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Effect of Nutrition Intervention on Macronutrient and Micronutrient Intake in a Group of Sleeve Gastrectomy Patients

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ABSTRACT

Introduction: There are several approaches to treat obesity including surgery in case of morbid obesity. The number of bariatric surgery patients has increased in Jordan, but in most cases there is a lack of proper nutrition intervention, monitoring, and follow up of patients. Our aim in this study was to assess the intakes of energy, macronutrients and certain micronutrients after 3 and 6 months post-operatively. **Methods**: A conventional sample of 50 patients from Jordan University Hospital participated in the study; 25 in the intervention group, and 25 in the control group. The intervention group patients were counseled regarding the use of an adequate low caloric balanced diet, post-operatively. Dietary assessment based on 3-day food intakes was carried out among all the participants before surgery and 3 and 6 months post-operatively. **Results**: There were no significant differences between the control and the intervention groups in the intakes of macronutrients and selected micronutrients (calcium, iron, zinc, B_{12} and folic acid) after 3 months post-operatively. However, there were significant increases ($P< 0.05$) in the intakes of protein, iron, zinc, and folate in the intervention group compared with the control group after 6 months post-operatively. **Conclusion**: Nutrition intervention enhanced the intake of some nutrients, especially protein intake.

Key words: Bariatric surgery, laparoscopic sleeve gastrectomy, macronutrients and micronutrients, nutrition intervention, obesity

INTRODUCTION

The prevalence of obesity has increased at an alarming rate during the last three decades (Badran & Laher, 2011; Geol *et al*., 2013). The World Health Organization (WHO) (2015) figures indicate that globally approximately more than 1.9 billion adults, 18 years and older, were overweight. Of these, over 600 million were obese in 2014. Also, these figures indicate that 42 million children under the age of 5 were overweight or obese in 2013 (WHO, 2015). In Jordan, several studies on obesity have shown that it appears to be a common metabolic disorder (Hourani, Naffa & Fardous, 2011). A survey conducted by the Ministry of Health (MoH) (2007), using a representative sample from all of the governorates, showed that the prevalence of obesity was 35.9%, and the prevalence

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of overweight was 30.5% in adults over 18 years (MoH, 2007). Also, in a cohort study by Karadsheh, Al-Qudah & Karadsheh (2013) on the prevalence of overweight and obesity in male students aged 12-15 years in public schools in Jordan, 10.2% were found to be overweight and 3.5% obese. Furthermore, WHO (2015) reported the prevalence of obesity in Jordan in 2014 to be ≥30.0% in females and 20%-29% in males. Overweight and obesity are risk factors for many health problems such as type 2 diabetes mellitus, high blood pressure, high blood lipids, asthma, sleep apnea and some cancers (Geol *et al*., 2013**).**

There is no single approach that can help prevent or treat overweight or obesity. Treatment may include a mix of behavioral treatment, diet, exercise, and sometimes weight-loss drugs. In some cases of extreme obesity, weight- loss bariatric surgery may be an option (NIH, 2012). While the medical management of obesity is relatively ineffective, bariatric surgery has been recognised to be the most effective long-term treatment for morbidly obese (BMI ≥ 40 kg/m^2), with demonstrated significant and durable weight loss and improvement of comorbidities (Toh *et al.,* 2009; Backman & Earthman, 2013). According to the 1991 consensus guidelines from the National Institutes of Health (NIH), candidates for bariatric surgery must have a BMI greater than 40 kg/m^2 or BMI greater than 35 with significant obesity related diseases (Herber *et al*., 2010; Backman & Earthman, 2013). The three most common types of bariatric surgery are adjustable gastric bands (AGB); sleeve gastrectomy (SG): and roux-en-Y gastric bypass (GBP) (Ziegler *et al*., 2009; Shankar, Boylan & Sriram, 2010).

Bariatric procedures produce changes in the gastrointestinal anatomy and physiology. As a consequence, there is a change in the quantity and quality of diet, which may result in vitamin and mineral deficiencies (Toh *et al.,* 2009). Accordingly, patients undergoing bariatric surgery must commit to a program of lifestyle changes, diet, eating behaviours, vitamin supplementation and follow up (Brethauer, Chand & Schauer, 2006; Ziegler *et al*., 2009). All types of bariatric surgery lead to a very reduced total calorie intake, especially in the first six post-operative months, typically ranging from 700 to 900 kcalories per day. This contributes to the decreased intake of all macronutrients, especially protein (Xanthakos, 2009). In addition to protein, the main nutrients affected by bariatric surgery are vitamin B12, folate, iron and calcium. Such deficiencies might be manifested clinically as anemia (due to deficiencies of iron, vitamin B12 and folic acid), neurological sequelae (due to deficiencies of vitamin B12, folic acid and thiamine) or osteoporosis (related to calcium and vitamin D deficiencies) (Thorell, 2011).

