

University of Bahrain

College of Science

Department of Biology



Bariatric Surgery in Bahrain: Looking at Weight Loss, Nutritional Related Complications and Adherence to Diet

Thesis submitted in partial fulfillment of the requirements for the degree
of M.Sc. in Nutrition and Dietetics

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Thesis Discussion Committee Decision

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The Discussion Committee met on 18-Jun-19 In *Department of Biology 541-0078* ext.. Upon discussing the student whose details are stated above in public, the discussion committee recommends the following:

The student is awarded a grade A in the thesis subject.

☐ Without making any changes to the thesis.

☒ After making the modifications attached with this decision.

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In accordance with Decision No. 736 2013 dated 14/3 201.
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Abstract

The prevalence of morbid obesity continues to increase and bariatric surgery has proven to be an effective intervention for significant weight loss and enhancing comorbidities related to obesity. However, this type of intervention may carry some negative side effects such as nutritional deficiencies and many other complaints. The current study investigated the prevalence of bariatric surgery in Bahrain with measuring the degree of weight loss, nutrient deficiencies and adherence to diet recommendations. A total of 396 patients were selected from two hospitals participated in this study, however, only 341 patients were eligible to be included. Medical records of patients included in the study were retrospectively reviewed and patients were asked to fill in a questionnaire through a phone interview. Results showed that at time of study, 47.5% were obese, 36.1% were overweight and only 16.4 % were normal and there was a significant effect related to the type of surgery (P value < 0.05) and time since surgery (P value < 0.01) on patients post body mass index (BMI). Type of surgery had no significant effect on % excess weight loss (EWL) or % total weight loss (TWL), whereas time since surgery affected both %EWL and % TWL significantly with P values of 0.006 and 0.001 respectively.

Patient's nutritional indicator status regardless the type or time of surgery showed that the majority of patients had normal levels of the reviewed nutritional indicators except for hemoglobin, hematocrit, mean corpuscular volume (MCV), 25 OH vitamin D, ferritin and iron. About half of patients were deficient in iron, MCV and hemoglobin with a frequency of 48.5 %, 47.1 % and 46.8 % respectively. For 25 OH vitamin D, 40 % had insufficient levels and 41.2 % were deficient, and that 38 % of patients were deficient in ferritin. The most common complaints that patients reported were: 59.5% hair loss, 39.3% flatulence, 34.3% dry skin, 33.2 gastro-esophageal reflux disease (GERD), 27.3% constipation, 26.9% low appetite and 26.7% anemia. There was a significant difference among surgery types for constipation, diarrhea, flatulence, anemia, hypoglycemia, Cholelithiasis and fatigue (P value ≤ 0.05). Patient's adherence to dietary recommendations was high to moderate. In accordance, 49.6% of the patients were following with a dietitian whereas 59.1% attributed their non-following that it was not important to the fact that it was not important to do so.

It can be concluded that although bariatric surgery is an effective intervention in obesity treatment and improve obesity-related co-morbidities, it carries some complications such as weight regain, nutrient deficiencies and other complaints. However, these complications could be controlled and managed through post-operative dietary and life style recommendations.

Dedication

This thesis work is dedicated to my husband who has been a constant source of support and encouragement during the challenges of study and life. I am truly grateful for having him in my life. This work is also dedicated to my parents, who first taught me the value of education.

To my kids Khalid, Dalal, Shaika and Mohamed who I sacrificed my time with them to make this work exist.

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List of Abbreviations

AACE	American Association of Clinical Endocrinologists
AGB	Adjustable Gastric Band
ANCOVA	Analysis of Covariance
ASMBS	American Society for Metabolic and Bariatric Surgery
BMD	Bone Mineral Density
BMI	Body Mass Index
BPD	Biliopancreatic Diversion
BPD-DS	Biliopancreatic Diversion with Duodenal Switch
DEXA	Dual Energy X-ray Absorptiometry
EWL	Excess Weight Loss
GBP	Gastric Bypass
GERD	Gastro - Esophageal Reflux Disease
Hb	Hemoglobin
HbA1c	Hemoglobin A1c
HDL	High Density Lipoprotein
IFSO	International Federation for the Surgery of Obesity
KHUH	King Hamad University Hospital
LAGB	Laparoscopic Adjustable Gastric Band
LDL	Low Density Lipoprotein
LSG	Laparoscopic Sleeve Gastrectomy
MCV	Mean Corpuscular Volume
MGB	Mini Gastric Bypass
RYGB	Roux en Y Gastric Bypass
SG	Sleeve Gastrectomy
SMC	Salmania Medical Complex
SOS	Swedish Obese Subjects

List of Abbreviations

TOS	The Obesity Society
TWL	Total Weight Loss
WHO	World Health Organization

List of Appendices

Appendix (1)	Questionnaire in English
Appendix (2)	Questionnaire in Arabic
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Appendix (5)	Secondary Health Care Research Sub Committee

Chapter One

Introduction to the Study

1.1 Introduction

1.2 Research Problem

1.3 Research Questions

1.4 Research Objectives

1.5 Research Significance

1.6 The Study's Setting

1.7 Research Terminology

Introduction to the Study

1.1 Introduction

Obesity nowadays is one of the most prevalent problems in both developing and developed countries and has become an epidemic. This problem was doubled in the world between the years 1980 and 2016; about 13% of the adults in the world were considered as obese in 2014 (World Health Organization [WHO], 2018). According to the World Health Organization (WHO), obesity is defined as accumulation of excessive fat in the body that could affect the health negatively by increasing the risk of having type 2 diabetes, cardiovascular diseases, coronary artery disease, hypertension, dyslipidemia and obstructive sleep apnea (Sugerman, 2008; Jensen et al., 2014). Body mass index (BMI) is a measure that could indicate the nutritional status in adults and it has 4 classes. A BMI between 18.5 and 25 kg/m² indicates a normal weight, while BMI of less than 18.5 kg/m² is considered underweight. A BMI between 25 kg/m² and 29.9 kg/m² is considered overweight. A BMI of 30 kg/m² or higher is considered obese (WHO, 2018).

In Bahrain, the National Nutritional Survey conducted in 2002 by the Ministry of Health showed that 23.3% of males and 32.3% of females were obese. In addition, the nutritional surveillance conducted in 2007 showed that prevalence of obesity is 34.1% and 40.3% among males and females, respectively (Ministry of Health, Bahrain 2009). These numbers prompted Bahrain Government represented by the Ministry of Health to establish obesity clinics in 2008. These clinics offered the consultations in changing lifestyle and motivation to lose weight (WHO, 2014).

Treatment of obesity could be managed with several strategies such as diet, exercise, medication and finally bariatric surgery.

Currently bariatric surgery is considered the most effective treatment of morbidity and mortality in morbid obese patients ($\text{BMI} \geq 40$) (Sjostrom et al., 2007; Sjostrom et al., 2013; Weiner et al., 2014).

Bariatric is a term that is composed of the word “bar,” which means weight or pressure ; “iat,” which means treatment; and “ic,” which is pertaining to, hence it can be translated literally to “pertaining to the treatment of weight (Patel et al., 2017)

Eligible persons for the surgery should have a $\text{BMI} > 40$ or a BMI between 35 and 40 suffering from obesity- related diseases such as diabetes, hypertension or cardiovascular diseases, according to the 1991 consensus guidelines from the National Institutes of Health (Brethauer et al, 2006). Range of age of candidates is between 18-60, however, it could be performed on adolescents in some cases.

The main outcome of bariatric surgery is weight loss which can be expressed by the percentage of excess weight lost. Buchwald et al (2004) conducted a meta-analysis stating that the percentage of weight loss for all the bariatric procedures combined was 61%, and that Biliopancreatic Diversion (BD) recorded the highest percentage of 70 %. Weight loss in Roux-en-Y Gastric Bypass (RYGB) procedure ranges from 68% - 80% and this weight loss has been recorded for up to 14 years (Pories et al., 1995; DeMaria et al., 2002; Papasavas et al., 2002). Other outcome is the improvement of obesity – related comorbidities, such as enhancement of glycemic profile due to improved insulin sensitivity resulted from weight loss with different degree of improvement according to the type of the procedure (Schauer et al., 2004; Pournaras et al., 2010). Cottam et al (2006) reported that after three years post-surgery, hypertension had been resolved by 56% and 81% for Adjustable Gastric Band (AGB) and RYGB, respectively. It can also reduce the risk of cardiovascular

diseases by 82% by decreasing low density lipoprotein (LDL) and increasing high density lipoprotein (HDL). The risk of cancer also was reduced by 76%, reduction in infectious diseases by 77% and 65% reduction for endocrinological diseases (Christou et al., 2004).

On the other hand, patients of bariatric surgeries suffer from many dietary related complaints such as nausea, vomiting, constipation, diarrhea, regurgitation (applies only in AGB), dumping syndrome (not common after AGB) and decreases appetite (Shanon et al., 2013). In addition, 5 to 10% of patients could have respiratory failure, bleeding, gastrointestinal leak, pulmonary embolism and stomal obstruction (Sarwar et al., 2009). Depending on the type of procedure, the alteration in eating behavior, meal pattern and gastrointestinal modifications in anatomy and physiology cause significant protein and micronutrient deficiencies in thiamin (vitamin B1), cobalamin (vitamin B12), folate, calcium and vitamin D (Mechanisk et al., 2013). Nutrient deficiency could also result from the patients non- adherence to minerals and vitamins supplementation that are needed in high doses lifelong (Schweiger et al., 2009; Nicoletti et al., 2013).

1.2 Research Problem

Obesity is growing with a steep increase all over the world causing many comorbidities leading to health consequences, an economic impact on the health care systems and a decreasing quality of life. Obesity could be treated in different ways including diet, physical activity, behavioral therapy and medications, however, bariatric surgery resulted in greater weight loss compared to those ways (Jensen et al., 2014, Beaulac & Sandre, 2016). Bariatric surgery is an option and the most effective

solution for morbidly obese persons who have failed to reduce weight through previously mentioned interventions. Although it is associated with significant weight loss and resolution of comorbidities, it has many side effects that should be addressed with the patient prior to surgery.

1.3 Research Questions

The study is designed to answer the following questions:

1. What is the percentage of weight loss among patients undergoing bariatric surgery in Bahrain?
2. According to the patient's biochemical tests, are there any nutritional deficiencies among patients? And what are the most prevalent?
3. Is there a relationship between nutritional deficiencies, amount of weight loss and the type of the procedure?
4. Is there any effect of predictors such as age, gender and time since surgery on nutritional complications?
5. What is the degree of adherence of bariatric patient to the long term recommended diet?

1.4 Research Objectives

1. To determine the prevalence of bariatric surgery procedures in Bahrain.
2. To measure the effectiveness of bariatric surgery in reducing weight by comparing the weight pre and post-surgery in Bahrain.
3. To determine the prevalence of post-surgery nutritional complications and their relationship with the type of surgery.

4. To measure the adherence of patients to the recommended diet.

1.5 Research Significance

Bariatric surgery is one solution for treating obesity when other solutions failed for selected patients with BMI ≥ 40 or ≥ 35 and with comorbidities. Within the first two years, an average of excess weight loss of 50-75% could be achieved (Colquitt et al., 2014). There are many studies discussing the complications of bariatric surgery and nutrient deficiencies, however no study was done in Bahrain describing these complications and the prevalence of this type of obesity treatment in main hospitals. In addition, no study was conducted regarding the patient's post-surgery diet adherence. The current study aimed to assess the prevalence of bariatric surgery in Bahrain with measuring the degree of weight loss, nutrient deficiencies and adherence to diet recommendations.

1.6 The Study's Setting

The study was conducted on patients admitted to bariatric surgery at King Hamad University Hospital (KHUH) and Salmania Medical Complex (SMC). Data were collected during the period from March to September 2018.

1.7 Research Terminology

Dyslipidemia: elevated levels of total cholesterol or (LDL), or low levels of (HDL) that is a risk factor for coronary heart disease and stroke (Fodor, 2010).

Body mass index: is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in

adults. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2) (WHO, 2018).

Laparoscopic Adjustable Gastric Banding (LAGB): surgical means of producing weight loss to restrict stomach size by placing a 5cm band around part of the stomach separating it into two pouches (Beitner & Kurian, 2012).

Laparoscopic Sleeve Gastrectomy (LSG): 70% - 80% of the stomach is removed creating a narrow gastric tube (DeBruyne et al., 2016).

Biliopancreatic Diversion with Duodenal Switch (BPD-DS): removing a large portion of the stomach and attaching the duodenum to the end of the intestine, closing off the middle portion (Laddu et al., 2011).

Roux-en-Y Gastric Bypass (RYGB): a small pouch is created at the top of the stomach, the middle segment of the small intestine (jejunum) is then connected to the pouch to bypass most of the stomach (Laddu et al., 2011).

Dumping syndrome: a cluster of symptoms that result from the rapid emptying of an osmotic load from the stomach into the small intestine (DeBruyne et al., 2016).

Pulmonary embolism: a blockage of an artery in the lung caused usually by a blood clot happened in an artery in the legs and traveled to the lungs (NHLBI, 2011).

Chapter Two

Theoretical Framework and Literature Review

2.1 Bariatric surgery types

2.2 Weight loss in post-operative bariatric patients

2.3 Nutritional Complications

2.3.1 Gastrointestinal complications

2.3.2 Nutritional deficiencies

2.4 Adherence to post-operative dietary and lifestyle
recommendations

Theoretical Framework and Literature review

2.1 Bariatric Surgery Categories

Bariatric surgery procedures are divided into three categories (Elder and Wolfe, 2007):

1. **Restrictive:** the concept is reducing the stomach capacity and inducing early satiety hence decreasing food intake; for example: (LAGB) and (LSG).
2. **Malabsorptive:** by reducing nutrient absorption, mainly impairment of fat absorption because a significant part of the intestine will be bypassed. For example, biliopancreatic diversion (BPD) with or without duodenal switch (DS).
3. **Combination of restrictive and malabsorptive:** by integrating restriction procedure with altered absorption such as: (RYGB).

Worldwide, the most three used bariatric surgeries are SG, MGB and RYGB (International Federation for the Surgery of Obesity [IFSO], 2018), figures 1-3 illustrate more detailed steps about these procedures.

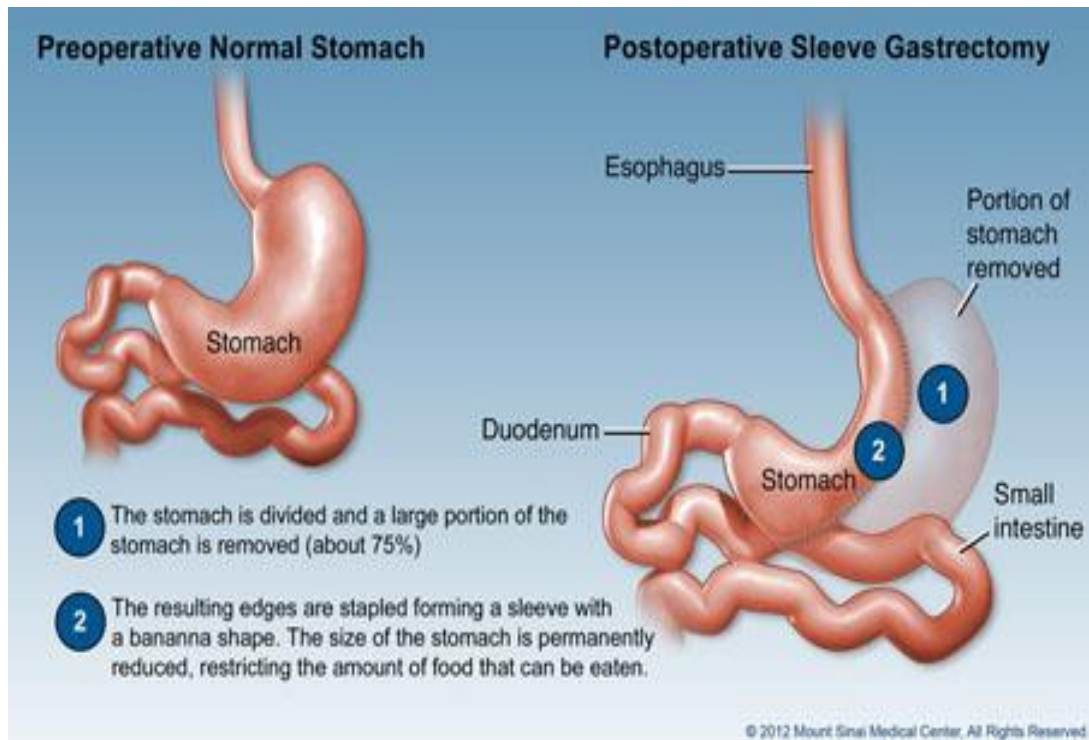


Fig. 1: Anatomy-based of sleeve gastrectomy (SG) (Mount Sinai Health System, 2012)

