More than that	8	3.50 ± 1.3	
Minced Food	Ten (10) days	14	3.00 ± 1.1	0.103
	Two (2) weeks	74	3.53 ± 0.9	
	More than that	12	3.75 ± 0.9	
Normal Food	A week	2	4.50 ± 0.7	0.170
	Ten (10) days	1	3.00 ± 0.0	
	Two (2) weeks	1	5.00 ± 0.0	
	More than that	96	3.45 ± 1.0	
Percentage of your commitment to the doctor's appointment after the operation and the necessary blood tests	50 percent	5	4.20 ± 0.8	0.167
	75 percent	56	3.52 ± 0.8	
	100 percent	40	3.35 ± 1.1	

<sup>a</sup>-significant using Independent *t*-test@<0.05 level.

**Discussion**

Overall, this study shows that vitamin deficiency is common in female gender who were working (78.0%) than male gender (54.8%). Similar to the study's findings, a study conducted by Schweiger and colleagues<sup>34</sup> stated that nutritional deficiencies were common in women than men.

Studies also show that more obese women turn into Bariatric surgery than men.<sup>34, 35</sup> Aiming to pin down the prevalence of nutritional paucities in obese patients for SG and the risk factors, a study was conducted by Ben-Porat et al. In their result, the risk factors for nutritional deficiencies

after operation exhibited that for both male and female, the occurrence of deficiencies before operation was the predictor mentioned as strongest of their occurrence after operation. They concluded therefore that in order to prevent deficiencies following surgery, we should focus on the nutritional status before the operation.<sup>36</sup>

Deficiency in vitamins was shown as more common before operation than after operation. The more prevalent shown in this study were HB (64.4%), Vit D (54.0%), Vit B12 (58.2%) and folic acid (70.4%) than iron and calcium as seen in the results of the research. In another study, however, prevalence of deficiency was more present in iron (35.1%) than Vit B12 (3.6%) and other vitamins and mineral supplements.<sup>34</sup> Results in other previous studies also found that deficiencies were in folate (32.2%), vitamin B12 (4.7%), corrected calcium (13.7%), iron (9.0%), and vitamin D (80.0%). Other vitamin mentioned were, albumin (11.8%), hemoglobin (2.8%), globulin (1.4%), phosphorus (10.4%), ferritin (1.9%), chloride (15.6%), sodium (7.6%) and potassium (5.7%).<sup>35</sup> In the review conducted by Whitfield and colleagues, the most usual deficiencies were folate, iron, vitamin B12, copper, zinc, vitamin D, and calcium. According to them, these can result to other problems namely Wernicke encephalopathy, osteoporosis, peripheral neuropathy, and anemia especially postoperatively.<sup>12</sup> In other case reports and retrospective studies, poor or deficiency in vitamin and supplements are more common after surgery with prevalence increasing of 82%. The mentioned deficiency in vitamins includes iron, vitamin D, vitamin B12 and calcium.<sup>37,38</sup>

The study showed that there's a trend in taking intensive fluids wherein as the period of intake increases the deficiency in vitamins also increases. There were guidelines/diets recommended by the clinicians to be followed by the patients after their operation including the amount and quantity of fluid and food intake within a period. In this study, we have concluded that taking intensive fluids beyond the prescribed period may cause nutritional deficiencies. The present study also concluded that low vitamin and supplement compliance results to vitamin deficiency. Inadequate compliance with vitamin and supplement can cause vitamin deficiency be it pre-operative or post-operative. This becomes a challenge to both patient and clinician. A retrospective study<sup>39</sup> in 2006 on 379 obese patients found in about 68.1% of the patients who have low vitamin D, 22% short in hemoglobin, 39% lacking in iron, 8.4% little in ferritin and 29% low in thiamine postoperatively due to low rate of multivitamin intake. The prior study was also comparable to the result of the study conducted by Madan, et. al.,<sup>40</sup> showing low levels in vitamins A, B12, D, zinc, iron and folate post-operatively. Colossi and colleagues in 2007,<sup>41</sup> determined the unceasing supplementation of multivitamins is necessary in a lifetime period subsequent to bariatric surgery. In a retrospective study conducted by Gasteyer, et. al., wherein they involved a 2-year follow-up of postoperative patients and remarked that in spite with an average multivitamin supplementation, 98% of the patients, included in their study, still needed