In Jordan, the number of bariatric surgery has increased in the last five years, at a rate of 90 surgeries / year (Obeidat, 2013, pers comm). The operations were done without a proper nutrition intervention, monitoring, and follow up. To the best of our knowledge, there are no studies done on the effect of medical nutrition therapy guidelines on the nutritional status of either macro or micronutrients in patients after bariatric surgery in Jordan. Therefore, the idea of this research was thought to be important.

The objectives of this study were to counsel bariatric surgery patients on the use of an adequate low calorie balanced diet, and to evaluate the effectiveness of this diet in these patients by using 3-day food records. Another objective was to evaluate energy and nutrient intake of macronutrients (protein, carbohydrate and fat) and intake of specific micronutrients (vitamin B12, zinc, iron, calcium, and folic acid) from the 3-day food record data, and compare the results after 3 and 6 months post-operatively between the control and the intervention groups.

METHODS

Study design and setting

This intervention study was carried out on 50 consecutive patients who had undergone laparoscopic bariatric surgery by a single surgeon at the Jordan University Hospital, Amman, Jordan between November 2013-October 2014, with a follow-up after six months. Inclusion criteria of patients in this study were: BMI ≥40 kg/m² with no comorbidities or BMI ≥35 kg/m² with obesity associated comorbidity (diabetes, sleep apnea and hypertension), and adults less than 60 years of age. Subjects included male and female patients on whom sleeve bariatric surgery had been conducted.

The patients were divided into two groups, the control and the treatment (intervention) groups with 25 patients in each group. They were assessed pre-operatively and three and six months post-operatively.

Initial interview

Each patient was first interviewed either at the Surgery Clinic or in the Surgery Ward of the Jordan University Hospital, to ensure eligibility for participation in the study according to the inclusion criteria. Pre-operative data (food habits, weight, height, age, obesity related diseases, allergy, cigarette smoking, marital status, and education level) were collected from the patients and their medical charts.

Follow-up information or questions were collected directly from the patients during the routine follow-up appointments in the Surgery Clinic, and by personal phone and WhatsApp messages. Furthermore, patients were counseled about their condition, and the study was explained in detail to each patient, regarding its objectives, methodology, and safety concerns. Those who agreed to participate were asked to sign a written informed consent.

The treatment group was counseled on a balanced low calorie diet (1200 kcal), and written instructions were given to the patients at the time of discharge from the hospital. On the other hand, the control group followed the diets as they were routinely given in the hospital. The patients of the treatment group were instructed to use the diet in stages as recommended in another study (Mechanick *et al*., 2009).

Nutrition guidelines for the intervention group in the different stages:

The following guidelines were applied in counseling the intervention group patients:

Stage I	Days 1 and 2 post-operatively	Clear liquids
Stage II	Day 3 post-operatively	Clear liquids plus full liquids
Stage III	Days 10-14 post-operatively	Soft, ground or pureed protein source as tolerated
Stage IV	Four weeks post-operatively	A balanced healthy solid diet (1200 kcal), which considers prevention of dumping syndrome development

- Stage I: Clear fluids are to be used. Non-carbonated beverages of low caloric content; no sugar; no or low caffeine drinks (examples of such fluids: water, tea and herbal tea without sugars, unsweetened pure fruit juice, fat-free clear broth, and sugar-free jelly) (Goldenberg & Sherry, 2015).
- Stage II: Patients should consume a minimum of 1400-1900 ml fluid per day: 700-900 ml or more of clear fluid plus 700-900 ml of any combination of full liquids (such as skimmed or semi-skimmed milk, yogurt, shanina (butter milk), creamed soups made with skim or 1% milk, low sugar/low fat custard

and milky pudding) (Goldenberg & Sherry, 2015).

- Stage III: Patients are encouraged to eat 4-6 small meals per day, as they may be able to tolerate only a couple of table spoons at each meal or snack. The patients are also encouraged to chewing well prior to swallowing and not to drink with meals but to wait nearly 30 min after each meal before resuming fluids. They are advised to eat from small plates and to use small utensils to help control portions.(Examples of recommended foods: mashed potato, sweet potato, mashed carrot, mashed zucchini, mashed banana, tinned fruit without syrup, stewed fruit, soft poached eggs, labenah, low fat cheese, pureed poultry and meat, and blenderised meat, poultry and cooked vegetables, in addition to clear and full fluids) (Goldenberg & Sherry, 2015).
- The following should be avoided: rice, bread, pasta, until patient is comfortably consuming 75 g protein per day plus fruits and vegetables (Mechanick *et al.*, 2009).
- Stage IV: The diet in this stage should be healthy, balanced and low in calories. All patients were asked to apply the following nutritional instructions: six meals per day (three main meals and three snacks), three servings from the dairy group, four servings from the meat group, and five servings of legumes, vegetables, and fruits per day, for a total of 1200 kcal/ day and protein 75g/day (Mechanick *et al.*, 2009; Donadelli *et al.*, 2012). Again, patients were advised to eat from small plates and to use small utensils to help control portions.