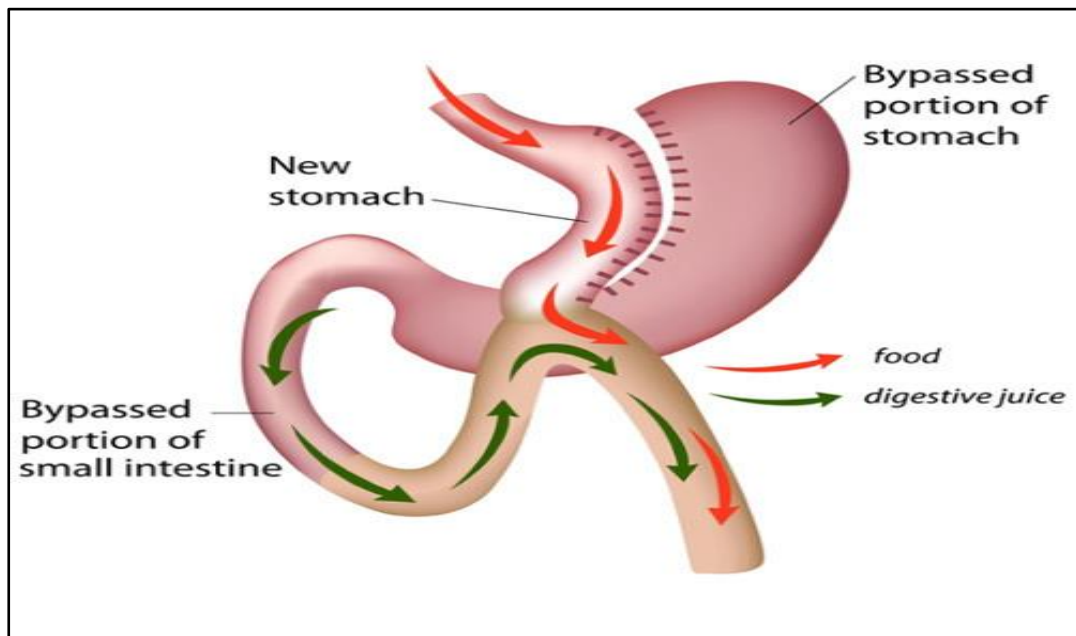


Fig. 2: Anatomy-based of mini gastric bypass (MGB) (Froehle et al., 2014)

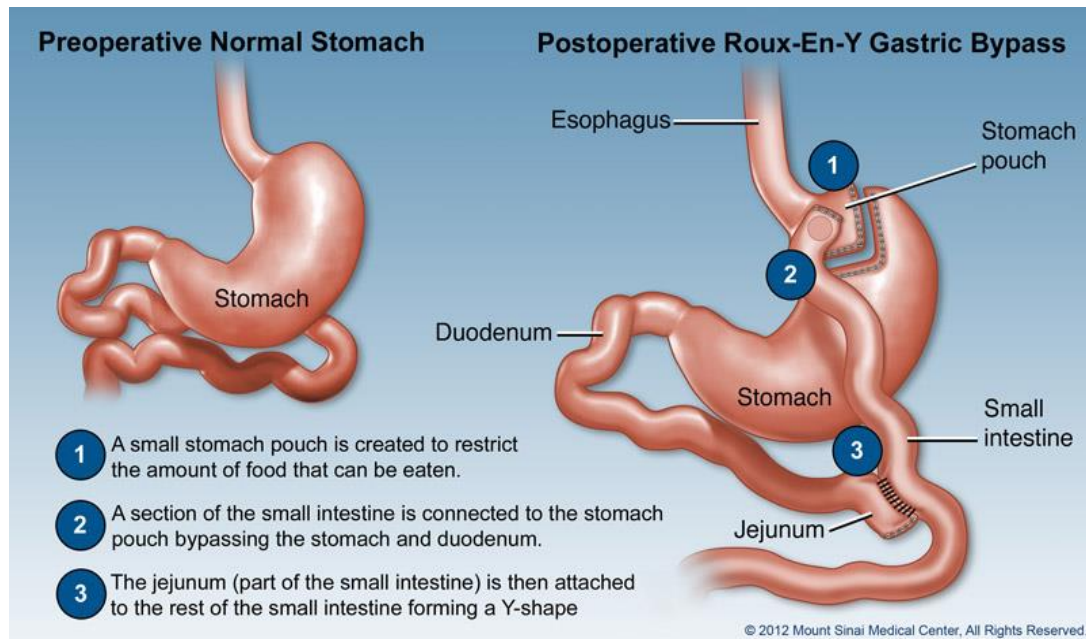


Fig. 3: Anatomy-based of Roux en-Y gastric bypass (Mount Sinai Health System, 2012)

2.2 Weight Loss in Post-Operative Bariatric Patients

Weight loss and accompanied resolution of obesity related diseases are the first targets of bariatric surgery outcomes. Despite other interventions for addressing obesity, observational studies and short term randomized controlled trials showed that surgical procedure appears to be the most effective for long-term weight loss management regardless of the type of surgery (Adams et al., 2012; Gloy et al., 2013; Sjostrom L, 2013; Beaulac & Sandre, 2016). As mentioned earlier, bariatric surgery attributed to weight loss through restricting food intake, food malabsorption or a combination of both.

Several studies evaluated the efficacy of this surgery by determining the percentage of reduction in weight in post-operative bariatric patients. Studies showed that amount of excess weight loss depends on the type of

procedure performed. AGB showed the lowest weight loss percentage compared to RYGB and SG. Chang et al. (2014) conducted a systematic review and meta-analysis that evaluate the effectiveness and risks of bariatric surgery during the period 2003-2013. This review included 164 studies concluded that AGB had the lowest percentage of weight loss in comparison to SG and gastric bypass.

In Bahrain, there are few published studies that evaluate bariatric surgery and its efficacy. Al Khalifa et al. (2013) conducted a five-year longitudinal study of 143 obese patients who had undergone laparoscopic adjustable gastric banding in Bahrain Defense Force hospital. The patients recruited in the study reported after 60 months of follow up an average BMI of 30.76 and 36.61 for men and women respectively, which means that both BMIs still in the obese category. This result approved that AGB is not effective in reducing weight.

Another study was done by Saeed et al. (2015) at King Hamad University hospital and was aimed to assess the outcomes of SG, MGB and BPD. It showed that weight loss percentage 12 months post-operative was 57.7% for MGB, 64% for BPD and 44% for SG. These findings are compatible with several other studies (Buchwald et al., 2004; Sjöström et al., 2013; Courcoulas et al., 2013; Chang et al., 2014 and Pedroso et al., 2018). Long-term effects of surgery remain unclear since most studies followed participants for a maximum of three years (Colquitt et al., 2014).

Weight regain is one complication that may face bariatric patients. The incidence of this problem largely depends on procedure type, length of follow up and the criteria of defining weight regain (Lupoli et al., 2017). The largest weight regain was shown in AGB with a percentage of 35%-40% of the weight lost (Sjöström et al., 2007; DiGiorgi et al., 2012) while in RYGB weight regain varies from 7-50 % (Magro et al., 2008). A

recent review conducted by Lauti et al. in 2016 that discussed weight regain in SG patients revealed that regain rates ranged from 5.7% at 2 years to 75.6% at 6 years. However, more long term studies need to be conducted on SG due to its relative novelty as a stand-alone procedure compared to other procedures.

Weight loss due to surgical intervention resulted in resolution of obesity related comorbidities such as type 2 diabetes, hypertension and dyslipidemia. Courcoulas et al. (2013) assessed the outcomes of bariatric surgery (AGB & RYGB) after three years post-operative on 2458 participants in a longitudinal study at ten hospitals in the United States. The study concluded that 67.5% of diabetic patients undergone RYGB and 28.6% undergone AGB had partial remission of diabetes at three years. Moreover, 61.9% of RYGB participants and 27.1% of AGB had dyslipidemia resolution, while hypertension resolution occurred in 38.2% of RYGB and 17.4% in AGB participants. These findings are consistent with two studies conducted in Bahrain, in which patients showed improvements in diabetes, hypertension, hyperlipidemia and sleep apnea (Al Khalifa et al., 2013; Saeed et al., 2015). A recent study published in 2018 by Al Khalifa et al., examined the short- and midterm outcomes of 59 SG patients with type 2 diabetes or impaired glucose tolerance at Bahrain Defense Force Hospital who underwent the surgery during the period 2011 - 2014. It showed that 88.14% of the participants (diabetic and prediabetic) accomplished a complete resolution of diabetes and achieved a normal HbA1C and blood glucose levels.

2.3 Nutritional Complications

Bariatric surgery, like other surgeries, carries some complications and may affect the quality of life.

2.3.1 Gastrointestinal Complications

Alteration caused by surgery to the upper gastrointestinal anatomy as described previously associated with long term nutritional consequences. The type of the surgery whether restrictive, malabsorptive or both determines the type of complications. Gastrointestinal complains in the first year post- operatively differs than those in the longer term since diet and weight are not stable in the first year. Most studies that investigated the gastrointestinal symptoms for more than 12 months after surgery tend to have some limitations such as small sample size and loss of follow up which may cause underestimation of these complains (Boerlage et al., 2016). The followings represent the most prevalent complications:

Nausea and vomiting are the most common complaints reported by patients, in particular in the first 8 weeks after SG and RYGB. These problems need to be addressed since it may cause thiamin deficiency, dehydration and fluid and electrolyte imbalance. Furthermore, anastomic stricture that may occur following SG or RYGB could result in vomiting; previously 10%, nowadays 2% of patients with a good anastomosis (Shanon et al., 2013). In a retrospective study by Goldenshluger et al. (2017) to evaluate gastrointestinal symptoms of patients after LSG found that postoperative GI symptoms occurred relatively in a high rate in the late term and that 25% of the subjects suffer from vomiting. Usually, long term nausea and vomiting occur after SG and RYGB when the patient exceeds the stomach capacity and overfeeds so the patient should reduce the total volume consumed in a single meal. In addition, it is suggested

that patient should not eat and drink at the same time and be reminded to eat slowly and chew well (Mechanick et al., 2013).

Dumping syndrome is characterized by a cluster of symptoms due to rapid gastric emptying from the stomach to the small intestine. It is mainly reported in patients who underwent SG and RYGB and not common after AGB (Shanon et al., 2013; Tack & Deloose 2014). After surgery, the rate of gastric emptying controlled by the pyloric sphincter is no longer regulated and the stomach's hyperosmolar nutrients rush into the small bowel more quickly after meals, causing a number of unpleasant symptoms that can be divided into "early" and "late" symptoms (DeBruyne et al., 2016).

Early symptoms can occur within 30 minutes and characterized by nausea, vomiting, abdominal pain, rapid heartbeat, lightheadedness and diarrhea. These symptoms reflect the release of gastrointestinal hormones due to the fluid shift from the blood stream to the intestinal lumen. Late symptoms may begin one to three hours after eating and are similar to that of hypoglycemia (Confusion, Headache, dizziness, hunger, palpitations sweating, weakness and feeling faint) (Tack & Deloose 2014; DeBruyne et al., 2016). In a prospective clinical study conducted by Papamargaritis et al. (2012) that evaluated the presence, incidence and severity of dumping syndrome via oral glucose administration to LSG patients before and six weeks after the surgery. Results showed that 29% of patients showed dumping or other symptoms similar to dumping syndrome.

Gastro-esophageal reflux disease (GERD) is a medical condition characterized by the reflux of the stomach acid content to the esophagus causing what people call "heartburn". Obesity is one risk factor that cause GERD due to increased pressure inside the stomach (DeBruyne et al.,

2016). According to data from large databases showed that bariatric surgery particularly GBP can improve the symptoms of GERD, other studies showed that bariatric surgery can induce GERD in some patients, especially in LSG patients (ElHadi et al., 2014; Tutuian, 2014; Goldenshluger et al., 2017). In a review conducted by Ma & Madura in 2015 that compared the gastrointestinal complications after four types of bariatric surgery; LSG, RYGB, AGB & BPD showed that patients who underwent AGB, GERD symptoms tripled from 13% to 39% while 23% of LSG patients reported post-surgery GERD.

2.3.2 Nutritional Deficiencies

Absorption of nutrients takes place mainly in the small intestine (duodenum, jejunum and ileum) with the greatest absorption in the middle portion of the intestine (Gropper et al., 2018). For the macronutrients, fats are absorbed in the jejunum, carbohydrates in the duodenum and jejunum and proteins are absorbed in the jejunum and upper ileum. For micronutrients, water soluble vitamins are absorbed in the jejunum and upper ileum (except for B12 which is absorbed in the lower ileum) while fat soluble vitamins are absorbed mostly in the lower duodenum and upper jejunum. Minerals such as calcium, iron, and magnesium are predominantly absorbed in the duodenum (Gropper et al., 2018). Therefore, any loss of function of any part of the intestine will influence the absorption of nutrients.

Bariatric procedures cause alteration in absorption and digestion of nutrients which can lead eventually to risky nutrient deficiency. However, patients may have vitamin and mineral deficiencies pre-operatively by which the surgery can exacerbate this problem. Surgery could also induce

new problems depending on the type of procedure, the degree of patient's adherence to supplements and dietary recommendations and meal patterns (Xanthakos, 2009; Al-Mutawa et al., 2018). Malabsorptive procedures compromise mostly for nutrient deficiencies due to bypassing some segments of the gastrointestinal tract, although deficiency can occur in restrictive procedures due to reduced food intake and nutrient dense foods intolerance (Bloomberg et al., 2005; Stein et al., 2014). Studies showed that the most prevalent deficiencies are iron, calcium, folate, vitamin B12, vitamin B1 and fat soluble vitamins (A, D, E, and K) and protein. (Stein et al., 2014; Aron-Wisnewsky et al., 2016; Lupoli et al., 2017). These specific nutrient deficiencies are discussed in detail below.

Proteins deficiency or malnutrition can be recognized through the clinical symptoms of excessive weight loss, edema, hair loss and low albumin serum level (< 3.5 g/dL). It occurs due to bypassing segments of the small intestine where proteins are primarily absorbed, food limitation, intolerances of high protein foods like red meat, loss of gastric acidity, dumping syndrome and bacterial overgrowth (Lupoli et al., 2017; Stroth et al., 2017; Still et al., 2018). Aron- Wisnewsky et al. (2016) compared the nutritional and protein deficiency in 22 obese women who underwent GBP or AGB at three timelines: baseline, 1 month and 3 months. Serum prealbumin test showed continuous decline which indicate mild protein depletion in 57% of gastric bypass patients and 63% of AGB patients. To prevent protein malnutrition, it is recommended to consume a minimum of 60 g/day (Mechanick et al., 2013).

Calcium and 25-OH vitamin D deficiencies appear to occur very early post-operatively, although many studies showed that 25-OH vitamin D deficiency is the most micronutrient deficiency found in bariatric

candidates pre-operatively and around 60-90% of obese subjects had low levels of calcium, 25-OH vitamin D and parathyroid hormone (Fujioka et al., 2011; Stein et al., 2014; Stroth et al., 2017; Al-Mutawa et al., 2018). In LSG procedures, due to the exclusion of most of the stomach, the acid will be reduced which in turn will reduce the calcium solubility (Lo Menzo et al., 2014). Epidemiologic studies have shown an increased risk of bone fracture after bariatric surgery. In particular, BPD and RYGB since SG considered as a newer procedure and its skeletal effects have not yet been well defined (Gagnon & Schafer, 2018). A very recent systematic review and meta-analysis conducted by Ablett et al in 2019 to measure the fracture outcomes of bariatric surgery and lifestyle weight management programs. Significant increased fracture risk was shown in 4 out of 6 observational studies of bariatric surgery. Six randomized clinical trials of weight management programs with 6214 participants revealed no clear effect on any type of fracture. However, one trial with a follow-up of 11.3 years showed an increased risk of frailty fracture. According to the American Association of Clinical Endocrinologists, The Obesity Society and American Society for Metabolic and Bariatric Surgery (AACE/TOS/ASMBS) patients who undergone combined procedures should monitor the bone mineral density (BMD) before and two years post-surgery, whereas restrictive surgeries patients can monitor BMD after 2 years post-surgery only (Mechanick et al., 2013; Parrott et al., 2017). For prevention of both, a daily dose of 2000 mg of calcium citrate and 400 IU of vitamin D is recommended (Stroth et al., 2017).

Iron deficiency and subsequent anemia, can be developed in all bariatric surgery types. Alexandrou et al. (2014) reported that SG and RYGB develop iron deficiency expressed by low serum ferritin in the same rate after 5 years post-surgery with a percentage of 30%. Prevalence of iron

deficiency reported in a recent review by Parrott et al. (2017) from 3 months to 10 years is as the following: 14% in AGB, 18% in SG, 20-55% in RYGB and 13-62% in BPD. Reasons behind this deficiency could be due to bypass of the duodenum and proximal jejunum where the iron is absorbed, inability of the GI tract to reduce Fe^{3+} into the more absorbable Fe^{2+} , reduced gastric acid and intolerance of iron rich food (Bloomberg et al., 2005; Handzlik-Orlik et al., 2014; Still et al., 2018). In one study that evaluated the nutrient deficiencies before and after sleeve gastrectomy in 407 patients found that 5% of participants were anemic preoperatively and increased to 6% one year post-operatively (Van Rutte et al., 2014). ASMBS recommend to take at least 18 mg of iron from multivitamin for patients that are at low risk.

Vitamin B12 and folate deficiency are often evaluated together. Parietal cells in the stomach secrete intrinsic factor (IF) that binds to vitamin B12 and then transported to ileum to be absorbed. Vitamin B12 develops mainly due to hypochlorhydria (abnormally low gastric acid secretions), inadequate mixing with IF and reduced consumption. Vitamin B12 deficiency can lead to pernicious anemia (Fujioka et al., 2011). It is difficult to determine the true incidence of vitamin B12 deficiency because of differences in laboratory methods and this reflects the inconsistency in the results got in many studies. For example, Bloomberg et al. (2005) and Stein et al. (2014) reported in a review that vitamin B12 occur in malabsorptive but not restricted procedures while other studies showed SG procedures causes vitamin B12 deficiency as well as RYGB but in a lower rate (Van Rutte et al., 2014; Parrott et al., 2017; Patel et al., 2017). Deficiency in vitamin B12 can be prevented with supplementation, and ASMBS recommended that all bariatric patients should take it (Parrot et al., 2017). It is recommended to take the vitamin

oral or sublingual 500µg/day or intramuscular 1000µg/ month. Folate (folic acid/ vitamin B9) is well absorbed in the small intestine with adequate food intake, and folate deficiency occurs due to poor dietary intake and non-adherence with multivitamin supplements rather than malabsorption (Fujioka et al., 2011; Stein et al., 2014; Parrot et al., 2017). Prevalence of folate deficiency is reported to be 65% post-surgery. However, Weng et al. (2015) conducted a systematic review and meta-analysis on six prospective and nine retrospective studies with a total of 5909 patients that investigate anemia and related nutrient deficiency after RYGB concluded that surgery increases the risk of anemia and vitamin B12 deficiency but not folate. Postoperatively, it is recommended to take 400–800 mg oral folate daily from prescribed multivitamin and women of childbearing age should take 800–1000 mg daily (Parrot et al., 2017).