more precise vitamin appendages by 24 months. Averagely, each one of their patients needed  $2.9 \pm 1.4$  exact supplements to be added to their multivitamin.<sup>38</sup> Inadequate compliance with the recommended vitamins preoperatively and postoperatively pose as high cause of nutritional deficiency. If left untreated, this can even lead to acute or chronic diseases.

Furthermore, it was also concluded in the present study that those who have complications after operation are more likely to comply with taking vitamins and supplements than those who have not experienced complications. It was found that 81.2% of the patients who went through surgery did not comply with the recommendation in the use of vitamins and supplements as according to them, they sometimes forget to take it. Other reasons mentioned by the participants were because they already felt better and even felt worse while taking the vitamins and supplements. They also revealed experiencing nausea and vomiting during the period of vitamin intake. Therefore, only when they discover complications postoperatively will they adhere to taking vitamins/minerals. It is vital to abide by the nutritional recommendations provided by clinician. Low adherence to vitamin/mineral intake has been reported in several previous studies especially in a long-term adherence. A previous study by Cooper, et.al.,<sup>42</sup> determined the adherence to vitamins and mineral supplements in 22 study population who've underwent weight loss surgery. A few months after surgery, 90% were adherent to vitamins/minerals however it gradually plummeted by about 50% a year after surgery thus signifying negative long-term observance.<sup>42</sup> Bariatric procedures worsen pre-existing nutrient deficiencies in obese patients for weight-loss surgery resulting the complications, to which this fact was highlighted in the review of Arnold and Barbul<sup>43</sup> wherein they also emphasized that although clinician strictly monitor their patients after operation and recommends supplementation in order to cure nutritional deficiencies, the process still will not succeed since the non-adherent of the patients to vitamins/minerals will still affect the nutrient supplementation. In another comparable previous study on adherence to vitamins and supplements which was conducted by Modi and colleagues,<sup>44</sup> it was stated that the compliance to multivitamin supplementation early after the patients' surgery was bizarrely low at about 30%. This was based on a laborious, unbiased and longitudinal measurement mentioned in their methodology. Moreover, no multivitamins were taken on 66% of days over the said duration. Adolescents do take multivitamins before operation and instantly postoperative, however they revealed decreasing compliance over the first 6 months following surgery.<sup>44</sup> Hence, the authors concluded that in order to achieve decline in complications subsequent to bariatric surgery and to enhance preoperative and postoperative therapy, preoperative supplementation of micronutrients to obese patients and proper recommendation and information on the status of their nutrient content are required.

According to some studies,<sup>34</sup> there's a misconception on bariatric surgery causing nutritional deficiencies, as perchance, nutritional deficiency is already present even before bariatric surgery for those who turn into it due to obesity. That's why it is important to monitor and comply with the recommendations provided by the health education before and after surgery to ensure its success.

### Conclusion

Obesity can be considered as one of the utmost significant public wellbeing difficulties around the world and one of the treatments plausible to stop this problem is bariatric surgery. Thus, it is the general purpose of this study to identify the prevalence and determinants of patients' compliance to the recommended vitamin and mineral supplements and determine the prevalence and determinants of post-bariatric surgery nutritional deficiencies in King Fahad General Hospital in Jeddah City in order to improve the outcome of bariatric surgery for the patients. This study concluded that various factors causing deficiencies such as gender, work status, complications, and vitamin and supplement compliance. Overall, the present study concluded that it is imperative for the patients to adhere to vitamins and supplements intake according to the recommendation of the clinician/dietician. Improved preoperative and postoperative therapy, preoperative supplementation of micronutrients to obese patients and proper recommendation and information on the status of their nutrient content are also required for the patients' good health. Due to the limitations of this study, more studies are essential to find out adequate information on the predominance and determinants of nutritional insufficiencies.

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