In addition, the following general dietary guidelines were written and explained to each patient in the intervention group (Goldenberg & Sherry, 2015):.

- Eat 5-6 times per day.
- Eat slowly (20-30 minutes per meal) and remember to chew well.
- Keep portion sizes small.
- Stop eating when you are no longer hungry or feel comfortably satisfied.
- All foods should be low in fat and simple sugars.
- Avoid sugars, honey, molasses, corn syrup, and other foods high in sugars to prevent dumping syndrome.
- Introduce new foods, one at a time in order to rule out intolerance. If a food is not tolerated, try to reintroduce it one week later.
- Do not drink liquids that have calories, except for milk/ protein liquids.
- Drink at least 6-8 cups of fluid per day to prevent dehydration.
- Do not drink with your meal (do not drink 30 min before or after meals).
- Eat only good quality food, remember protein first; this will help prevent a protein deficiency
- If nausea or vomiting occurs; stop eating solids and return to clear liquids for 24 h.
- Exercise at least 30 min a day (such as: walking, biking, group classes, and team sports).

These guidelines were translated into Arabic, given and explained verbally to each patient in the intervention group. Additional information was given to individual patients in this group, taking into consideration the individual tolerances, food allergies, and their likes and dislikes.

Anthropometric measurements

Anthropometric measurements of all patients were taken at the initial interview including body weight and height. Weight was re-obtained after 3 and 6 months. Body mass index (BMI) was also calculated as shown below. Patients were weighed while dressed in light clothing (without shoes) (Lee & Nieman, 2010). Patients' height was measured with their shoes and socks removed (Lee & Nieman, 2010). BMI

Table 1. Characteristics of the study sample

Intervention	*Control*		*Variable*	
	NO.	*Percent*	*NO.*	*Percent*
Sex				
Male	6	24%	6	24%
Female	19	76%	19	76%
Marital status				
Single	8	32%	10	40%
Married	16	64%	15	60%
Widow	1	4%	0	0
Comorbidities				
Diabetes Mellitus	6	24%	6	24%
Hypertension	1	4%	0	0
No comorbidities	18	72%	19	76%

was calculated as the ratio of weight in kilograms divided by the square of height in meters (kg/m^2) (WHO, 2015).

Dietary assessment

A 3-day food record (one of was a non-working day) was obtained from each patient (in the control and the intervention groups) for dietary assessment after three and six months (Schröder *et al.,* 2001; Freire *et al.,* 2012). Patients were instructed (verbally) about food measures and portion sizes, food ingredients and descriptions of dishes, snacking, food varieties, and preparation methods (Schröder *et al.,* 2001).

All dietary intakes were entered into 3-day food records, including foods, snacks, and beverages eaten over the last 24-h period. All foods consumed during every meal of each day were included; taking into consideration vitamin and mineral supplements in the study period. The amounts of all foods consumed were recorded in special units such as spoons, cups, etc.

Data from the 3-day food records were individually analysed in terms of energy, macronutrients (carbohydrate, protein, fat), and selected micronutrients (calcium, iron, zinc, vitamin B12, and folic acid) contents. Food records were analysed using Food Processor SQL Nutritional Software (version 10.6.3. 2010, ESHA Research).

Statistical analysis

Statistical analysis was performed using Statistical Program for Social Studies (SPSS), version 19.0 for Windows. Differences were considered significant at $P < 0.05$. Results were expressed as mean ± standard error of mean (SEM). Differences of the means before surgery and after 3 and 6 months post-operatively in each group (the control and the intervention groups), and differences of means between both groups were calculated using Student *t*-test for independent samples with a 2-tailed index for significant levels.

RESULTS

Characteristics of the study sample

Characteristics of the study sample (the control and the intervention groups) are shown in Table 1. This study included 50 patients (25 in the control group and 25 in the intervention group). The majority of the patients were females (76% n= 19 in each group), whereas the males constituted 24% (n=6 in each group).

Table 2. Anthropometric measurements of the study sample before surgery (1-3)*

Group	*NO.*	*Mean*	*SEM*	*Min.*	*Max.*
Age (year)					
Control	25	36.20	±1.91[a]	20.00	60.00
Intervention	25	34.72	±1.73 [a]	19.00	54.00
Ht. (cm)					
Control	25	164.20	±1.60 [a]	145.00	178.00
Intervention	25	163.84	±1.88 [a]	150.00	180.00
Wt. (kg)					
Control	25	131.72	±5.47 [a]	100.50	200.00
Intervention	25	127.21	±4.40 [a]	100.50	180.10
BMI (kg/m^2)					
Control	25	48.55	±1.47 [a]	35.29	63.84
Intervention	25	48.26	±1.44 [a]	36.61	63.28

[1] Results are expressed as Mean ± SEM.
[2] There were no significant differences in anthropometric measurements between control and intervention groups (P≥0.05).
[3] Values in columns with different superscripts are significantly different (P< 0.05).
*Abbreviations: SEM: standard error of the mean; Min: minimum, Max: maximum; Ht.: height; Wt.: weight; BMI: Body Mass Index.