2.4 Adherence to Post-Operative Dietary and Lifestyle Recommendations

Adherence to the post-surgery dietary recommendations is a major contributor to the post-operative outcomes of this type of weight loss intervention. Dietary non-compliance is associated with weight regain and aggravate the nutrients deficiencies post-operatively. Researches showed that rates of adherence or compliance decreased significantly with time, recording maximum adherence at pre-surgery and immediately after surgery (Story, 2017).

Sarwer et al. (2008) carried out a prospective investigation on 200 gastric bypass patients that measured weight loss, macronutrient intake, dietary adherence and eating behavior both pre-operatively and post-operatively at 20, 40, 60 and 92 months. The study found that patients with high adherence scores lost 4.5% more weight at week 92 than those with low

adherence scores. Moreover, the authors found that both caloric intake and sweet/desserts consumption increased over time. Sjostrom et al. (2004) reported approximate daily intake of 2900 kcal before surgery that declined to 1500 kcal six months post-surgery and steadily increased to 2000 kcal by four to ten years after surgery.

Another recent prospective cohort study was on 100 SG patients with 12 months follow-up. This study measured anthropometrics, biochemical tests, food intake, food tolerance, common surgery-related side effects, physical activity (PA), supplementations, and number of follow-up meetings with a dietitian (Sherf Dagan et al., 2017a). In this study, authors found that patients in their first year post-operatively had high to medium adherence to the recommended dietary and life style recommendation and their attrition to the recommended supplementation was reflected on their better micronutrient status during the first year after surgery.

Monitoring patients post-operatively through the follow up visits, can be used to assess the weight loss as well as to measure their dietary adherence and eating behavior. However, studies reported missed appointments among bariatric patients ranges between 65-72 % (Toussi et al., 2009; Khorgami et al., 2015).

Daily supplementation is necessary for long term requirement after bariatric surgery to reduce as much as possible the incidence of nutrient deficiencies occurred post-operatively. Unfortunately, bariatric population recorded low rates of adherence to supplements, Agaba et al. (2015) investigated bariatric patients compliance with post-gastric bypass vitamin therapy and found that only 25% of the patients taking all recommended supplements while 10% reported not taking supplements at all. Many patients have pre-existing poor dietary habits pre-surgery, so they have to be advised to change these behaviors that may result in

weight regain and increase surgery side-effects. Patients after surgery are encouraged to establish eating behaviors that are compatible with their new situation. These behaviors include cut food into small pieces, eat 4-6 nutritious meals and avoid skipping meals, consume small portions only, eat slowly and chew well, avoid eating and drinking at the same time and engage in a physical activity to lose weight while keeping lean tissue. Moreover, high calories dense foods should be reduced to very limited amounts, and minimal protein intake should be at least 60 g/day (Mechanick et al., 2013; Shanon et al., 2013). Here comes the role of the registered dietitian who's responsible to educate patients how to obtain all nutrients required to maintain good health and ideal weight for long term success of bariatric surgery (Story, 2017).

Overall, from the above literature reviews, it has been shown that RYGB was the most procedure that had been studied extensively compared to other procedures since it was the gold standard procedure worldwide. Most of studies had a minimum follow-up duration of 12 months while long term studies are few which may affect the evaluation of the surgery outcomes. Regarding weight loss post-operatively, many studies followed participants for 24 -36 months, therefore the long term effects of surgery remain unclear. The most famous long-term study is the Swedish obese subjects (SOS) which started in 1987 and involved 2010 patients who underwent bariatric surgery (LAGB & GBP) and follow up reports varied from 10-20 years. The study revealed that patients who undergone both procedures began to regain weight between the first and second year post operatively (Sjöström et al., 2004; Sjöström et al., 2007). After 10 years, about 10% of patients who underwent GBP and 25% who underwent LAGB failed to maintain at least 5% reduction in their initial weight. When it comes to the post-surgery nutrient deficiencies, the

documentation about it has become more prevalent over the past few years. Although, this topic deserves a closer look especially following the more recent procedures such as SG in which related studies are limited in comparison with other procedures. Studies showed that there are discrepancies to what extent could SG cause micronutrient deficiencies. Adherence to post-operative dietary recommendations is a corner stone to succeed the aim of the surgery. However, this topic have received only a modest amount of research attention to date and additional studies on short and long term are needed to clarify more it's impact on the surgery outcomes (Sherf Dagan et al., 2017a).

This study hypothesizes that bariatric patients who failed to reduce their weight through dietary and behavioral weight management treatment, may benefit from this type of intervention in reducing weight and related comorbidities. However, despite the overall positive outcomes of bariatric surgery, most patients exposed to nutritional complications caused by the alteration of the physiology of the gastrointestinal tract represented in gastrointestinal complains and micronutrient deficiencies. In addition, researches showed that bariatric surgery is tightly related to a risk of nutritional deficiencies that may already present pre-surgery but worsened by the surgical procedure. Moreover, studies showed that patients may experience weight regain in the long term. Studies have suggested that suboptimal weight loss and other unwanted outcomes (e.g., vomiting, malnutrition and dumping) are often due to poor adherence to the postoperative diet and lifestyle recommendations and/or a shift to maladaptive eating behaviors. Thus, it is very important to sustain the improvements in dietary intake and eating behaviors to get a long term success after the surgery.

Chapter Three

Methods and Procedures

3.1 Methodology Used

3.2 Study Population

3.3 Research Tools

3.4 Data Collection/Procedures

3.5 Statistical Methods

Methods and Procedures

3.1 Methodology Used

An observational study was conducted during the period March-September 2018 at (KHUH) and (SMC). Permission to conduct the study was obtained from the research and ethics committees from both hospitals. The study population consisted of all patients who underwent bariatric surgery in the past 6 years (2012-2017).

3.2 Study Population

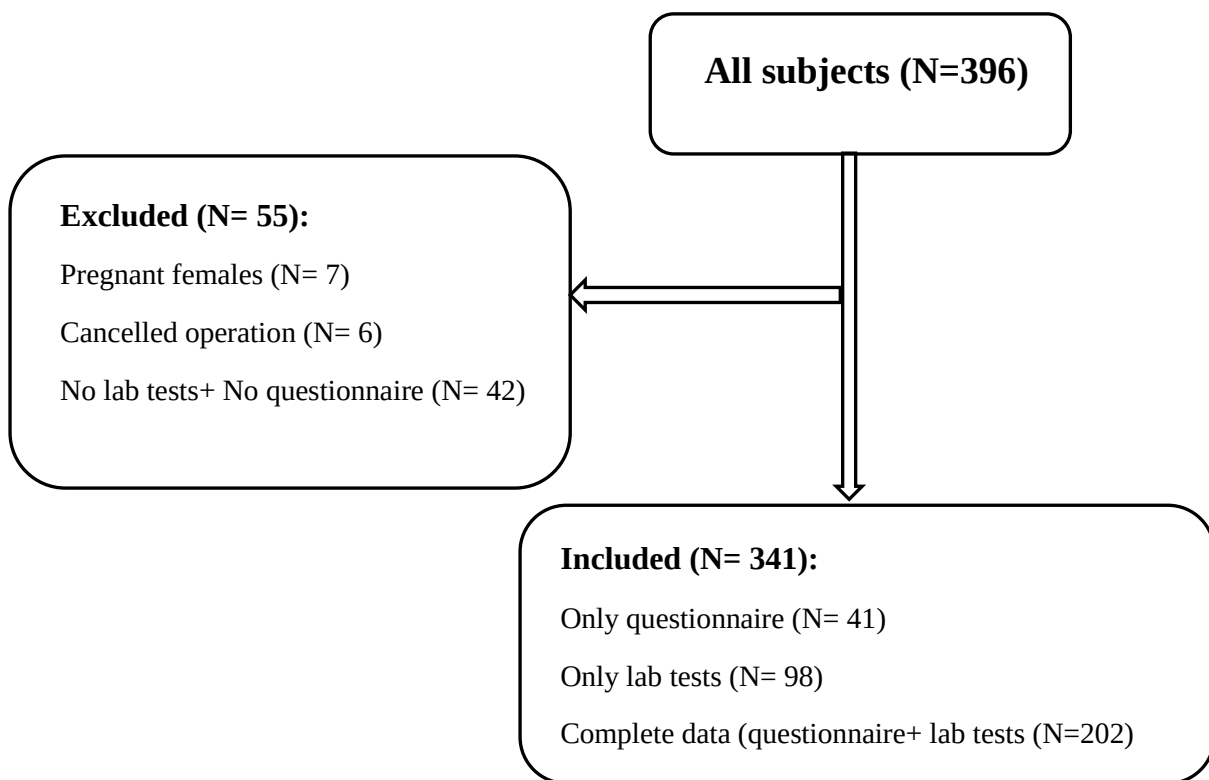
Appropriate candidates for the present study were patients who had a minimum of one year post bariatric surgery at the two participated hospitals. Before starting the study, the sample size was calculated based on Bahrain average population size from 2012-2017 which was 1.382.833 (World Bank, 2017). The representative sample size with 95% confidence level were 384 by using the following formula (Australian Bureau of Statistics, 2018):

$$\text{Sample size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N} \right)}$$

Population Size = N | Margin of error = e | z-score = z | e is percentage

A total of 396 patients were selected from both hospitals, 183 patients from KHUH and 213 from SMC. However, only 341 patients were eligible to be included. Fifty five patients were excluded from the study due to the following reasons: 7 females were pregnant at the time of the

study, 6 patients that eventually they decided not to undergo with the surgery and 42 patients were not accessible to fill in the questionnaire or were not willing to do so. In addition, such patient's biochemical tests were old or have no lab tests done at all in the participated hospitals. Figure (4) shows the flowchart of the study patients.



*N= Number of patients

Fig. 4: Flowchart of study population

3.3 Research Tools

The study was based on a questionnaire developed and written in both Arabic and English (Appendix). The questionnaire consisted of three parts:

The first part includes demographic data such as age, gender, nationality, educational level, type of procedure, period since surgery, weight pre and post-surgery in kg and height in cm to calculate the percentage of excess weight loss and to compare the percentages among the different procedures. Regarding pre weight, the KHUH patient list has mentioned the patient height and weight pre- surgery. However, those patients were asked to answer the two questions regarding their pre-surgery weight and height through the phone interview in order to confirm the hospital information.

The second part investigated the possibility the participant having at that time some complications such as dehydration, constipation, hair loss, hypoglycemia, and hypotension and if they develop cholelithiasis since surgery.

The third part focused on the most important post-surgery dietary recommendations adopted in the present study based on the work of Mechanick et al. (2013). Participants were asked to rate themselves how they adhere to each recommendation. Responses were rated using Likert scale with choices of “all of the times”, “most of the times”, “some of the times”, and “rarely/never”. Patients were asked another question suggested by the consultant from KHUH. The question was: “Since surgery, did you follow up with a dietitian? In case of you are not following up with a dietitian, what were the reasons? And they were given 6 choices: lack of transportation, unaware of benefits, cost of attendance, not interested, unimportant and improper attitude of the dietitian.

3.4 Data Collection/Procedures

Permission to conduct the study was obtained from the education and proficiency center - research and ethics committee in (KHUH) (Ref. KHUH/Research/No. 211/2018) and from the health research committee at the Ministry of Health (NO:AUHR/498/2018). followed by another approval obtained from the secondary care research committee in (SMC).

Data collection procedures contained two parts:

The first part was collecting medical records of patients included in the study that underwent bariatric surgery and were retrospectively reviewed. The patients lists given by the two hospitals contained age, gender, telephone number, type of procedure received, pre- surgery weight and height (only KHUH list) and the latest biochemical tests conducted. Nutritional deficiencies were identified by reviewing and comparing the nutritional parameters of the patients including: calcium, 25-OH vitamin D, vitamin B₁₂, iron, ferritin, cholesterol, sodium, potassium and magnesium beside the biochemical indicators hemoglobin (HB), hematocrit and mean corpuscular volume (MCV). Nutritional deficiency or excess levels were defined as a concentration below or above the normal reference range of the hospital laboratory. Nutritional parameters were compared among the different procedures and among different time period.

The second part, a questionnaire was filled in through a phone interview with patients. The questionnaire was pilot tested after receiving the approval from the University of Bahrain. The participants of the pilot test were 13 people of the age 18 years old or above, who had bariatric surgery not necessarily at the two hospitals participated in the study. Those patients were not included in the study sample. Five attempts were

made to reach patients by phone. Patients that were not reached or not interested to fill in the questionnaire, only their lab tests were reviewed. At the beginning of the interview, patients were informed about the purpose of the study and that this study is part of the program requirements for the Master degree in Nutrition and Dietetics program. In addition, they were informed that their answers will be respected and will be treated in strict secrecy and will only be used for scientific research purposes and that the interview will take approximately 5 minutes. Finally, a written informed consent was obtained from all participants included in the study.

3.5 Statistical Methods

All analysis was carried out using the statistical package for social science (SPSS version 23) and statistical package from Excel 2010 (Microsoft Corporation). Descriptive statistics were presented as frequencies, means and standard deviations (SD). Repeated measures analysis of variance was used to analyze the effect of type of surgery and time since surgery on the patient's BMI before and after surgery by which age, gender and time or type of surgery were adjusted. Differences among surgeries and time intervals regarding % EWL, %TWL and nutritional parameter values were compared by utilizing analysis of covariance (ANCOVA) after adjusting the appropriate covariates each time. Relationship among nutritional parameters and variables was tested with multiple linear regression model by which the nutritional parameters were the dependent variables and other variables were the independent ones. Differences among surgeries for nominal data were tested using Pearson chi square. All reported *P* values are 2-sided. *P* values less than 0.05 were considered to be statistically significant.

Chapter Four

Results, Discussion, and Recommendations

4.1 The Study's Results

4.1.1 Prevalence of Bariatric

4.1.2 Study Participants Descriptive

4.1.3 Weight Loss

4.1.4 Nutritional Complications

4.1.4.1 Micronutrient Deficiencies

4.1.4.2 Common Complications

4.1.5 Adherence to Dietary Recommendations

4.2 Discussion of Results

4.3 Study's Recommendations

Results, Discussion, and Recommendations

4.1 The Study's Results

4.1.1 Prevalence of Bariatric Surgeries

Number of bariatric surgeries performed during the period 2012-2018 was investigated in both hospitals participated in the study. For KHUH, data were available from 2013- 2018 while for SMC it was available from 2015 - 2018. Table 1 illustrated the statistics of both participated hospitals regarding bariatric surgery performed along with surgery types. The results have shown that KHUH performed more surgeries than SMC and that in 2018 KHUH performed surgeries 5 times that of SMC. These results could be attributed to the fact that the KHUH bariatric consultant surgeon performed only bariatric surgery, whereas SMC surgeons performed bariatric as well as other types of surgeries.

Table (1): Bariatric surgery descriptive statistics in participating hospitals

Year	KHUH					SMC		
	<i>SG</i>	<i>RYGB</i>	<i>MGB</i>	<i>BPD</i>	<i>Total</i>	<i>SG</i>	<i>MGB</i>	<i>Total</i>
2012	0	0	1	12	13	N.A	N.A	N.A
2013	21	0	41	38	100	N.A	N.A	N.A
2014	121	4	33	3	161	N.A	N.A	N.A
2015	129	11	31	0	171	29	4	33
2016	229	6	20	0	255	47	34	81
2017	306	6	18	0	330	70	23	93
2018	N.A	N.A	N.A	N.A	500	66	43	109

KHUH, King Hamad University Hospital; SMC, Salmania Medical Complex; N.A, data not available; SG, sleeve gastrectomy; RYGB, Roux- en-Y-gastric bypass; BPD, biliopancreatic diversion; MGB, mini gastric bypass

There was a significant increase in the total number of procedures performed from 2015 to 2018 as shown in Figure 5. The number started with 204 surgeries in 2015 and reached up to 609 in 2018; approximately 100% elevation in number of operations. There was a significant difference among four years by which the p value is < 0.001 .

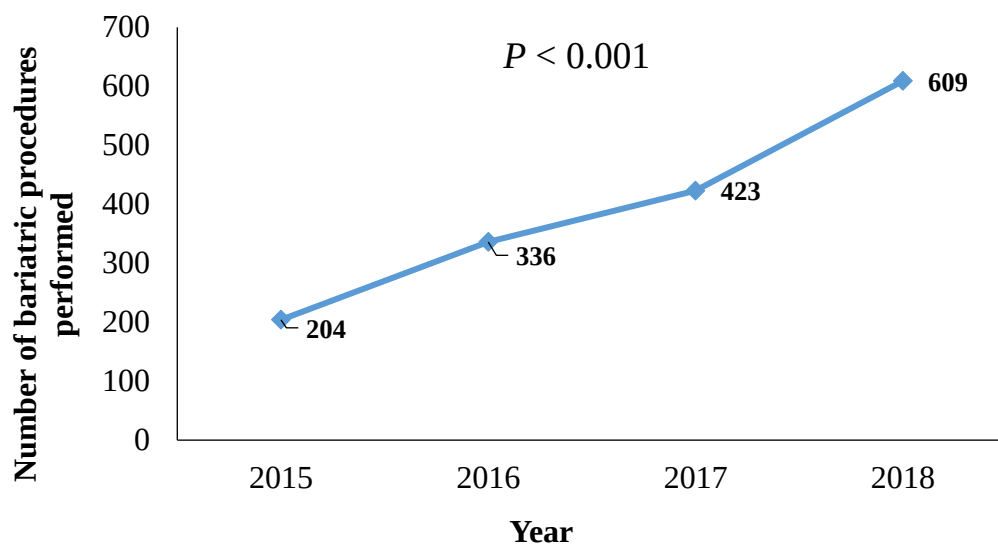


Fig. 5: Trends in number of procedures performed during the period 2015-2018

Figure 6 shows the trend in number of each bariatric surgery type during the period 2012 - 2017. It was shown that SG surgery had the highest increase in number throughout the period and considered the most surgery type performed nowadays. Second place was for MGB, whereas BPD diminished in number and stopped in 2014. RYGB surgery recorded low numbers compared to SG and MGB. Analysis of variance showed a significant difference among the four surgery types with a p value of 0.005.

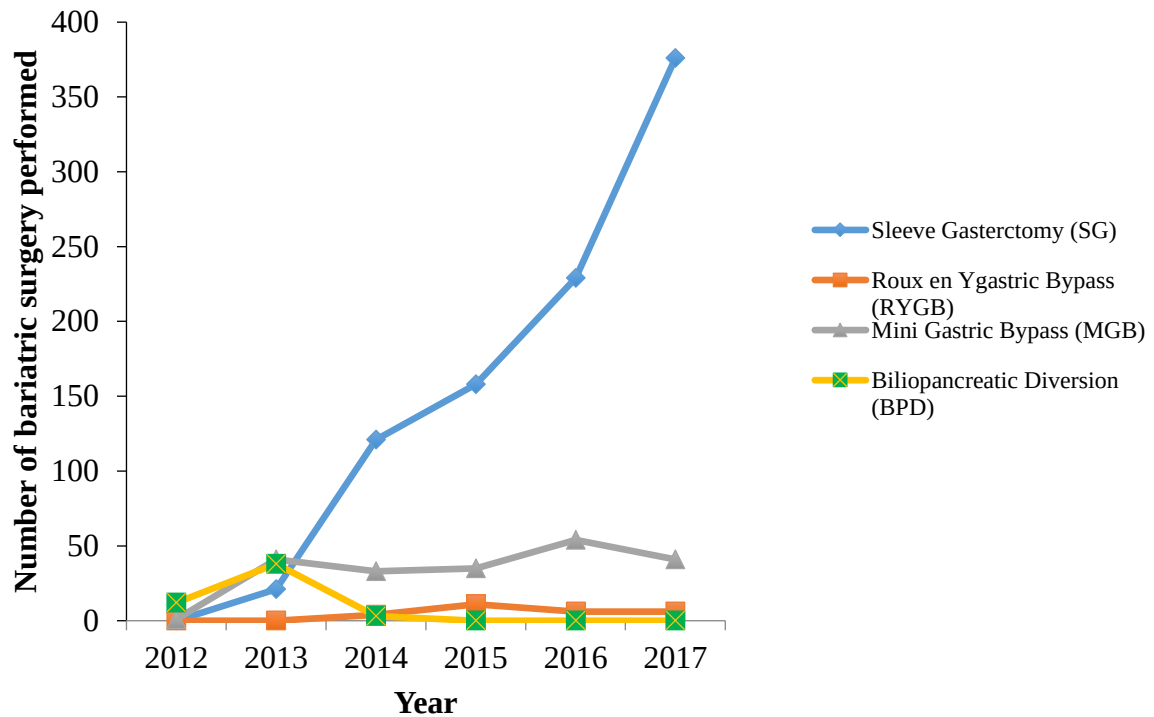


Fig. 6: Trends in number of surgery types performed during the period 2012-2017

4.1.2 Study Participants Descriptive

Characteristics of the respondents are reported in Table 2. The results show that the mean age of the participants was 39.82 ± 9.95 and that females compromise almost two third of the sample (67.5%). Around 43% of patients were holding secondary school certificate, 98% were Bahrainis and 73% were married. Regarding the type of surgery received, SG was the most procedure performed with a percentage of 57% followed by MGB (32%). Approximately 31% of the patients included in the study received the surgery one year ago from the starting date of the study, whereas the longest period since surgery (6 years) included only 2.6 % of the patients. The average baseline BMI for the sample was 48.16 ± 9.25 whereas the average post BMI was 30.16 ± 5.97 .

Table (2): Patient characteristics

Patient's characteristics	N(%)
Age (year)	39.82 ± 9.93*
Gender	
Male	111 (32.5)
Female	231 (67.5)
Nationality	
Bahraini	238 (98.3)
Non Bahraini	4 (1.7)
Education	
Primary	5 (2.1)
Intermediate	17 (7.1)
Secondary	103 (42.7)
Diploma/ BSc.	99 (41.1)
High education	17 (7.1)
Marital status	
Single	65 (27)
Married	176 (73)
Time since surgery	
First year (2017)	105 (30.7)
Second year (2016)	84 (24.6)
Third year (2015)	24 (7)
Fourth year (2014)	59 (17.3)
Fifth year (2013)	61 (17.8)
Sixth year (2012)	9 (2.6)
Surgery type	
Sleeve Gastrectomy	189 (57.6)
Biliopancreatic Diversion	34 (10.4)
MGB	105 (32)
RYGB	2 (0.6)
weight	
Pre-operative BMI	48.16 ± 9.25 *
Current BMI	30.16 ± 5.97 *

* Mean± SD

N= number of patient

4.1.3 Weight Loss

Self- reported weights of patients in pre and post- surgery in addition to height were taken from the information recorded in the questionnaire to calculate their body mass index (BMI). Percent excess weight loss (%EWL) was calculated as follow (Al Khalifa et al., 2018):

$$\%EWL = [(Pre\ BMI - Post\ BMI) / (Pre\ BMI - Ideal\ BMI)] * 100$$

In which ideal BMI is defined by the BMI of 25

Whereas percent total weight loss (%TWL) was calculated as:

$$\%TWL = [(Pre\ weight - Post\ weight) / (Pre\ weight)] * 100$$

Figure 7 represented the repeated measures analysis of variance to analyze the effect of type of surgery on the patient's BMI before and after surgery by which age, gender and time of surgery were adjusted to remove the effect of these covariates on the estimates. It was shown that patients underwent BPD surgery had the highest mean (BMI) both before and after surgery (56.76 kg/m² and 34.81 kg/m² respectively). SG and MGB almost had the same pre (BMI) (SG: 47.23 kg/m², MGB: 47.58 kg/m²), although post MGB surgery patients had the lowest (BMI) among surgery types. On the other hand, RYGB patients had the lowest (BMI) and the second highest BMI post-surgery. The analysis of variance showed a significant effect of the type of surgery on the (BMI) indicated by the *p* value <0.05.

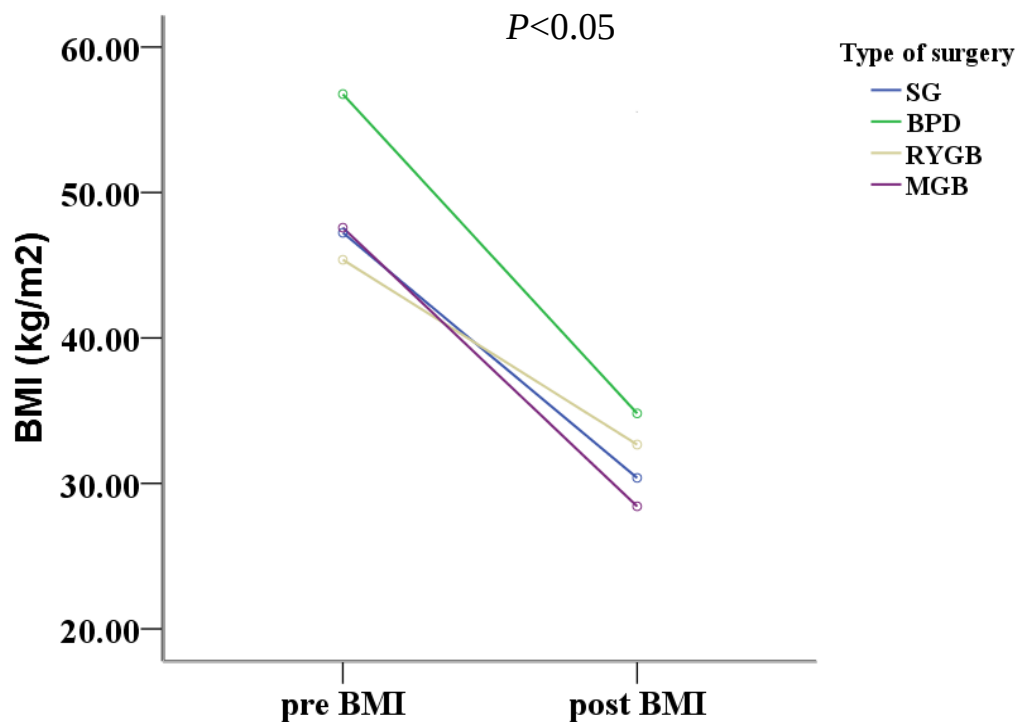


Fig. 7: Estimated means of BMI pre and post-surgery in association of type of surgery

Patient's BMI before and after surgery was analyzed in comparison with time of surgery as shown in Figure 8 by which the covariates type of surgery, age and gender were adjusted. Results showed that patients underwent surgery 6 years ago, had the highest pre and post-surgery BMI whereas the lowest post BMI was reported for patients underwent surgery 3 years ago. Patients who performed the surgery more recently (1-2) years reported almost the same post BMI (29.6 kg/m² and 29.5 kg/m² respectively). The Figure also showed as time increased (≥ 4 years), the drop in post BMI increased. The analysis showed that there is a significant effect of time since surgery on the post BMI since the p value was <0.01 .

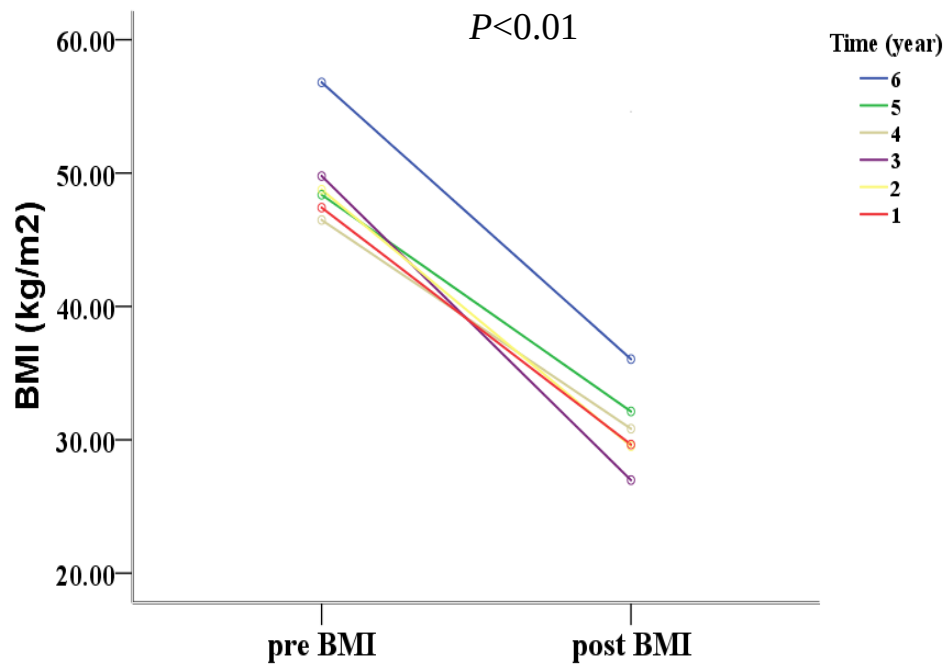


Fig. 8: Estimated means of BMI pre and post-surgery in association of time of surgery

In term of % EWL, Figure 9 showed that patients underwent MGB had the highest value (82.01%) in comparison with the other three types. SG patients came in the second place with 78.13% followed by BPD with 70.14 % of EWL. ANCOVA showed that there was no significant effect of the type of surgery on % EWL (P value = 0.206).

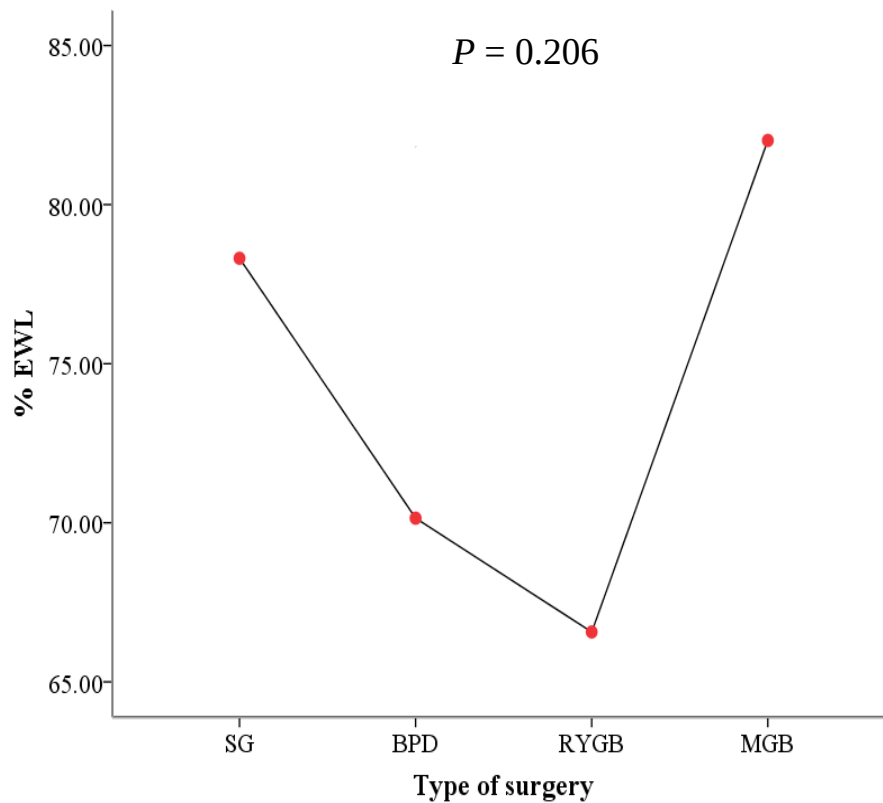


Fig. 9: Comparison of effect of different types of bariatric surgery on % EWL

However, Figure 10 showed that the effect of time of surgery on %EWL was significant (p value <0.01). After controlling the covariates (age, gender and time of surgery), the maximum %EWL (94.12%) was reported for patients performed the surgery 3 years ago whereas the lowest (61.32%) was reported for 6 years patients. Patients of one and two years post-surgery had almost the same %EWL (79.83% and 79.29% respectively).

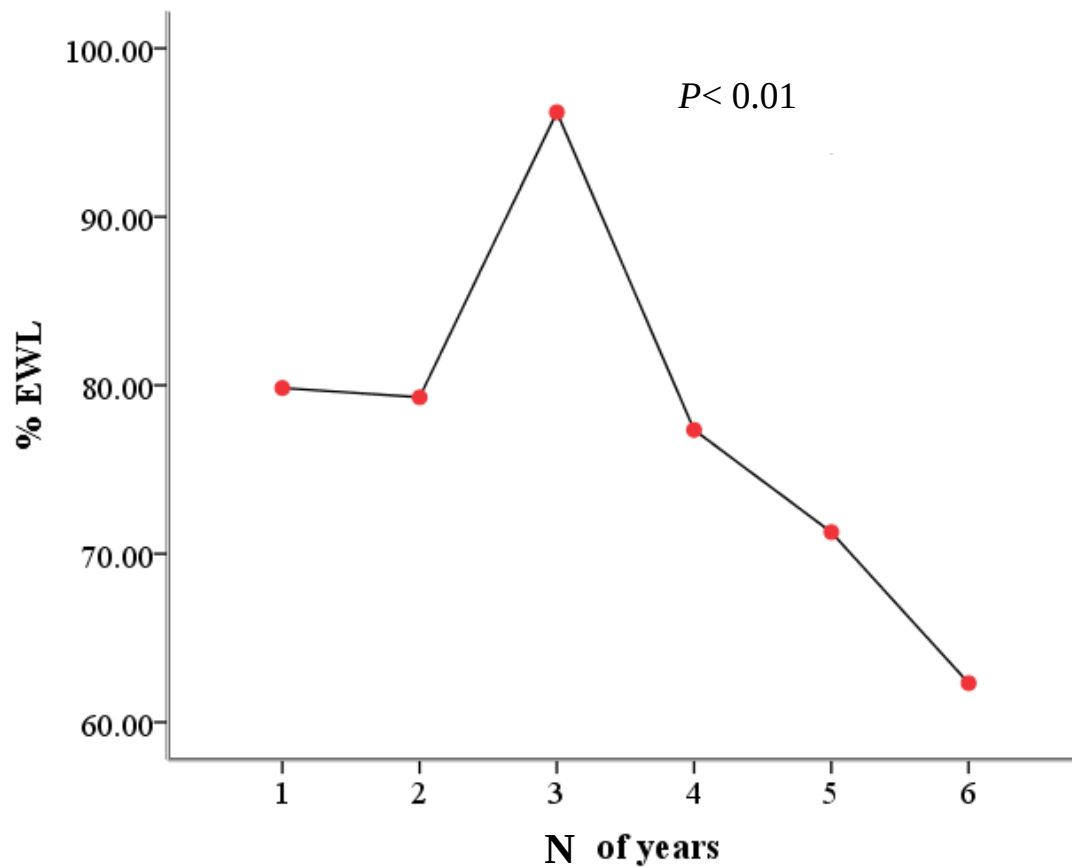


Fig. 10: Comparison of effect of different time intervals on % EWL

In Figure 11, the %TWL was represented in association of type of surgery. It was been shown that SG patients had the lowest percentage of TWL (35.61%), while MGB patients had the maximum %TWL (38.89%). BPD patients reported a mean of 38.40% which was relatively close to MGB surgery whereas RYGB reported 37.97%. Analysis of covariance (ANCOVA) after controlling the covariates (age, gender and time of surgery) revealed that there was no significant effect of the type of surgery on %TWL since p value was 0.190.