Anthropometric measurements of the study sample before surgery

Anthropometric measurements of the study sample before surgery are shown in Table 2. At the time of surgery, patients' age ranged from 20 to 60 years in the control group, and between 19 to 54 years in the intervention group, with a mean of 36.20 ±1.91 years in the control and 34.72 ±1.73 years in the intervention group. The weight of the patients before surgery in the control group ranged from 100.50 to 200.00 kg with a mean of 131.72 ±5.47 kg, whereas in the intervention group, it ranged from 100.50 to 180.10 kg with a mean of 127.21 ±4.40 kg. The mean for BMI before surgery was 48.55 ± 1.47 and 48.26 ± 1.44 for the control and the intervention groups, respectively. There were no significant differences (P > 0.05) in anthropometric measurements (age, height, weight, and BMI) between control and intervention groups before surgery.

The control group

Macronutrient and selected micronutrient intakes in the control group

The average daily intake of macronutrients and selected micronutrients after 3 and 6 months of surgery in the control group are shown in Table 3. Differences in energy intake (868.98 ± 77.32 Kcal and 1327.64 ± 87.91 Kcal after 3 and 6 months, respectively) were significant (P< 0.05). Also, protein intake (in gram) was significantly different after 3 months (28.28 ± 3.06 g) and after 6 months (38.96 ± 3.08 g). There was a significant difference (P< 0.05) in daily fat intake between patients in the control group after 3 months (24.96 ± 3.17 g) and 6 months (46.39 ± 6.05 g), but there were no significant differences (P>0.05) in daily carbohydrate intake, Ca, Fe, Zn, B12 and folate after 3 months and 6 months of surgery in this group. All macronutrients and selected micronutrients did not reach the recommended intake after 3 months

Table 3. Average daily intake of macronutrients and selected micronutrients after 3 and 6 months in the control group (1-3).

V*ariable*	*Recom-mended intakes**	*NO.*	*After 3 months*		*% of Rcmd.*	*After 6 months*		*% of Rcmd.*
			Mean	*SEM*		*Mean*	*SEM*	
Energy (kcal)	1200	25	868.98	±77.32[b]	72.42%	1327.64	±87.91[a]	110.64%
Protein (g)	75	25	28.28	±3.06[b]	37.71%	38.96	±3.08 [a]	51.95%
CHO (g)	150	25	134.25	±13.79[b]	89.50%	193.30	±12.73[a]	128.87%
Fat (g)	33.33	25	24.96	±3.17[b]	74.89%	46.39	±6.05[a]	139.18%
Ca (mg)	1000	25	378.74	±49.27[a]	37.87%	481.69	±64.57[a]	48.17%
Fe (mg)	Male 8	6	5.33	±1.00 [a]	66.63%	6.61	±1.04[a]	82.63%
	Female 18	19	6.82		37.89%	8.21		45.61%
Zn (mg)	Male 11	6	2.86	±0.34[a]	26.00%	3.09	±0.48[a]	28.09%
	Female 8	19	3.08		38.50%	4.06		50.75%
B12 (µg)	2.4	25	6.00	±2.60[a]	250%	7.36	±3.04[a]	306.67%
Folate (µg)	400	25	104.91	±27.54[a]	26.23%	169.46	±24.51[a]	42.37%

[1]Results are expressed as Mean ± SEM.
[2]Values in rows with different superscripts are significantly different (P< 0.05).
[3]Abbreviations: SEM: standard error of mean; CHO: carbohydrate; Rcmd: recommendation.
*The recommended intake of energy and protein (Mechanick *et al.*, 2009; Donadelli *et al.*, 2012), the micronutrients recommended intake as RDI (Mahan, Escott-Stump & Raymond, 2014).

of surgery except for vitamin B12 intake (250%). Percentage daily intake of energy, carbohydrate, fat, and B12 was higher than the recommended intake after 6 months of surgery (110.64%, 128.87%, 139.18%, and 306.67%, respectively).

The intervention group

Intake of macronutrients and selected micronutrients in the intervention group

The intakes of macronutrients and selected micronutrients of the intervention group patients are shown in Table 4. There were significant differences (P< 0.05) in the average daily intakes of energy, protein, fat, Fe, and Zn in this group after 3 and 6 months after surgery. Carbohydrates, Ca, B12 and folate intakes were not significantly different (P> 0.05) after 3 and 6 months in this group.