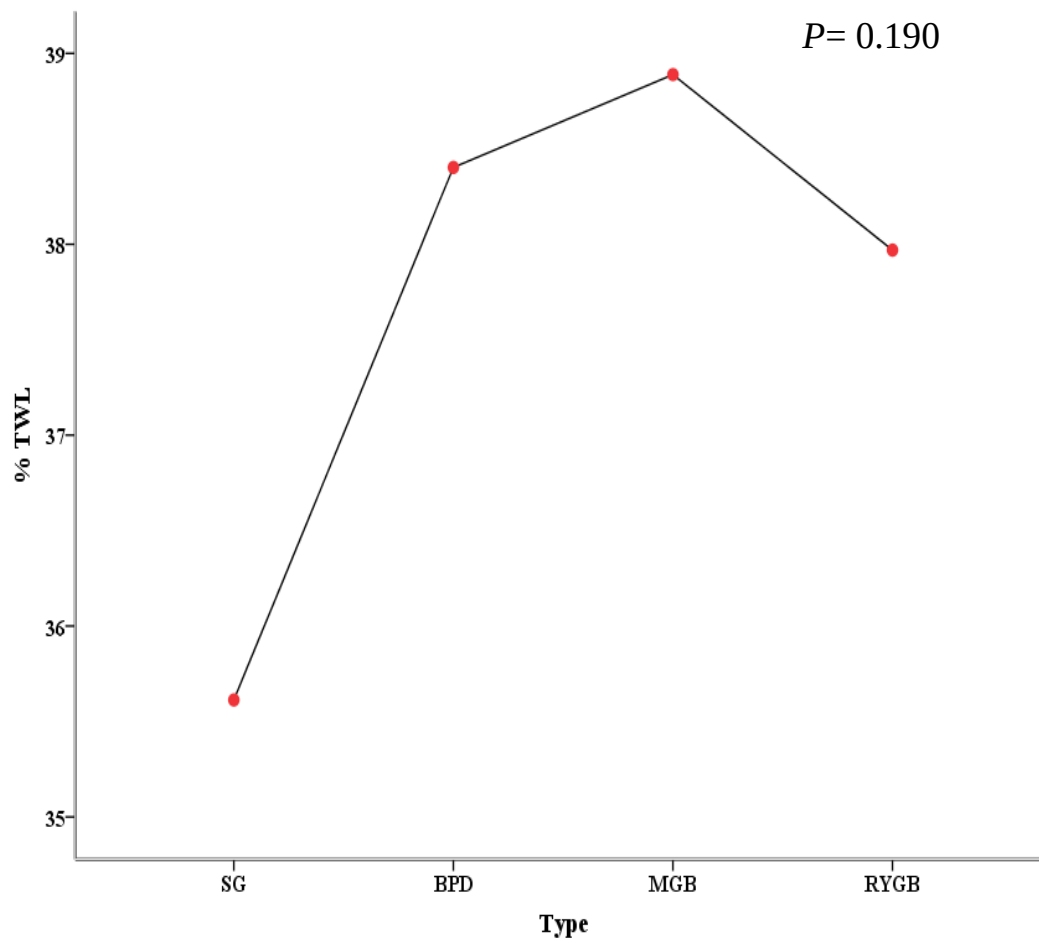


Fig. 11: Comparison of effect of different types of bariatric surgery on % TWL

The effect of time since surgery on %TWL was measured as shown in Figure 12. It showed that the 3 years time had the maximum %TWL (45.01%), while 5 years time reported the minimum %TWL (32.74%). The time of 4 years had the second lowest %TWL (34.66%), while 1 and 6 years reported equal %TWL (37.13%). ANCOVA revealed that the time since surgery had a significant effect on %TWL by which p value < 0.001 .

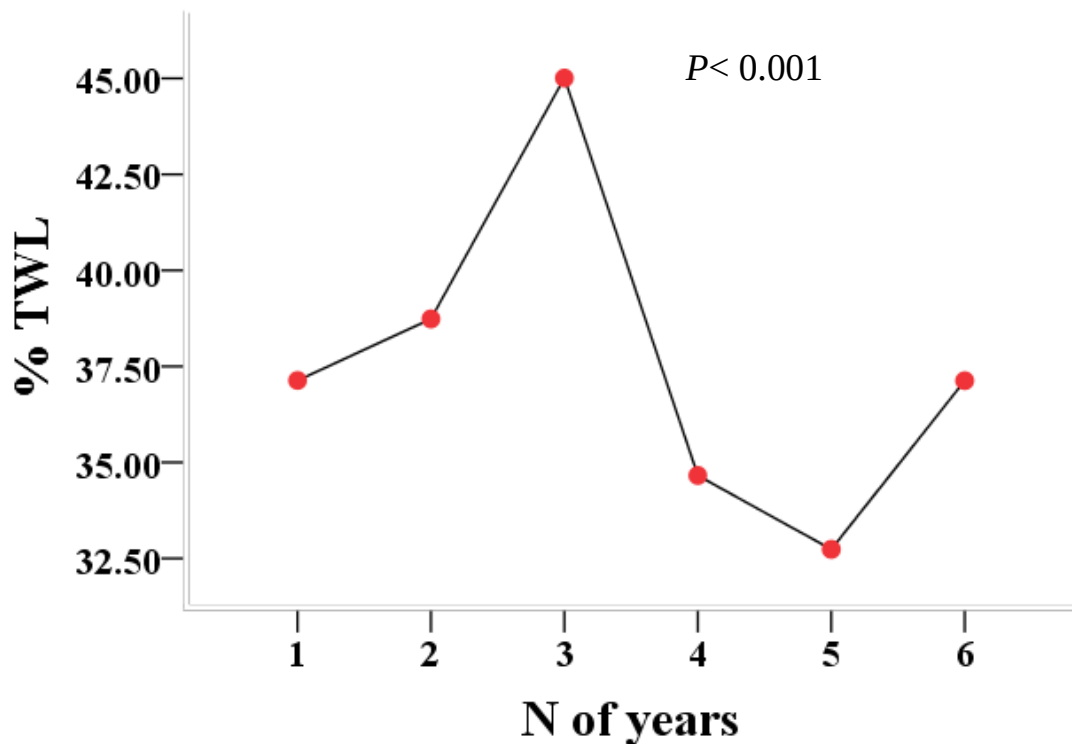


Fig. 12: Comparison of effect of different time intervals on % TWL

Table 3 represents a description of subject's post-surgery BMI category at time of study based on the WHO BMI classification (WHO, 2007). In general, 36% of the participants were overweight, 30% were class I obese and only 16% fall under the normal BMI category. When cross tabulation made between BMI classification and type of surgery, it was shown that almost one third of patients underwent SG were overweight and 32% were still obese. The majority of BPD patients fall under the obese class, whereas around 44% of MGB were considered as overweight.

On the other hand, when cross tabulation were made between year of surgery and BMI classes, it has shown that the majority of patients performed the surgery six years ago (2012) were obese and that no one had a normal BMI. The highest percentage of patients with normal BMI

was recorded for year 2015 patients (39%), while 44% of the patients underwent the surgery recently (2017) were overweight.

Table (3): Description of subjects BMI classification

	BMI Classification				
	Normal (%) 18.5-24.9 (kg/m ²)	Overweight (%) 25-29.9(kg/m ²)	Obese class I (%) 30-34.9(kg/m ²)	Obese class II (%) 35-39.9(kg/m ²)	Obese class III (%) ≥ 40 (kg/m ²)
Classification of all subjects	16.4	36.1	30.3	10.9	6.3
<i>Type of surgery</i>					
SG	16.8	33.6	32.1	13.1	4.4
BPD	4.8	19	28.6	23.8	23.8
MGB	19.2	43.6	28.2	3.8	5.1
RYGB	0	100	0	0	0
<i>Time of surgery</i>					
2012	0	20	40	0	40
2013	14.6	24.4	31.7	14.6	14.6
2014	16.2	32.4	37.8	8.1	5.4
2015	38.9	33.3	22.2	5.6	0
2016	17.5	39.7	25.4	15.9	1.6
2017	12	44	30.7	8	5.3

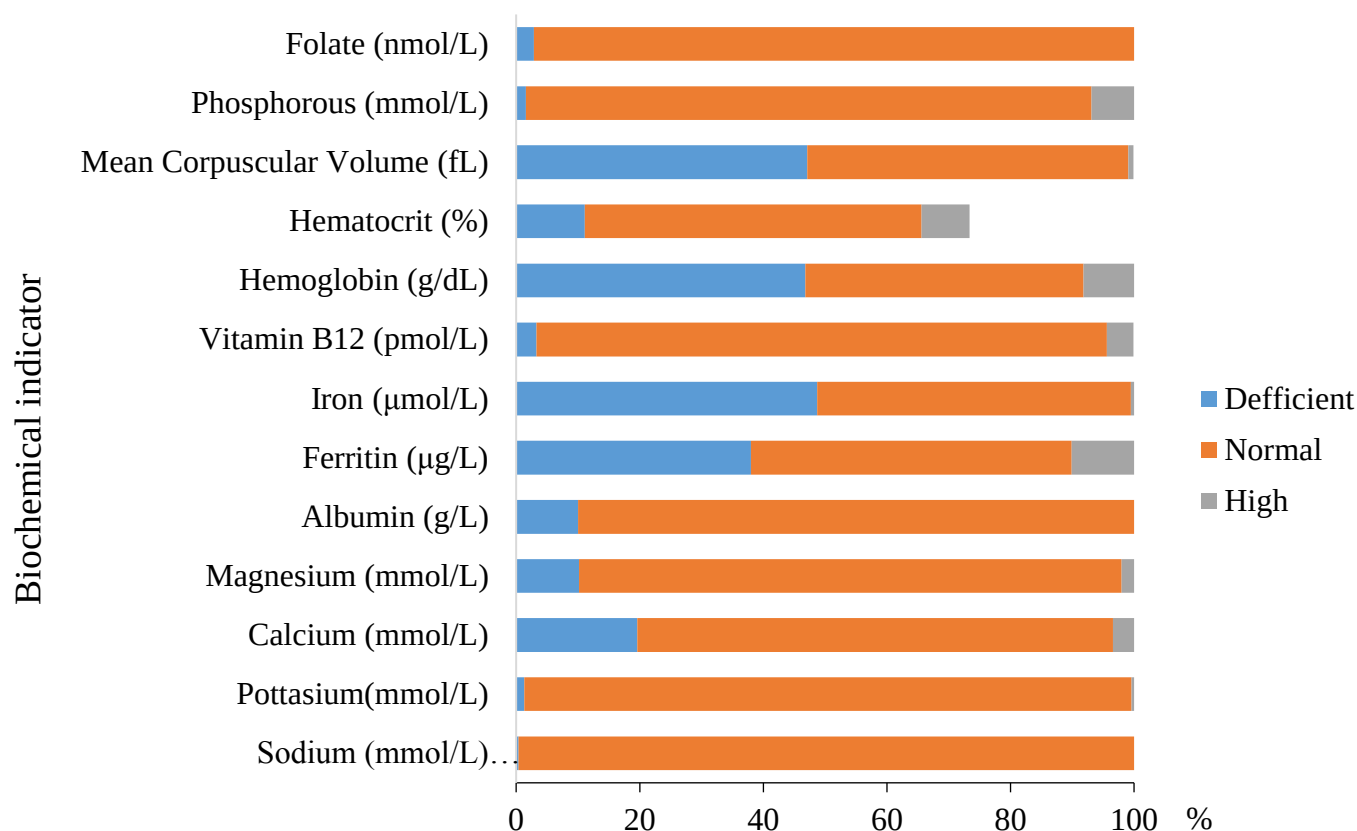
BMI = Body mass index

4.1.4 Nutritional Complications

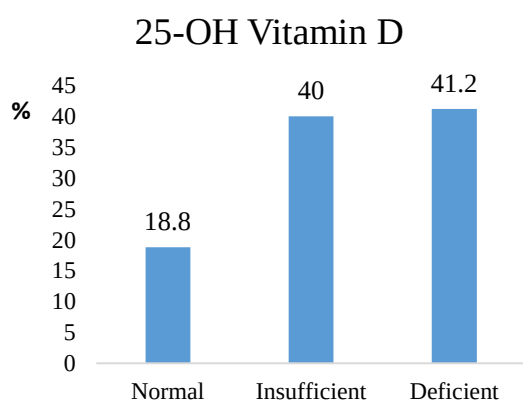
4.1.4.1 Micronutrient Deficiencies

Indicators of nutritional status of patients at time of study were investigated via reviewing their biochemical markers. Both hospitals used the International System of Units (SI) for all biochemical tests investigated in this study except two parameters were using the conventional units in KHUH. These two were 25-OH vitamin D and vitamin B12 by which values were measured in pg/ml instead of pmol/L as in SI unit. To convert vitamin D values, they were multiplied by the conversion factor (2.6) while 25-OH vitamin B12 values were multiplied by (0.738). (American Medical Association; 2000).

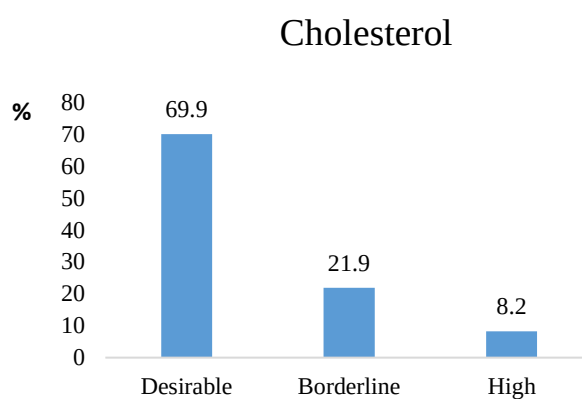
Description of patient's nutritional indicator status regardless the type or time of surgery taken from patient's recent lab tests was summarized in Figure 13. They were categorized into three groups according to their biochemical indicators level as deficient, normal and high except for 25-OH vitamin D categories as normal, insufficient and deficient and for cholesterol the categories were borderline, desirable and high. Figure 13 showed that the majority of patients had normal levels of the reviewed indicators except for hemoglobin, hematocrit, MCV, 25-OH vitamin D, ferritin and iron. Deficiency was found for iron, MCV and hemoglobin by which about half of patients were deficient with a percentage of 48.5%, 47.1% and 46.8 % respectively. For 25-OH vitamin D, 40% had insufficient levels and 41.2% were deficient, and 38% of patients were deficient in ferritin.



(A)



(B)



(C)

Fig. 13: Patients classification frequencies for each biochemical indicators

Table 4 lists different nutritional parameters with their normal reference range for patients in association with type of surgery to identify nutrition deficiency. In general, patient's biochemical mean values were within the normal reference range regardless the type of surgery although there were few exceptions. The first exception was found for calcium in BPD patient by which their calcium level mean (2.12 mmol/L) was lower than the normal one (2.15- 2.5 mmol/L). Moreover, iron level in BPD and MGB patients and vitamin D in MGB patients was also lower than the normal reference range. Hemoglobin recoded levels were slightly lower than the normal range in all bariatric surgery types except for SG, while SG and MGB patients were had lower MCV level than the normal level.

Analysis of covariance (ANCOVA) after controlling the covariates age, gender and time of surgery indicated that there was no significant effect of type of surgery on all lab tests except for cholesterol.

Table (4): Nutritional parameters in association with type of surgery

	N	Mean (CI 95%)	Normal Reference range	P value
Sodium (mmol/L)				
SG	127	140.44 (139.97, 140.92)	132 – 146	0.261
BPD	21	141. 20 (139.89, 142.51)		
MGB	3	139.99 (139.40, 140.57)		
RYGB	77	141.28 (138.37, 144.19)		
Potassium (mmol/L)				
SG	128	4.37 (4.29, 4.40)	3.5- 5.5	0.201
BPD	21	4.37 (4.16, 4.58)		
RYGB	3	4.41 (4.32, 4.50)		
MGB	7	3.90 (3.43, 4.36)		

N = number of patients

Continue Table (4)

	N	Mean (CI 95%)	Normal Reference range	P value
Calcium (mmol/L)				
SG	110	2.27 (2.24, 2.30)	2.15- 2.5	0.062
BPD	16	2.12 (2.04, 2.24)		
RYGB	2	2.22 (2.17, 2.26)		
MGB	66	2.24 (2.00, 2.48)		
Magnesium (mmol/L)				
SG	60	0.83 (0.81, 0.85)	0.74 - 1.00	0.489
BPD	4	0.87 (0.78, 0.96)		
MGB	28	0.86 (0.83, 0.90)		
RYGB	2	0.85 (0.73, 0.97)		
Albumin (g/L)				
SG	94		35-52	0.436
BPD	14	39.98 (39.25, 40.70)		
MGB	58	40.00 (37.82, 42.17)		
RYGB	3	39.16 (38.26, 40.05) 38.15 (34.25, 42.06)		
Ferritin (µg/L)				
SG	42	107.32 (69.36,145.29)	14 – 233	0.291
BPD	7	87.14 (-17.31,191.59)		
MGB	34	54.63 (13.20, 96.06)		
RYGB	1	22.47 (-219.69, 264.63)		
Iron (µmol/L)				
SG	74	14.11 (12.61, 15.61)	11.6-31.3	0.066
BPD	10	8.46 (3.85, 13.07)		
MGB	44	11.32 (9.44, 13.20)		
RYGB	2	13.06 (4.20, 21.92)		
Vitamin B12 (pmol/L)				
SG	75	286.36 (229.15, 343.57)	133 – 675	0.609
BPD	11	357.46 (183.09, 531.84)		
MGB	49	334.14 (265.34, 402.95)		
RYGB	2	156.88 (-186.52, 500.28)		
25-OH Vitamin D (pmol/L)				
SG	89	53.32 (46.29, 60.35)	>50.0	0.062
BPD	14	66.54 (41.32, 91.76)		
MGB	60	43.45 (35.04, 51.87)		
RYGB	2	55.80 (16.82, 94.78)		

Continue Table (4)

	N	Mean (CI 95%)	Normal Reference range	P value
Cholesterol (mmol/L)				
SG	82	4.74 (4.52, 4.96)	Desirable: <5.2 Borderline: 5.2 - 6.2	< 0.001
BPD	13	3.26 (2.61, 3.92)		
MGB	40	4.43 (4.12, 4.74)		
RYGB	2	3.62 (2.22, 5.02)		
Hemoglobin (g/dL)				
SG	151	12.17 (11.89, 12.46)	12.0 - 14.5	0.120
BPD	19	11.34 (10.45, 12.24)		
MGB	82	11.67 (11.29, 12.04)		
RYGB	3	11.67 (9.74, 13.60)		
Hematocrit (%)				
SG	141	38.44 (37.58, 39.30)	33-45	0.053
BPD	17	35.62 (32.74, 38.500)		
MGB	69	36.66 (35.45, 37.86)		
RYGB	3	35.65 (29.88, 41.41)		
Mean corpuscular volume (fl)				
SG	141	78.50 (76.82, 80.18)	80.0 - 97.0	0.586
BPD	17	82.09 (76.46, 87.74)		
MGB	69	79.19 (76.83, 81.56)		
RYGB	3	83.03 (71.76, 94.30)		
Phosphorus (mmol/L)				
SG	68	1.26 (1.21, 1.32)	0.81 - 1.45	0.853
BPD	3	1.15 (0.84, 1.45)		
MGB	31	1.26 (1.18, 1.360)		
RYGB	2	1.34 (1.03, 1.64)		
Folate (nmol/L)				
SG	37	26.24 (22.29, 30.20)	7.00 - 28.10	0.665
BPD	1	32.55 (5.85, 59.25)		
MGB	22	26.62 (21.44, 31.81)		
RYGB	1	40.83 (16.47, 65.20)		

Another association was made between nutrition parameters and time of surgery. This association is represented in Table 5 where means (CI 95%) of nutritional indicators and numbers of patients are listed against the time of surgery. ANCOVA of parameters means after controlling age, gender and type of surgery revealed that there was a significant effect of time of surgery on sodium, potassium, calcium, albumin, vitamin B12 and hemoglobin. *P* values reported were < 0.001 for sodium, potassium and albumin while calcium *p* value was 0.034, vitamin B12 (0.004) and hemoglobin had a value of 0.005. Although there was no significant effect of time on 25-OH vitamin D levels between time groups, the mean values for patients performed the surgery one year, 4 and 6 years ago were less than the normal value. The same was found for MCV, patients of 2, 3, 5 and 6 years had lower levels than that of the normal.