After 3 months of surgery, the intakes of macronutrients and selected micronutrients were less than the recommended intake (except for vitamin B12, 216.67%). But after 6 months post-operatively, the fat and B12 intakes were more than the recommended intakes (121.81% and 108.8%, respectively).

Comparison between the control group and the intervention group after 3 and 6 months of surgery

Comparison of the average daily intakes of macronutrients and some selected micronutrients after 3 and 6 months between the control and the intervention groups are shown in Table 5. There were no significant differences (P>0.05) between the control and intervention groups in the intakes of macronutrients (energy, protein, carbohydrate, and fat), and selected micronutrients after 3 months.

After 6 months, there were significant differences (P<0.05) in the intake of protein, carbohydrate, Fe Zn and folate between the control and the intervention groups, but there were no significant differences

Table 4. Average daily intakes of macronutrients and selected micronutrients after 3 and 6 months in the intervention group (1-3).

Variable	*Recommended Intake**	*NO.*	*After 3 Months*		*% of Rcmd.*	*After 6 Months*		*% of Rcmd.*
			Mean	*SEM*		*Mean*	*SEM*	
Energy (kcal)	1200	25	825.27	±57.23[b]	68.77%	1088.39	±56.04[a]	90.70%
Protein (g)	75	25	30.89	±2.24[b]	41.19%	49.26	±2.62[a]	65.68%
CHO (g)	150	25	123.87	±8.93[a]	82.58%	131.09	±9.38[a]	87.39%
Fat (g)	33.33	25	25.24	±2.68[b]	75.73%	40.60	±3.07[a]	121.81%
Ca (mg)	1000	25	451.44	±59.83[a]	45.14%	581.26	±53.42[a]	58.13%
Fe (mg)	Male 8	6	7.39	±1.46[a]	92.38%	9.30	±1.56[a]	116.25%
	Female 18	19	8.60		47.78%	13.00		72.22%
Zn (mg)	Male 11	6	3.53	±0.34[b]	32.09%	3.54	±0.73[a]	32.18%
	Female 8	19	2.71		33.88%	6.08		76.00%
B12 (µg)	2.4	25	5.20	±1.90[a]	216.67%	4.04	±1.40[a]	168.33%
Folate (µg)	400	25	182.06	±27.18[a]	45.52%	239.08	±31.86[a]	59.77%

[1] Results are expressed as Mean ± SEM.
[2] Values in rows with different superscripts are significantly different (P< 0.05).
[3] Abbreviations: SEM: standard error of mean; CHO: carbohydrate; Rcmd: recommendation.
* The recommended intake of energy and protein (Mechanick *et al.*, 2009; Donadelli *et al.*, 2012), the micronutrients recommended as RDI (Mahan, Escott-Stump & Raymond, 2014).

Table 5. Comparison of the average daily intakes of macronutrients and selected micronutrients after 3 and 6 months postoperatively in the control and the intervention groups (1-3).

V*ariable*	*NO.*	*After 3 months*		*After 6 months*	
		Control group	*Intervention group*	*Control group*	*Intervention group*
		Mean ± SEM	*Mean ± SEM*	*Mean ± SEM*	*Mean ± SEM*
Energy (kcal)	25	868.98 ± 77.32[a]	825.27 ± 57.23[a]	1327.64 ± 87.91[a]	1088.39 ± 56.04[a]
Protein (g)	25	28.28 ± 3.06[a]	30.89 ± 2.24[a]	38.96 ± 3.08 [b]	49.26 ± 2.62[a]
CHO (g)	25	134.25 ± 13.79[a]	123.87 ± 8.93[a]	193.30 ± 12.73[a]	131.09 ± 9.38[b]
Fat (g)	25	24.96 ± 3.17[a]	25.24 ± 2.68[a]	46.39 ± 6.05[a]	40.60 ± 3.07[a]
Ca (mg)	25	378.74 ± 49.27[a]	451.44 ± 59.83[a]	481.69 ± 64.57[a]	581.26 ± 53.42[a]
Fe (mg)	25	6.46 ± 1.00[a]	8.31 ± 1.46[a]	7.83 ± 1.04[b]	12.11 ± 1.56[a]
Zn (mg)	25	3.03 ± 0.34[a]	2.91 ± 0.34[a]	3.83 ± 0.48[b]	5.47 ± 0.73[a]
B12 (µg)	25	6.00 ± 2.60[a]	5.20 ± 1.90[a]	7.36 ± 3.04 [a]	4.04 ± 1.40[a]
Folate (µg)	25	104.91 ± 27.54[a]	182.06 ± 27.18[a]	169.46 ± 24.51[b]	239.08 ± 31.86[a]

[1]Results are expressed as Mean ± SEM.
[2]There were no significant differences in the average daily records of macronutrients and some selected micronutrients between control and intervention groups after 3 months (P≥0.05).
[3]Abbreviations: SEM: standard error of mean; CHO: carbohydrate.

Table 6. Vitamin and mineral supplements used by patients in the control and the intervention groups

Supplements	*Control group*		*Intervention group*	
	No. of patients after 3 months	*No. of patients after 6 months*	*No. of patients after 3 months*	*No. of patients after 6 months*
Calcium (as carbonate)				
Elemental Ca 400mg/day	1	1		
Elemental Ca 200mg/day			1	2
Ferrous (as gluconate)				
Elemental Fe 7mg/day	-		1	1
Elemental Fe 14mg/day		2		
Zinc (as gluconate)				
Elemental Zn 1.4mg/day			1	1
Elemental Zn 3.6mg/day	1	2		2
Elemental Zn 7.2mg/day		1		
Vitamin B12				
1000µg/month	2	1	2	1
50µg/day	1	2		
FeFol□				
5mg/day	1	1	1	2
Centrum□				
1 tablet/day	1	2	1	2
Multivitamin□				
1 tablet/day	2	3	3	3

Fefol: contains folic acid:500µg and ferrous sulfate: 150mg
□ Centrum contains: folic acid:195µg, B12: 1µg, Calcium phosphate dibasic dehydrate:162mg, zinc oxide:5mg, and ferrous fumarate:10mg.
□ Multivitamin contains: Vitamin B1, Vitamin B2, Niacin, Vitamin A, and Vitamin B3

in the intakes of other macronutrients (energy, and fat), and intakes of Ca and B12 between the two groups. The patients in the two groups used vitamin and mineral supplements according to the physician's recommendations depending on serum concentration of vitamins and minerals. These supplements were taken into consideration in calculating the average daily intakes of micronutrients (Table 6).

DISCUSSION

Comparison of the results of this study with other studies conducted in different parts of the world should be done with caution due to many reasons, particularly differences in study design. In addition, there are other factors that should be taken into consideration, such as differences in socio-demographic characteristics, culture, dietary habits, ethnicity, geographical locations, and lifestyle characteristics. Through a literature search, it was found that in Jordan, data on bariatric surgery are very scarce.

In this study, the majority of participants were women, which is consistent with other studies (Coupaye *et al.,* 2014; Soares *et al.,* 2014). This may be related to the fact that obesity is more common in women than in men. In addition, women are more sensitive to being obese and more

dissatisfied with appearance compared to men; consequently they are more likely to seek obesity treatment (Soares *et al.,* 2014). Mean BMI was found to be (48.55±1.47 kg/m^2) for the control group and (48.26±1.44 kg/m^2) for the intervention group before the surgery. The nutritional state is classified as class 3 obesity according to WHO standards (WHO, 2015), and this is in agreement with selection of patients for surgical therapy as an option for treating their obesity (Herber *et al*., 2010; Backman & Earthman, 2013).

When the dietary intakes of macronutrients and selected micronutrients (calcium, iron, zinc, vitamin B12, and zinc) are compared with the results of another study (Moore & Sherman, 2015), we found some differences and similarities between the two studies. They found that after 3 months of bariatric surgery, the daily energy intake was 824±240 Kcal, protein 48±15 g, carbohydrate 79±41g, fat 36±13 g, vitamin B12 3.5±1.9 µg, and folate was 330±260 µg. Looking into the results of our study (Table 5), we found that the intakes of protein, carbohydrate, and vitamin B12 were higher in our study than in the study of Moore & Sherman (2015), whereas the intakes of fat and folate were lower. However, the energy intake of their study was similar to our study with no significant differences in the results between the control and the intervention groups after 3 months post-operatively.

In their study on SG and Roux-en-y gastric bypass (RYGB) patients, Moize *et al*. (2013) followed up their patients for 5 years. At 6 months post-operatively, the results were: energy intake: 1163 ±76.7 Kcal, calcium intake: 741.1 ±53.0 mg, and iron intake 8.4 ±1.7mg. In comparison to the results of our study, energy results were in the range of the two groups (the control and the intervention) in our study, calcium results were higher than in our study, while the iron intake results were nearly similar to those of the control group.

The average daily intakes of all macronutrients and selected micronutrients were increased in the control group after 6 months post-operatively in comparison with 3 months post-operatively due to the increase in energy intake after 6 months (see Table 3). Only the average daily intakes of macronutrients (energy, protein, carbohydrate, and fat) were increased significantly. This is apparently due to the increased intake of high calorie foods such as cereals and fatty foods with time in this group. Increased consumption of these dense calorie foods, in combination with other factors such as eating disorders, and non-compliance with lifestyle modification may have contributed to weight regain after bariatric surgery in the long term (Goritz & Duff, 2014).