Table (5): Nutritional parameters in association with time of surgery

		N	Mean (CI 95%)	Normal Reference range	<i>P</i> <i>value</i>
Sodium (mmol/L)					
Year	1	72	140.90 (140.31, 141.50)	132-146	< 0.001
	2	61	141. 31 (140.68, 141.94)		
	3	14	141.15 (139.81, 142.48)		
	4	37	138.90 (138.09, 139.72)		
	5	37	139.59 (138.75, 140.44)		
	6	7	136.91 (135.04, 138.79)		
Potassium					
Year	1	73	4.37 (4.28, 4.46)	3.5-5.5	< 0.001
	2	61	4.51 (4.41, 4.61)		
	3	14	4.61 (4.40, 4.82)		
	4	37	4.14 (4.01, 4.27)		
	5	37	4.34 (4.20, 4.47)		
	6	7	4.30 (3.40, 4.59)		

N = number of patients

Continue Table (5)

		N	Mean (CI 95%)	Normal Reference range	P value
Calcium (mmol/L)					
Year	1	69	2.30 (2.26, 2.34)	2.15- 2.5	0.034
	2	50	2.21 (2.17, 2.26)		
	3	8	2.22 (2.10, 2.34)		
	4	31	2.22 (2.16, 2.28)		
	5	31	2.18 (2.12, 2.24)		
	6	5	2.27 (2.12, 2.42)		
Magnesium (mmol/L)					
Year	1	53	0.83 (0.81, 0.85)	0.74-1.00	0.745
	2	32	0.85 (0.82, 0.88)		
	3	10	0.84 (0.97, 0.89)		
	4	20	0.82 (0.79, 0.86)		
	5	19	0.85 (0.81, 0.89)		
	6	4	0.81 (0.74, 0.89)		
Albumin (g/L)					
Year	1	72	40.49 (39.59, 41.39)	35-52	< 0.001
	2	62	40.40 (39.45, 41.36)		
	3	15	40.28 (38.31, 42.26)		
	4	39	37.95 (36.74, 39.16)		
	5	43	38.41 (37.23, 39.58)		
	6	8	35.01 (32.34, 37.68)		
Ferritin (µg/L)					
Year	1	41	106.93 (72.58, 141.27)	14-233	0.345
	2	26	74.72 (32.11, 117.32)		
	3	7	22.29 (-60.07, 104.64)		
	4	21	91.54 (43.82, 139.25)		
	5	23	86.26 (39.19, 133.33)		
	6	5	25.11 (-71.82, 122.04)		
Iron (pmol/L)					
Year	1	67	12.49(11.03-13.96)	11.6-31.3	0.233
	2	45	13.86 (12.09-15.63)		
	3	9	11.65 (7.67-15.63)		
	4	33	12.86 (10.77-14.95)		
	5	30	11.43 (9.19-13.67)		
	6	6	7.96 (3.11-12.80)		
Vitamin B12 (pmol/L)					
Year	1	64	328.55 (270.66, 386.44)	133-675	0.004
	2	53	262.14 (199.01, 325.28)		
	3	11	238.22 (97.53, 378.91)		
	4	29	341.58 (255.63, 427.53)		
	5	35	335.16 (255.02, 415.29)		
	6	6	656.40 (469.20, 843.59)		

Continue Table (5)

		N	Mean (CI 95%)	Normal Reference range	P value
25-OH Vitamin D (nmol/L)					
Year	1	58	49.84 (43.53, 56.14)	> 50	0.204
	2	41	52.27 (44.85, 59.68)		
	3	7	54.41 (36.32, 72.50)		
	4	28	37.69 (28.61, 46.77)		
	5	27	50.51 (40.90, 60.12)		
	6	4	46.07 (22.22, 69.92)		
Cholesterol (mmol/L)					
Year	1	47	4.66 (4.35, 4.97)	3.6 - 5.2	0.114
	2	41	4.59 (4.27, 4.92)		
	3	5	4.82 (3.87, 5.77)		
	4	19	4.35 (3.87, 4.83)		
	5	21	4.21 (3.75, 4.67)		
	6	4	3.28 (2.23, 4.32)		
Hemoglobin (g/Dl)					
Year	1	83	12.41 (12.04, 12.78)	12.0 - 14.5	0.005
	2	64	12.04 (11.62, 12.46)		
	3	20	11.59 (10.84, 12.35)		
	4	43	11.96 (11.44, 12.47)		
	5	39	11.12 (10.57, 11.68)		
	6	6	10.91 (9.55, 12.28)		
Hematocrit (%)					
Year	1	80	38.28 (37.15, 39.41)	33 - 45	0.119
	2	63	38.36 (37.09, 39.63)		
	3	20	37.44 (35.17, 39.71)		
	4	34	37.22 (35.49, 38.95)		
	5	28	35.52 (33.57, 37.48)		
	6	5	34.76 (30.27, 39.26)		
Mean corpuscular volume (fl)					
Year	1	80	80.58 (78.41, 82.76)	80.0 – 97.0	0.083
	2	64	77.88 (75.46, 80.30)		
	3	20	75.30 (70.94, 79.66)		
	4	34	81.75 (78.42, 85.07)		
	5	28	76.62 (72.85, 80.38)		
	6	5	78.87 (70.22, 87.51)		
Phosphorus (mmol/L)					
Year	1	53	1.27 (1.21, 1.33)	0.81 – 1.45	0.777
	2	34	1.25 (1.18, 1.33)		
	3	8	1.26 (1.11, 1.41)		
	4	4	1.34 (1.13, 1.56)		
	5	4	1.19 (0.97, 1.4)		
	6	1	1.02 (0.59, 1.4)		

Continue Table (5)

		N	Mean (CI 95%)	Normal Reference range	P value
Folate (mmol/L)					
Year	1	31	26.35 (22.02, 30.69)	7.00-28.10	0.647
	2	19	28.88 (23.30, 34.47)		
	3	7	21.64 (12.62, 30.67)		
	4	1	19.27 (-5.43, 43.96)		
	5	3	31.21 (17.21, 45.22)		

In Table (6), multiple linear regression analyses were conducted to examine the relationship between the nutritional parameters and age, time of surgery, post weight, post BMI, % EWL and %TWL of study patients. Beta coefficients and *p* values revealed that the time of surgery is the most independent variable or predictor that had a positively significant relationship with some nutritional indicators. These indicators were: sodium ($\beta = 0.370$), calcium ($\beta = 0.197$), albumin ($\beta = 0.387$) hemoglobin ($\beta = 0.244$) and hematocrit ($\beta = 0.230$) by which all Beta values were positive which means an increase in time will increase the value of parameters. Another significant relationship was found between ferritin and %TWL in which β coefficient was 0.519 which means an increase in %TWL, ferritin will increase in value by about 0.5. The last significant relationship was found between vitamin B12 and post weight, but since β is negative (-0.510) it indicated a negative relationship by which any decrease in post weight, vitamin B12 will increase by about 0.5.

Table (6): Multivariate linear regression for predictors of nutritional parameters

	Age (year)	Gender	Time (year)	Post weight (kg)	Post BMI(kg/m ²)	% EWL	% TWL
Sodium							
<i>Beta</i>	0.123	0.007	0.370	-0.076	-0.022	-0.121	0.043
<i>P value</i>	0.150	0.949	<0.001	0.669	0.932	0.641	0.758
<i>CI 95 %</i>	-0.123,0.078	-1.234,1.316	0.389,0.966	-0.075,0.048	-0.285,0.262	-0.087,0.054	-0.066,0.091
Potassium							
<i>Beta</i>	-0.076	-0.133	0.158	-0.094	-0.136	-0.370	0.030
<i>P value</i>	0.397	0.234	0.061	0.612	0.617	0.176	0.839
<i>CI 95 %</i>	-0.110,0.004	-0.335,0.082	-0.002,0.092	-0.013,0.007	-0.056,0.033	-0.020,0.004	-0.012,0.014
Calcium							
<i>Beta</i>	-0.012	-0.075	0.197	0.045	0.117	0.296	-0.272
<i>P value</i>	0.832	0.531	0.030	0.832	0.708	0.363	0.099
<i>CI 95 %</i>	-0.004,0.003	-0.127,0.066	0.002,0.045	-0.004,0.005	-0.018,0.026	-0.003,0.009	-0.012,0.001

Continue Table (6)

	Age (year)	Gender	Time (year)	Post weight (kg)	Post BMI (kg/m ²)	% EWL	% TWL
Magnesium							
<i>Beta</i>	0.064	0.276	0.012	0.450	-0.346	-0.139	0.104
<i>P value</i>	0.586	0.063	0.913	0.048	0.316	0.705	0.586
<i>CI 95 %</i>	-0.067,0.118	-0.143,5.273	-0.567,0.634	0.001,0.246	-0.862,0.282	-0.187,0.127	-0.121,0.212
Albumin							
<i>Beta</i>	-.088	-0.168	0.387	-0.094	0.029	0.116	-0.158
<i>P value</i>	0.256	0.092	< 0.001	0.566	0.890	0.582	0.225
<i>CI 95 %</i>	-.084,0.023	-2.967,0.225	0.571,1.248	-0.101,0.055	-0.276,0.318	-0.052,0.093	-0.152,0.036
Ferritin							
<i>Beta</i>	0.302	-0.115	0.104	0.137	-0.357	-0.515	0.519
<i>P value</i>	0.008	0.405	0.343	0.588	0.348	0.155	0.008
<i>CI 95 %</i>	1.046,6.663	-103.51,42.21	-8.551,24.290	-2.565,4.494	-24.72,8.81	-7.479,1.208	1.928,12.156

Continue Table (6)

	Age (year)	Gender	Time (year)	Post weight (kg)	Post BMI (kg/m ²)	% EWL	% TWL
Iron							
<i>Beta</i>	0.025	0.114	0.051	0.227	-0.204	-0.015	0.057
<i>P value</i>	0.803	0.367	0.587	0.214	0.458	0.954	0.739
<i>CI 95 %</i>	-0.427,0.550	-7.011,18.831	-2.069,3.639	-0.242,1.070	-3.411,1.548	-0.609,0.574	-0.666,0.936
Vitamin B12							
<i>Beta</i>	-0.601	-0.172	-0.068	-0.510	0.599	0.229	-0.246
<i>P value</i>	0.507	0.139	0.431	0.014	0.052	0.420	0.092
<i>CI 95 %</i>	-5.81,2.89	-213.34,30.02	-36.69,15.74	-13.81,1.58	-0.237,54.85	-3.97,9.47	-13.40,1.02
25-OH Vitamin D							
<i>Beta</i>	0.021	-0.140	0.113	-0.327	0.387	0.057	0.013
<i>P value</i>	0.840	0.268	0.251	0.148	0.251	0.862	0.939
<i>CI 95 %</i>	-0.510,0.625	-23.31,6.54	-1.42,5.40	-1.28,0.196	-1.39,5.25	-0.791,0.942	-0.939,1.02

Continue Table (6)

	Age (year)	Gender	Time (year)	Post weight (kg)	Post BMI (kg/m ²)	% EWL	% TWL
Cholesterol							
<i>Beta</i>	0.191	0.251	0.172	0.386	-0.527	-0.353	0.079
<i>P value</i>	0.096	0.105	0.124	0.140	0.096	0.243	0.699
<i>CI 95</i>	-0.004,0.052	-0.153,1.58	-0.046,0.377	-0.010,0.070	-0.279,0.023	-0.055,0.014	-0.040,0.059
Hemoglobin							
<i>Beta</i>	0.040	-0.205	0.244	0.042	0.073	0.224	-0.132
<i>P value</i>	0.600	0.042	0.001	0.246	0.713	0.315	0.340
<i>CI 95 %</i>	-0.0260,0.045	-2.20,-0.040	0.174,0.665	-0.110,0.093	-0.170,0.248	-0.026,0.080	-0.095,0.033
Hematocrit							
<i>Beta</i>	0.060	-0.210	0.230	0.245	-0.056	-0.012	0.075
<i>P value</i>	0.469	0.054	0.004	0.141	0.788	0.961	0.613
<i>CI 95 %</i>	-0.068,0.148	-6.50,0.051	0.410,2.05	-0.038,0.263	-0.686,0.521	-0.159,0.151	-0.142,0.240
MCV							
<i>Beta</i>	0.077	-0.191	0.151	-0.298	0.321	0.115	-0.101
<i>P value</i>	0.395	0.111	0.079	0.106	0.171	0.660	0.539
<i>CI 95 %</i>	-0.100,0.252	-9.82,1.03	-0.143,2.55	-0.454,0.044	-0.302,1.69	-0.198,0.311	-0.411,0.216

Continue Table (6)

	Age (year)	Gender	Time (year)	Post weight (kg)	Post BMI (kg/m ²)	% EWL	% TWL
Phosphorus							
<i>Beta</i>	0.032	0.076	-0.029	0.545	-0.014	0.440	-0.105
<i>P value</i>	0.819	0.684	0.825	0.058	0.975	0.352	0.643
<i>CI 95 %</i>	-0.005,0.006	-0.120,0.181	-0.066,0.053	0.000,0.013	-0.033,0.032	-0.004,0.012	-0.010,0.006
Folate							
<i>Beta</i>	-0.002	0.012	-0.152	-0.114	-0.787	-0.764	-0.438
<i>P value</i>	0.991	0.957	0.452	0.815	0.292	0.177	0.174
<i>CI 95 %</i>	-0.536,0.530	-11.74,12.38	-9.78,4.47	-0.700,0.555	-4.64,1.44	-0.936,0.180	-1.28,0.243

4.1.4.2 Common Complications

Table (7) illustrated the frequencies of common complications that may a patient have following surgery. It had been shown that almost more than half of patients had hair loss (59.5%) followed by flatulence and abdominal pain with a percentage of 39.3%. Regarding the distribution of the complication among the surgery type, most of patients that still have hair loss were SG patients (84 patients) followed by MGB patients and the same was found for flatulence although the difference among surgery types was significant for flatulence but not for hair loss.

Dry skin recorded a frequency of 34.3% and GERD (heart burn) 33.2% and again the number of patients underwent SG had the highest counts for both complications and chi-square test revealed that there was no association between the surgery and these two complications. Constipation, low appetite, anemia, hypotension, diarrhea and hypoglycemia frequency of occurrence among patients ranged from 20 – 27%. SG patients were the highest in number in low appetite, constipation and hypotension, whereas MGB patients were the highest for diarrhea, anemia and hypoglycemia. Significant association was found in constipation, diarrhea, anemia and hypoglycemia but not in hypotension nor low appetite.

Around 14% of patients had the removal of gallbladder either at the same time when undergone bariatric surgery or due to developing Cholelithiasis (gallstones) by which the number of patients in each type of surgery were almost the same (except RYGB) that ranged from 10-12 patients and there was a strong association between the type of surgery and cholelithiasis since P value was < 0.001 . Since surgery, 13.2% of patients had developed lactose intolerance, 14 patients underwent MGB, and 12 patients underwent SG and only 6 BPD patients with no

significant association. Patients that felt fatigue 18.5% even with less effort most of them were MGB patients with a strong association between the type of surgery and fatigue. Finally, the lowest complication occurred was dysphagia with a frequency of almost 10% and *P* value of 0.407 and that SG patients recorded the highest patients number.