The post-operative gradual increases in the intakes of energy and other macronutrients in our results during the study period are consistent with those of other studies (Goritz & Duff, 2014; Mercachita *et al.,* 2014). A higher prevalence of female patients may influence food intake results. Research from clinical practice has shown that women eat less protein and more carbohydrates (Soares *et al.,* 2014).

The relatively high level of vitamin B12 intake in both groups after 3 and 6 months post-operatively could be due to the supplements of vitamin B12 taken in different concentrations by a number of patients after surgery. The number of patients who were on vitamin B12 supplementation was 4 patients out of 25 and 5 patients out of 25 after 3 months and 6 months post-operatively in the control group, respectively. In the intervention group, however, 3 patients out of 25 were taking B12 supplements (Table 6), after 3 and 6 months.

Although we recommended 1200 Kcal diet and 75 g protein for the intervention group, patients in both groups did not reach this energy intake after 3 months of surgery. This is in agreement with the

literature, since energy intake was reported to vary from 500 to 1000 Kcal per day after 3-12 months of surgery. However, after 6 months of surgery, the average level of energy intake was 90.7% of DRI in the intervention group which indicated that the patients were close to the recommended intake (Novais *et al.,* 2012). As energy increased, the protein intake increased. The protein intake was higher in the intervention group than in the control group, although it did not reach the recommended level(75 g/ day) after 6 months of surgery. Inadequate protein intake is reported to be associated with low caloric intake after surgery, due to intolerance to certain food sources such as red meat, cereals, legumes and milk products (Soares *et al*., 2014). This was true in the present study especially in the control group patients.

The average intakes of calcium, iron, zinc and folate were higher in the intervention group than in the control group, apparently due to the counseling that was given to the patients in the intervention group. The average intake of iron was less in the control group probably because of lower intake of protein and its iron-rich sources due to food intolerance specially to red meat, bread, pasta and rice (Bowser, 2012).

To the best of our knowledge, this study is the first in Jordan, and perhaps in the Arab countries, that studied the impact of counseling patients to use an adequate low calorie balanced diet on intakes of energy, macronutrients and selected micronutrients after 3 and 6 months postoperatively. However, this research has two major limitations: follow-up period was relatively short, and this study was carried out in one place in Jordan (The Jordan University Hospital).

CONCLUSIONS

Based on the results of the current study, it can be concluded that there were significant increases in the intakes of protein, iron, zinc, and folate in the intervention group as compared with the control group after 6 months post-operatively. However, patients in the intervention group did not fully apply the nutrition counseling and recommendations given by the researchers partly due to their intolerance to some foods such as bread, rice, pasta, red meat, fruits, etc., and other factors.

It is recommended that nutrition intervention studies on BS patients are conducted over a longer follow-up periods with a larger sample size, and to include other hospitals in Jordan. Also, it is important to provide protein supplements to bariatric surgery patients to increase their protein intake, and to involve dietitians in nutrition counseling of bariatric patients.

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Conflict of interest

There is no conflict of interests among the authors (Seham M Abu Jadayil, Hamed R Takruri, Firas W Obeidat).

REFERENCES

Badran M & Laher I (2011). Obesity in Arabic-speaking countries. *Obesity* 1-9.

Beckman L & Earthman C (2013). Nutritional implications of bariatric surgery and the role of registered dietitians. *J Acad of Nutr Diet* 113(3): 398-399.

Bowser J (2012). Nutritional Intake and Quality of Life after Laparoscopic Sleeve Gastrectomy. Unpublished Master Dissertation, University of Mount Saint Vincent, Halifax, Nova Scotia, Canada.

Brethauer S, Chand B & Schauer P (2006). Risks and benefits of bariatric surgery: Current evidence. *Cleveland Clinic J Med* 73: 1-15.

Coupaye M, Rivière P, Breuil MC, Castel B, Bogard C, Dupré T, Flamant M, Msika S & Ledoux S (2014). Comparison of nutritional status during the first year after sleeve

gastrectomy and Roux-en-Y gastric bypass. *Obes Surg* 24(2): 276-283.

Donadelli SP, Junqueira-Franco MV, De MattosDonadelli C, Augusto Salgado W, Ceneviva R, Marchini J, Dos Santos J & Nonino C (2012). Daily vitamin supplementation and hypovitaminosis after obesity surgery. *Nutrition* 28(4): 391-396

Freire R, Borges M, Alvarez-Leite J & Correia M (2012). Food quality, physical activity, and nutritional follow-up as determinant of weight regain after Roux-en-Y gastric bypass. *Nutrition* 28: 53-58.

Goel R, Agarwal A, Shabbir A, So J, Pasupathy S, Wong A, Cheng A & Lomanto D (2013). Bariatric surgery in Singapore from 2005 to 2009. *Asian J of Surg* 36: 36-39.