Table (7): Common bariatric surgery complications in accordance with the type of surgery

Complications	Total (n)	%	SG (n)	%	BPD (n)	%	MGB (n)	%	RYGB (n)	%	χ^2	P value
Dry skin	83	34.3	45	54.9	10	11.0	28	34.1	0	0.0	8.081	0.232
Constipation	66	27.3	46	69.7	2	3.0	18	27.3	0	0.0	21.777	0.001
Diarrhea	50	20.7	10	20.4	15	30.6	24	49.0	0	0.0	58.306	< 0.001
Dysphagea	25	10.3	15	60.0	0	0.0	10	40.0	0	0.0	6.150	0.407
Low appetite	65	26.9	38	57.1	3	4.8	24	38.1	0	0.0	5.947	0.429
Hair loss	144	59.5	84	58.3	8	5.6	51	35.4	1	0.7	9.766	0.135
Flatulence and abdominal pain	95	39.3	42	43.6	13	13.8	39	41.5	1	1.1	14.787	0.022
Anemia	64	26.7	24	38.1	11	17.5	29	44.4	0	0.0	19.841	0.003
Hypotension	61	25.3	31	50.0	6	10.0	24	40.0	0	0.0	5.435	0.489
Hypoglycemia	48	20.2	20	41.7	3	6.3	24	50.0	1	2.1	12.628	0.049
Lactose Intolerance	32	13.2	12	37.5	6	18.8	14	43.8	0	0.0	11.012	0.088
GERD	80	33.2	43	54.4	5	6.3	31	39.2	0	0.0	8.309	0.216
Cholelithiasis	33	13.6	10	30.3	11	33.3	12	36.4	0	0.0	31.883	< 0.001
Fatigue	44	18.5	12	27.3	4	9.1	28	63.6	0	0.0	28.415	< 0.001

GERD= gastro esophageal reflux disease; n= number of patients, BPD = biliopancreatic diversion; SG = sleeve gastrectomy; MGB = mini gastric bypass

4.1.5 Adherence to Dietary Recommendations

The most important long-term dietary recommendations after the bariatric surgery are summarized in Table (8). The patients' responses were categorized as adhered and not adhered. Adherence was determined by the choice of either "all of the times" or "most of the times". Non-adherence was determined by the choice of either "some of the times" or "rarely/never". The highest adherence was reported for the statement "I avoid eating and drinking at the same time" with a frequency of 76.7% for both the responses "all of the times" and "most of the times". On the other hand, the lowest adherence was reported for the statement "I exercise at least 3 times a week" with a percentage of 40.1% followed by the statement "I avoid eating high calorie snacks (milk shakes, sugary juices, ice cream, chocolate, crisps, cookies, etc.)" with a percentage of 45.9%. Patients reported another low adherence for taking their recommended vitamins and minerals supplements with a percentage of 49.2%. The remaining statements' scores ranged between 62% - 68% which reflected a degree of adherence to those recommendations.

Table (8): Patient's degree of adherence to standard post-operative dietary and lifestyle recommendations

Statement	All of the times		Most of the times		Some of the times		Never/ rarely	
	N	%	N	%	N	%	N	%
1. I eat 4-5 meals a day (3 main meals and 1-2 snacks).	72	29.8	80	33.1	64	26.4	26	10.7
2. I eat and chew food slowly.	97	40.1	63	26.0	49	20.2	33	13.6
3. I control my portion size and try not to overeat.	153	63.5	42	7.4	32	13.3	14	5.8
4. I avoid eating high calorie snacks (milk shakes, sugary juices, ice cream, chocolate, crisps, cookies, etc).	50	20.7	61	25.2	58	24.0	73	30.2
5. I avoid eating and drinking at the same time.	156	64.7	29	12.0	29	12.0	27	11.2
6. I'm taking my recommended vitamins and minerals supplements.	91	37.6	28	11.6	66	27.3	57	23.6
7. I exercise at least 3 times a week.	62	25.6	35	14.5	61	25.2	84	34.7
8. I still follow up my appointments with my doctor and do all tests required.	139	57.4	25	10.3	33	13.6	45	18.6

N = number of patients

Patients were asked if they still follow up with a dietitian, and if they do not, what are the reasons. Their answers are shown in Figure (13) and Figure (14). For the first question, 50.4% of patients said that they were still following with a dietitian while 49.6% were not. The most reason mentioned for not following is that it's not important to follow up with a dietitian with a percentage of 59.1% while 16.7% said that they were not referred by a doctor and 12.5% due to far appointments.

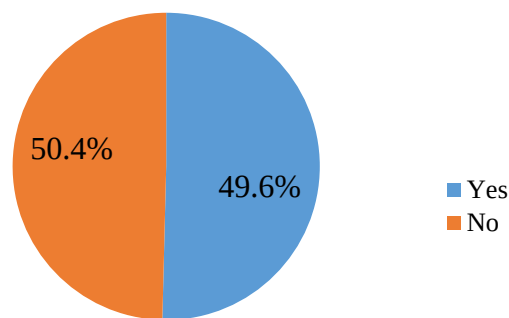


Fig. 14: Following up with a dietitian frequencies

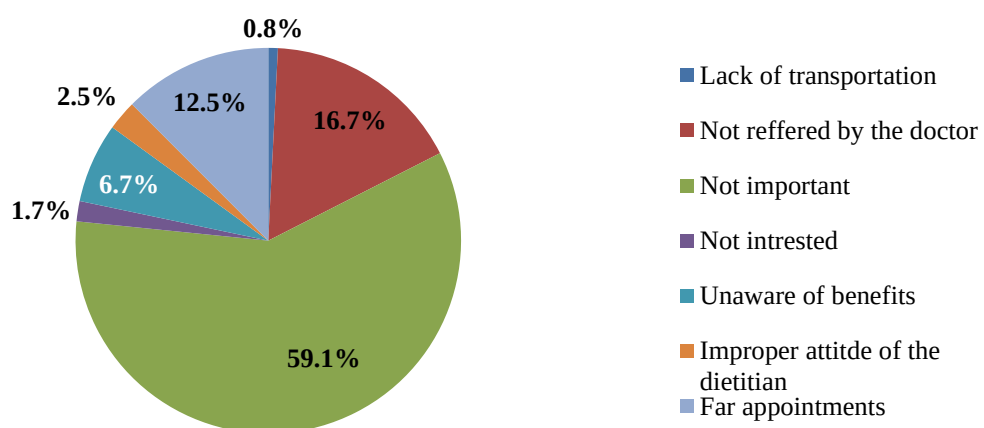


Fig. 15: Reasons for not following up with a dietitian

4.2 Discussion of Results

The epidemic of obesity continues to grow all over the world in both developed and developing countries increasing the risk of getting serious diseases. Bahrain population considered as one with the highest prevalence of obesity in the world (Dillinger, 2018).

Bariatric surgery could be one of the most effective treatments for obesity and its related comorbidities. The fourth International Federation for the Surgery of Obesity (IFSO) report released in 2018 stated that there were 394,431 operations performed in 51 countries in which SG comprised 46% of the total recorded operations, while gastric bypass operations comprised 38.2%. In Bahrain, there is no national published registries regarding bariatric surgeries, hence there is no official statistics that can be relied on. One of the participated hospitals in this research (KHUH) is one of the contributors to the fourth IFSO registry report, which can be considered as a good baseline for bariatric surgery in the country. Results of this study showed that SG was the most performed bariatric surgery followed by MGB, which is the trend in the Middle East while in North America, South America and Western Europe RYGB still is the predominant type (IFSO, 2018). BPD surgery was performed in one participated hospital but cancelled later and no more are performed nowadays as the worldwide trend due to its high risk and complexity. The US Bariatric Outcomes Longitudinal Database reported a rate of one year complication (25.7%) after BPD (Demaria et al., 2010).

Weight loss and resolving comorbidities is the main target of performing bariatric, and it is well documented (Beaulac & Sandre, 2016). Weight loss is the first part studied in this research among participated patients by comparing their BMIs pre and post surgeries and calculating their %TWL and % EWL. Results showed that patients who underwent surgery one,

two and three years ago had the highest % TWL and % EWL and the lowest current BMI , while more time since surgery showed lower weight loss and hence higher BMI. Unfortunately, the majority of patients underwent surgery five and six years ago were considered as obese at the time of study. This finding is compatible with many studies that tackle the problem of failure of maintaining weight loss over time and regain weight after 2-3 years post-surgery (Karmali et al., 2013; Lauti et al., 2016; Nasta et al, 2018).

Regarding weight loss in association with the type of surgery, recent researches usually compared RYGB, MGB and SG because other types like AGB and BPD are no more performed. The present study included 34 patients who underwent BPD 5 and 6 years ago which was a good opportunity to compare with other types. Although results showed that the effect of the surgery type on %TWL and %EWL were not significant, however other studies showed that patients underwent malabsorptive or combined restrictive-malabsorptive procedures loses more excess weight than do pure restrictive procedures (Saeed et al., 2015; De Jong & Hinnen, 2017). In our sample this was the case for MGB, in which patients underwent MGB had the lowest BMI among surgeries, but not BPD nor RYGB. This may be explained by the fact that most BPD patients had the surgery five and six years ago, which was the longest period since surgery and it was mentioned previously the relationship of time and weight loss. The other thing is that RYGB surgery included only two patients in which we cannot generalize the findings on that type.

One reason that can explain the problem of weight regain is the dilation of the gastric sleeve created over the time, resulting in an increased amount of caloric intake and reduced satiety response (Karmali et al.,

2013). The other reason is patient's low adherence to the post-surgery recommendations regarding diet and physical activity.

The negative side of bariatric surgery is its possibility to cause some complications and nutritional deficiencies depending on the type of surgery. However, many literatures proved that such deficiencies were prevalent in obese patients prior to surgery but the surgery may have exacerbate the problem and/or produce new ones (Xanthakos, 2009; Billeter et al, 2015; Al-Mutawa et al., 2018). This study investigated the patient's current nutritional status through reviewing their most recent lab tests, bearing in mind there was no data available regarding the baseline of the nutritional indicators before surgery. Therefore, it could not be said that if there was any deficiency it's related to the surgery, but at least it gives an overview about their nutritional status and if the health professionals need to pay more attention to the most prevalent deficiencies.

When patients were categorized by their nutritional indicator levels as low, normal and high at the time of reviewing their records, around 50 % of the patients were deficient in iron, hemoglobin and MCV which are indicators for anemia. This result is compatible with many studies stated that iron deficiency is the most common nutritional deficiency that could occur at post bariatric surgery (Stein et al., 2014; Lupoli et al., 2017; Patel et al., 2017). However, iron deficiency is also prevalent among obese patients prior to surgery due to inflammation caused by obesity that produced hepcidin which is a protein made in the liver that has the ability to block iron absorption in the intestine (Gletsu-Miller and Wright, 2013).

When iron and hemoglobin levels were compared among the 3 types of bariatric surgeries (excluding RYGB patients since there were only two), BPD and MGB patients had lower levels than the reference range compared to SG although those levels were not significantly different. This finding is consistent with other studies reported high prevalence of iron deficiency in malabsorptive and mixed procedures than purely restrictive one (Gehrer et al., 2010; Al-Jafar et al., 2018). In relation to time, iron deficiency was found in patients performed the surgery 5 and 6 years ago along with hemoglobin and MCV. All patients included in this time interval were BPD and MGB patients which confirm the effect of this type of surgery on patient's iron status.

Although serum iron levels alone is a poor biomarker for iron deficiency and that ferritin is more sensitive and specific indicator for anemia, only 38 % were deficient while around 52% had normal levels which does not correlate with their iron status. Similar findings were shown in a study conducted by Rutte et al. (2014) by which patients after one year of SG surgery in which iron deficiency persisted in the affected patients but ferritin serum levels significantly increased. They explained those results due to supplementation consumption, as it could be the reason behind such result. In addition to the fact that in this study there were only 84 records that included ferritin test while there were 130, 255 and 229 for iron, hemoglobin and hematocrit respectively.

Vitamin B12 deficiency was uncommon among all surgery types and all interval times and there were only 3.3 % who were deficient. Surprisingly, patients who did the surgery 6 years ago, had the highest average level of this vitamin and this could be related to the supplementations in particular intramuscularly dosage of the vitamin.

Folate was the lowest lab test evaluated, and there were only 61 records that contained folate test by which the majority had normal levels. This low attention to do folate test by physician may be due to the fact that folate is absorbed throughout the entire small intestine, and if there is any deficiency it would be due to low dietary intake (Weng et al., 2015). 26.7% of the patients (who were included in the questionnaire part), reported that they experienced anemia after the surgery that was not present before. From the reviewed lab test records, anemia reported by the study subjects could be related mainly to iron deficiency rather than vitamin B12 nor folate deficiencies.

For the electrolytes sodium, potassium and magnesium, average levels were normal among the surgical types and there were only 2 patients who had hypokalemia (low potassium); one SG and one BPD, 3 deficient in magnesium and 1 deficient in sodium. Studies regarding these electrolytes were not sufficient, although few studies discussed the situation of magnesium and potassium in bariatric patients (Stein et al., 2014; Busetto et al., 2018)

Moreover, patient's average levels of albumin were normal, although there were few numbers of patients who were deficient in protein and mainly they were MGB. In addition, cholesterol average levels were also normal for SG and MGB while RYGB were almost border line to low level and BPD patients were deficient. This could be attributed to the great malabsorption accompanied with this type of bariatric surgery and the big role of bariatric surgery in resolving hyperlipidemia in obese patients (Courcoulas et al., 2013; Saeed et al., 2015).

Calcium was normal among all surgery types except BPD patients in which the average levels were little lower than the reference range, while

nutritional indicators categories showed a deficiency of approximately 17% among patients. Since calcium deficiency linked to osteoporosis and that bone compromise more than 90% of human body calcium, then measuring bone density using dual energy X-ray absorptiometry (DEXA) considered a more reliable marker (Gletsu-Miller and Wright, 2013).

Average levels of vitamin D was lower than the reference range in MGB patients and there were around 41% that were deficient and 40% had insufficient levels. There was a conflict in which the averages of vitamin D levels among surgery types (except MGB) were normal whereas patients when categorized by the vitamin status, the majority of patients were either deficient or had insufficient levels of the vitamin. This contradiction may be partly due to large standard deviations of serum vitamin D levels within each surgery group. Studies showed that significant hypovitaminosis D is already present in patients pre-operatively, and it's ranged from 25 % to 80 % (Stroh et al., 2017; Al-Mutawa et al., 2018). Reasons for this deficiency are low consumption, low sun exposure, and decreased bioavailability of vitamin D due to its being deposited in adipose tissue (Stein et al., 2014). As for calcium, vitamin D deficiency following malabsorptive procedures is caused by the exclusion of the duodenum and the short common channel as well as weight reduction (Stroh et al., 2017).

Many gastro-intestinal symptoms and nutrition related complains are common after bariatric surgeries and may influence the quality of life. Hair loss is one of the most reported common complications that could occur post bariatric surgery. It is related to rapid weight loss, iron and zinc deficiency and other micronutrient deficiencies (Ruiz-Tovar et al., 2014). Around 60% of patients in the present study reported this problem which is in line with other studies that revealed a percentage of hair loss

ranged between 40% and 60% (Sauer et al., 2014; Goldenshluger et al., 2017; Lin et al., 2019) However, these studies reported higher hair loss frequency in MGB patients compared to SG patients while the opposite was found in the present study. This may be related to higher patients number of SG patients recruited in this study (57.6%) and about 56% performed the surgery one and two years ago in which weight loss is rapid during this period. Another common complication is GERD, in this study about 33% of patients either developed de novo GERD or it has existed pre-surgery but it was worsened post-operatively and most of them were SG patients compared to MGB. A review conducted by Tutuian (2014) said that studies included in his review indicated that GERD may develop after SG while number of studies documented that RYGB improves GERD symptoms.

Hypoglycemia has not yet been sufficiently studied in bariatric population and it is frequently identified with dumping syndrome. The risk increased 2-7 fold post-operatively in gastric bypass patients (Handzlik-Orlik et al., 2014). The same finding was observed in this study by which 50% of patients who suffered from hypoglycemia were MGB. However, this complain was self-reported and some patients sometimes may be confused to distinguish between hypoglycemia and hypotension. Patients with hypoglycemia are usually referred to an endocrinologist and advised to consume small amounts of sugar in the first hour of postprandial (Sherf Dagan et al., 2017b).

Other complications that reported mostly in gastric bypass patients were diarrhea, flatulence and fatigue. Study results showed that diarrhea and fatigue occurred mostly in MGB patients while flatulence recorded more in SG patients although the frequencies were approximately close, 43.6% and 41.5% in SG and MGB respectively. Diarrhea and abdominal pain

could be a result of dumping syndrome, so it is recommended to eat and swallow food slowly, consume lactose free milk, avoid simple sugars and avoid gas producing foods (Sherf Dagan et al., 2017b). Fatigue prevalence in bariatric patients could be related to many reasons such as iron deficiency, magnesium and potassium deficiency, not drinking water and food intake (Shanon et al., 2013).

Complaining from lactose intolerance (inability to fully digest the milk sugar lactose) post-operatively is rarely addressed by researches. Moreover, the process of bariatric surgery in developing such intolerance is unclear (Borbély et al., 2017). In this study, there were about 13% complaining from lactose intolerance since surgery and most of them were MGB surgery. Constipation and dry skin are common side effects after bariatric surgery by which prevalence ranges between 7% and 39% (Andromalos, 2017). These two complaints could be related to that patients often consume a suboptimal fluid intake as a result of the fluid restriction at meals and snacks to avoid dumping syndrome (Dowd, 2005). As the questionnaire showed that 64.5% never eat and drink at the same time and most of them said that they are forced to do so because if they don't they will suffer from abdominal pain. Furthermore, constipation could be as a result of using vitamin and mineral supplements that patients should take for long periods (Sherf Dagan, 2017b).

Rapid weight loss post bariatric surgery beside the changes in the cholesterol content of bile and the motility of gallbladder may result in gallstone formation (Cholelithiasis). Theoretically, cholelithiasis expected to be more frequent in gastric bypass than in SG since nutrients continue to be passed through the normal gastrointestinal tract (Bora et al., 2017). However, some studies reported no difference between SG and RYGB

and that what was found in this study by which the removal of gallbladder (cholecystectomy) among different surgery types was 30.3%, 33.3% and 36.4% for SG, BPD and MGB respectively (Bora et al., 2017).

Adherence to dietary and lifestyle recommendations is critical to the long term health and weight outcomes for patients who undergo bariatric surgery. In the present study, it had been found a medium to high adherence to the most important recommendations. This could be due to the fact that 30.7% of the patients underwent the surgery one year ago, by which according to literatures a great adherence would be prior to surgery and immediately post-surgery and then as time progress the rate of adherence decreases (Story, 2017). One recommendation that patients recorded the lowest adherence to, was avoiding high calorie snacks (milk shakes, sugary juices, ice cream, chocolate, crisps, cookies, etc.) which could have a big impact on patient's weight. In turn, this may explain the finding in the present study that 36.1% of the patients were overweight and 47.5% were obese. Furthermore, a study conducted by Leahey et al. (2012) compared food cravings between patients who underwent bariatric surgery and a control group. It has found that although bariatric patient's cravings decreased, they still did not fully reduce to normative levels. In addition, patients also showed low adherence to conduct physical activity that can have impact on the weight loss maintenance and prevent muscle wasting (Sherf Dagan et al., 2017a).

A critical cause for nutritional deficiencies post bariatric is non-adherence to recommended supplementations. Few studies discussed the degree of bariatric patients adherence to supplementations and its correlation to nutritional deficiencies beside the lack of patient awareness for the necessity of life- long supplementations (Agaba et al., 2015). Half of patients in this study reported that they adhered to their recommended

supplementations and this could be related to that approximately half of them were still following-up by their doctors and of course they will encourage them to take their prescribed multivitamins and minerals. However, several studies have found low compliance with follow up post bariatric surgery, and that attrition ranged from 3% to 63% (Khorgami et al., 2015; Story 2017).

Dietitians play a vital role before and after bariatric surgery. Around half of the studied patients were following up with a dietitian, this percentage is due to the fact that the majority of those patients performed the surgery one year and two years ago after the operation in SMC hospital. SMC hospital is a governmental hospital that performs bariatric surgeries free of charge including all other services, such as following-up with a dietitian. On the other hand, the other hospital (KHUH) is charging for all services. In addition, KHUH started performing bariatric surgery in the year 2012 in which there was no dietitian in the hospital and that's why 16.7% said that they were not referred to a dietitian by the surgeon.

Most of the other half who said they were not following with a dietitian, claimed that it is not important to do so and they can surf the net and find all required information and recommendations and if they need any consultation they can refer to their physicians. Unfortunately, some of those patients thought that the role of the dietitian is only giving recommendations and what to eat and what not to. This perception, could be attributed to the outdated counseling styles that some dietitians are following, styles that are authoritative and not effective in building good rapport with the patient (Story, 2017). In a prospective study conducted by Sherf Dagan and his colleagues in 2017a found that patients who had more visits to the dietitian post-surgery experienced greater weight loss than those who had fewer visits to the dietitian.

Another essential component of effective intervention is patient education by a multidisciplinary team that focuses on patient-centered education that can help patient to overcome barriers to lifestyle changes post-surgery. Furthermore, 12.5% attributed the lack of following-up with a dietitian to the fact that appointments were spaced far apart resulting in them forgetting to attend. This was particularly the case for those hospitals that did not send a reminder message or phone call to the patients. About 7% of the patients did not know the role or the benefit of the dietitian, thus the awareness of that issue should start prior to the surgery from other members of the bariatric team.

It can be concluded that although bariatric surgery is an effective intervention in obesity treatment and improve obesity-related co-morbidities, it carries some complications that affect the outcomes. The first complication is weight regain that could begin several years following surgery, secondly is the nutrient deficiencies that are common post-bariatric surgery manifestations depending on the type of the surgery. In addition, patients could suffer from some complaints that may affect their quality of life such as hair loss, hypoglycemia and diarrhea. All those complications could be controlled and managed through adherence to dietary and life style recommendations post operatively. Poor diet quality, supplementations non-compliance, inappropriate food choices, and lack of nutritional counseling all serve as predictors for all previously listed complications. Patients should be aware that bariatric surgery alone is not a miracle cure to weight loss while keeping all obesity related behaviors practiced prior the surgery.

4.3 Study's Recommendations

The current study has several strengths and limitations. The large number of patients included in both the questionnaire part and the biochemical tests studied and the participation of two main hospitals can be considered as strengths of the present study. Regarding limitations, first limitation was the type of the study that is retrospective cohort study, by which it looked at patient's weight at the time of study and prior to surgery. It would have been better to extract from the patient's record their weight at several time intervals to find the trend of weight loss and at what time exactly patient start weight regain. However, this weight related information could be found for patients who underwent the surgery recently or maximum two years ago since patients performed surgery several years ago mostly do not follow up with their surgeon unless serious problems appeared which can limit the comparison with longer time after surgery.

Secondly, nutritional parameters were detected only at the time of the study, so making a comparison to find out the exact cause of the deficiency cannot be concluded. Reasons behind not taking the pre surgery lab tests were mainly due to the fact that SMC hospital and health centers kept the lab data for a maximum of two years and sometimes a little more. Therefore, previous lab tests would not be available for comparison. Another reason was that two third of the patients belonged to KHUH were doing their lab test outside the hospital; mostly in government health centers where lab tests are done for free of charge and some were conducted at private laboratories. Hence, it was a good chance to conduct the study in a government hospital so missing lab test in KHUH hospital can be avoided. Moreover, there were several missing values for some biochemical indicators which made the sample size for

some of these indicators smaller than others. Therefore, it is possible that some values showed up to be significant in some surgery types or time, but not in others due to sample size.

Third drawback was that adherence data were collected via self-reports; hence, patients may answer the questions in a manner perceived as socially accepted.

Nevertheless, this study was able to assess the nutritional status of bariatric patients and address common complications beside measure their adherence to dietary recommendations for the first time in Kingdom of Bahrain. Results showed that bariatric population were facing the problem of weight regain, non-compliance with supplements and other recommendations that could affect the surgery outcomes. This has important clinical implications for tailoring dietary and psychological counseling both before and after surgery in order to improve and maintain outcomes. For future research, it is suggested that biochemical indicators should be reviewed pre and post-operatively to identify any association between the surgery and any detected deficiency.

Based on this study findings, it is recommended for future work in bariatric surgeries the followings:

1. Although SG was the lowest surgery that had complications, long-term data need to be evaluated to better determine risks and benefits of this growing type of bariatric surgery.

2. Both strong nutritional education and counseling are essential components of effective interventions, so health practitioners are responsible to encourage patients to follow up.
3. Dietitians are encouraged to gain knowledge in regard to the educational and counseling theories and strategies that can maximize outcomes.
4. Identify nutritional and behavioral non-compliance barriers specific to the bariatric population will tackle an important issue.
5. To increase patient's engagement, social media could be used and online educational programs beside telephone consultations to minimize barriers such as time, distance, and cost.

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Appendices

Questionnaire

Bariatric Surgery in Bahrain

The questionnaire will take approx. 5 minutes.

Dear Participant, The purpose of this questionnaire is to determine the extent to which those who are subject to obesity treatment are committed to post-surgery nutritional guidelines and to know the main problems they suffer. This questionnaire is part of the graduation research for the Master in Nutrition and Dietetics program, so please kindly answer the questions accurately and objectively, as it has a significant impact to get positive results. Note that your answers will be respected and will be treated in strict secrecy and will only be used for scientific research purposes. Thank you in advance.

Personnel Information

- Age:
- Gender: ☐ Male ☐ Female
- Nationality: ☐ Bahraini ☐ Non- Bahraini
- Educational Level: ☐ Elementary ☐ Intermediate ☐ Secondary ☐ Diploma/
Bachelor ☐ Post- Graduate
- Marital Status: ☐ Single ☐ Married
- Year of Surgery: Month..... Year.....
- Type of Surgery: ☐ Sleeve Gastrectomy ☐ Gastric Band ☐ Gastric Bypass
☐ Biliopancreatic Diversion ☐ Other
- Height.....
- Weight before surgery..... Kg
- Current weight Kg

❖ In general, how can you describe your dietary habits since you did the surgery?

		All of the time	Most of the time	Some of the time	Never/ Rarely
1	I eat 4-5 meals a day (3 main meals and 1-2 snacks)				
2	I eat and chew food slowly				
3	I control my portion size and try not to overeat				
4	I avoid eating high calorie snacks (milk shakes, sugary juices, ice cream, chocolate, crisps, cookies, etc)				
5	I avoid eating and drinking at the same time				
6	I'm taking my recommended vitamins and minerals supplements				
7	I exercise at least 3 times a week				
8	I still follow up my appointments with my doctor and do all tests required.				

Since surgery, did you follow up with a dietitian?

☐ Yes

☐ No

- In case of you did not following with dietitian, what were the reasons (you can choose more than one):
 - lack of transportation
 - Not referred by the doctor
 - Cost of attendance
 - Not important
 - Not interested
 - Unaware of the benefits
 - Improper attitude of the dietitian
 - Far appointments

❖ Since you did the surgery, did any of the following problems appeared or still appearing to you? (put √)

symptoms	Nothing	Appeared in the begging but not any more	Still appearing
Dry skin			
Constipation			
Diarrhea			
Difficulty in swallowing			
Low appetite			
Hair loss			
Flatulence (abdominal gases)			
Anemia			
Low blood pressure			
Low blood sugar			
Milk intolerance			
Heart burn			
Gallstones			
Fatigue			
Other.....			

استبيان

يستغرق الاستبيان قرابة 5 دقائق

عزيزي المشارك، أن الغرض من هذا الاستبيان هو معرفة مدى التزام الخاضعين لعمليات معالجة السمنة بالارشادات التغذوية لما بعد جراحة السمنة ومعرفة أبرز المشاكل التي يعانون منها. يعتبر هذا الاستبيان جزء من بحث التخرج من برنامج ماجستير التغذية والنظم الغذائية، لذا نرجو منك التكرم بالإجابة على الأسئلة بدقة و موضوعية لما له من أثر كبير في الحصول على نتائج ايجابية. علما أن كل مايرد في اجابتك سيكون موضع احترام و سوف يعامل بسرية تامة ولن يستخدم الا لأغراض البحث العلمي فقط.

البيانات الشخصية: -

- العمر:

- الجنس: ذكر أنثى

- الجنسية: ☐ بحريني ☐ غير بحريني

- المستوى التعليمي: ☐ ابتدائي ☐ اعدادي ☐ ثانوي ☐ دبلوم ☐ بكالوريوس ☐ دراسات عليا

- الحالة الاجتماعية: ☐ أعزب ☐ متزوج

: الشهر السنة - السنة التي قمت فيها باجراء العملية

- نوع العملية: ☐ تكميم ☐ تحويل ☐ ربط المعدة (الحلقة) ☐ تحويل مسار ☐ أخرى

- الطول:

- الوزن قبل العملية: كجم.

- الوزن الحالي: كجم.

❖ بشكل عام، كيف تصف عاداتك الغذائية منذ قيامك بإجراء العملية:

		دائما	معظم الاحيان	بعض الاحيان	أبدا
1	أتناول 4- 5 في اليوم (3 وجبات رئيسية و 1-2 وجبة خفيفة).				
2	أتناول الأكل ببطء و أمضغ الطعام جيدا قبل بلعه.				
3	أستطيع السيطرة على مقدار ما أتناوله وأحاول ألا أزيد من الكمية				
4	أتجنب تناول الطعام ذو السعرات الحرارية العالية (الأيس كريم، الميلك شيك، رقائق البطاطس، الشوكولاتة، العصائر المحلاة، البسكوت).				
5	أتجنب الشرب أثناء الاكل (ماء، عصير، مشروبات غازية، لبن).				
6	أتناول حبوب الفيتامينات والمكملات الغذائية الموصوفة لي من قبل الطبيب بانتظام.				
7	أمارس الرياضة على الأقل 3 مرات في الاسبوع.				
8	أتابع مع الطبيب جميع المواعيد وأقوم بكافة الفحوصات المختبرية بانتظام				

منذ اجراءك للعملية ، هل تابعت مع أخصائي التغذية؟

○ نعم

○ لا

في حالة عدم متابعتك مع أخصائي التغذية، ما هي الاسباب:

- عدم توافر المواصلات
- لم يحولني الطبيب للاخصائي
- التكلفة العالية
- غير ضروري
- غير مهتم
- لا أعلم فائدة الاخصائي
- لا يعجبني اسلوب الاخصائي
- المواعيد البعيدة

❖ منذ اجرائك العملية, هل ظهرت او لا زالت تظهر عليك اي من الاعراض التالية (ضع علامة √):

الاعراض	لا يوجد	ظهرت في البداية و لكنها الان غير موجودة	لا زالت مستمرة
الجفاف			
الامساك			
الاسهال			
صعوبة البلع			
انخفاض الشهية			
تساقط الشعر			
الانتفاخ			
الأنيميا (فقر الدم)			
انخفاض ضغط الدم			
انخفاض سكر الدم			
أعراض مصاحبة لتناول الحليب			
حموضة			
حصى المرارة			
الشعور بالتعب و الاعياء			
اخرى (أذكرها).....			

ملخص

لا يزال معدل انتشار السمنة المرضية في ازدياد، وقد أثبتت جراحة علاج البدانة أنها تدخل فعال لفقدان الوزن ومعالجة الأمراض المصاحبة المرتبطة بالسمنة. ومع ذلك، فإن هذا النوع من التدخل قد يحمل بعض الآثار الجانبية السلبية مثل نقص التغذية ويشكو بعض المرضى من بعض المشاكل ما بعد العملية. تبحث الدراسة الحالية مدى انتشار جراحة السمنة في مملكة البحرين من خلال قياس درجة فقدان الوزن، المشاكل التغذوية المصاحبة والالتزام بتوصيات النظام الغذائي.

تم اختيار 398 مريضاً بشكل عشوائي من مستشفيات شاركا في هذه الدراسة، ولكن تم إدراج 343 مريضاً فقط مؤهلين للمشاركة في الدراسة. تمت مراجعة السجلات الطبية للمرضى المشمولين في الدراسة بأثر رجعي وطلب من المرضى ملء استبيان من خلال مقابلة عبر الهاتف. أظهرت النتائج أنه في وقت الدراسة، كان 47.5% يعانون من السمنة المفرطة، 36.1% يعانون من زيادة الوزن بينما 16.4% فقط كانت أوزانهم طبيعية. وقد كان هناك تأثير كبير لنوع الجراحة (القيمة الاحتمالية = 0.025) والوقت منذ الجراحة (القيمة الاحتمالية = 0.008) على مؤشر كتلة الجسم لدى المرضى. أشارت النتائج أيضاً أنه لم يكن لنوع الجراحة تأثير كبير على نسبة فقدان الوزن الزائد (EWL) أو نسبة مجموع فقدان الوزن (TWL)، في حين أن الوقت منذ الجراحة أثر على كل من نسبة فقدان الوزن الزائد (EWL) و نسبة مجموع فقدان الوزن (TWL) بشكل كبير بقيم احتمالية تساوي 0.006 و 0.001 على التوالي.

أظهرت حالة المؤشر الغذائي للمرضى بغض النظر عن نوع أو وقت الجراحة أن غالبية المرضى كانت لديهم مستويات طبيعية من المؤشرات التي تمت مراجعتها باستثناء الهيموغلوبين، الهيماتوكريت، متوسط حجم كريات الدم، فيتامين د، الفيريتين والحديد. فقد كان حوالي نصف المرضى يعانون من نقص الحديد، متوسط حجم كريات الدم والهيموغلوبين بنسب 48.5%، 47.1% و 46.8% على التوالي. أما بالنسبة لفيتامين (د)، أشارت الفحوصات أن 40% من المرضى لديهم مستويات غير كافية و 41.2% يعانون من نقص في هذا الفيتامين، بالإضافة أن 38% من المرضى يعانون من نقص الفيريتين. كانت القيم المتوسطة للمغذيات التي تمت دراستها للمرضى ضمن النطاق المرجعي الطبيعي بغض النظر عن نوع الجراحة رغم وجود استثناءات قليلة. لم يكن هناك تأثير كبير لنوع الجراحة على جميع الفحوصات المخبرية باستثناء الكوليسترول بينما كان هناك تأثير كبير للوقت منذ الجراحة على كل من الصوديوم والبوتاسيوم والكالسيوم والألبومين وفيتامين ب ١٢ والهيموجلوبين. أما بالنسبة للمشاكل الأكثر شيوعاً بين المرضى ما بعد إجراء العملية كانت كالتالي: 59.5% تساقط الشعر، 39.3% انتفاخ البطن، 34.3% جفاف البشرة، 33.2% ارتجاع المريء، 27.3% الإمساك، 26.9% انخفاض الشهية و 26.7% فقر الدم. كان هناك تأثير كبير لنوع العملية الجراحية بين المرضى الذين يعانون من الإمساك والإسهال و انتفاخ البطن و فقر الدم و نقص السكر في الدم و الحصوات في المرارة والتعب والاعياء. كان التزام المرضى بالتوصيات الغذائية الواجب اتباعها بعد إجراء العملية مرتفعاً إلى متوسط، ووجد أن 49.6% من المرضى كانوا يتابعون مع اختصاصي تغذية بينما 59.1% من المرضى الذين لم يتابعوا مع اختصاصي التغذية يرون أنه ليس من المهم القيام بذلك.

جامعة البحرين

قسم علوم الحياة

كلية العلوم



جراحة السمنة في البحرين: النظر في تخفيف الوزن، المضاعفات التغذوية المصاحبة و الالتزام بالنظام الغذائي

أطروحة مقدمة كجزء من متطلبات الحصول على درجة الماجستير في التغذية و النظم الغذائية

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