Goldenberg L & Sherry J (2015). The Cornell weight loss surgery program: dietary guidelines for laparoscopic sleeve gastrectomy**.** 1-14. Retrieved from *www.cornellweightlosssurgery.org/.../dietary_guidelines*

Goritz T & Duff E (2014). Bariatric surgery: comprehensive strategies for management in primary care. *J Nurse Pract* 10(9): 687-693.

Heber D, Greenway F, Kaplan L, Livingston E, Salvador J & Still C (2010). Endocrine and nutritional management of the post-bariatric surgery patient: an endocrine society clinical practice guidelines. *J Clin Endocrinol Metab* 95(11): 4823-4843.

Hourani H, Naffa S & Fardous T (2011). National commitment to action on social determinants of health in Jordan: addressing obesity. World Conference on Social Determinants of Health, Rio De Janeiro, Brazil 19-21 October, 2011, 1-11.

Karadsheh M, Al-Qudah F & Karadsheh R (2013). The prevalence of overweight and obesity among 12 – 15-year-old males in military affiliated schools in Jordan. *J Roy Med Serv* 20(2): 76-79.

Lee RD & Nieman DC (5th ed) (2010). Nutritional Assessment. McGraw-Hill, New York.

Mahan LK, Escott-Stump S & Raymond JL (2014). Krause's Food & Nutrition Care Process(13th ed). Middle Eastern Edition. Saunders Elsevier, St. Louis, Missouri.

Mechanick J, Kushner R, Sugerman H, Gonzalez-Campoy M, Collazo-Clavell M. Spitz A, Apovian C, Livingston E, Brolin R, Sarwer D, Anderson W & Dixon J (2009). American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic & Bariatric Surgery Medical Guidelines for clinical practice for the preoperative nutritional, metabolic and nonsurgical support of the bariatric patient. *Obesity* 17(1): S1-S70.

Mercachita T, Santos Z, Limão J, Carolino E & Mendes L (2014). Anthropometric evaluation and micronutrients intake in patients submitted to laparoscopic Roux-en-Y gastric bypass with a postoperative period of ≥1 year. *Obes Surg* 24(1): 102-108.

Ministry of Health (2007). Prevalence of Risk Factors of Non-Communicable Diseases in Jordan. Directorate of Disease Control and Prevention. MoH, Amman. Jordan.

Moizé V, Andreu A, Flores L, Torres F, Ibarzabal A, Delgado S, Lacy A, Rodriguez L & Vidal J (2013). Long-term dietary intake and nutritional deficiencies following sleeve gastrectomy or Roux-En-Y gastric bypass in a Mediterranean population. *J Acad Nutr Diet* 113: 400-410.

Moore CE & Sherman V (2015). Effectiveness of B vitamin supplementation following bariatric surgery: rapid increases of serum vitamin B12. *Obes Surg* 25: 694-699.

National Institute of Health (2012). Overweight and Obesity Statistics. Department of Health and Human Services. U.S.

Novais PF, Rasera I, Leite CV, Marin F & De Oliveira M (2012). Food intake in women two years or more after bariatric surgery meets adequate intake requirements. *Nutr Res* 32(5): 335-341.

Schröder H, Covas MI, Marrugat J, Vila J, Pena A, Alcántara M & Masia R (2001). Use of a 3-day estimated food record, a 72-hour

recall and a food-frequency questionnaire for dietary assessment in a Mediterranean Spanish population. *Clin Nutr* 20(5): 429-437.

Shankar P, Boylan M & Sriram K (2010). Micronutrient deficiencies after bariatric surgery. *Nutrition* 26: 1031–1037.

Soares FL, Bissoni de Sousa L, Corradi-Perini C, Ramos da Cruz M. Rosa Nunes M & Branco-Filho A (2014). Food quality in the late post-operative period of bariatric surgery: An evaluation using the bariatric food pyramid. *Obes Surg* 24: 1481-1486.

Thorell A (2011). Clinical Nutrition University: nutritional support after bariatric surgery. *The Europ e-J of Clin Nutr and Metab* 6 (2): e96-e100.

Toh S, Zarshenas N. Nutr.Diet M & Jorgensen J (2009). Prevalence of nutrient deficiencies in bariatric patients. *Nutrition* 25: 1150–1156.

World Health Organization (2015). Global Strategy on Diet, Physical Activity and Health. Obesity and Overweight. WHO Press, Geneva.

Xanthakos S (2009). Nutritional deficiencies in obesity and after bariatric surgery. *Pediatr. Clin. North Am* 56(5): 1105–1121.

Ziegler O, Sirveaux MA, Brunaud L, Reibel N & Quilliot D (2009). Medical follow up after bariatric surgery: nutritional and drug issues general recommendations for the prevention and treatment of nutritional deficiencies. *Diabetes Metabol* 35: 544–557.