T.C.
YEDİTEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
DEPARTMENT OF NUTRITION AND DIETETICS

# COMPARISON OF EXCESS BODY WEIGHT LOSS AND PREOPERATIVE AND POSTOPERATIVE VITAMIN AND MINERAL STATUS OF PATIENTS WHICH UNDERWENT SLEEVE GASTRECTOMY OPERATION IN A PRIVATE CLINIC

MASTER THESIS

FATMA KAHRAMAN GÖK

Istanbul, 2018

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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu`nun 22/06/2018 tarihli ve 2018/11-08 sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ
Sağlık Bilimleri Enstitüsü Müdürü

## DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

18.07.2018

Fatma KAHRAMAN GÖK

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## LIST OF SYMBOLS AND ABBREVIATIONS

| | |
|---|---|
| 25(OH)D | 25-Hydroxy Vitamin D |
| AACE | American Association of Clinical Endocrinologists |
| ASMBS | American Society of Metabolic and Bariatric Surgery |
| BEL | Best Evidence Levels |
| BMI | Body Mass Index |
| BPD | Biliopancreatic Diversion |
| BPD/DS | Biliopancreatic Diversion with Duedonal Switch |
| CCK | Cholecystokinin |
| CHD | Congenital Heart Disease |
| CVD | Cardiovascular Disease |
| DASH | Dietary Approach to Stop Hypertension |
| DS | Duedonal Switch |
| EBML | Excess Body Mass Loss |
| EBW | Excess Body Weight |
| EBWL | Excess Body Weight Loss |
| EBWL% | Percentage of Excess Body Weight Loss |
| FDA | The USA Food and Drug Administration |
| GLP-1 | Glucagon-Like Peptide-1 |
| HDL | High-density Lipoprotein |
| IBW | Ideal Body Weight |
| IGT | Impaired Glucose Tolerance |
| IU | International Unit |
| LAGB | Laparoscopic Adjustable Gastric Band |
| MBSAQIP | Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program |
| NIH | National Institutes of Health |
| PCOS | Polycystic Ovary Syndrome |
| PEM | Protein Energy Malnutrition |
| PYY | Peptide YY |
| RYGB | Roux-en-Y Gastric Bypass |
| SG | Sleeve Gastrectomy |
| SOS | Swedish Obese Subjects |
| STEP | Stepwise Approach to Surveillance |
| TOS | The Obesity Society |
| TUİK | Türkiye İstatistik Kurumu |

| | |
|---|---|
| TURDEP | Türkiye Diyabet, Hipertansiyon, Obezite ve Endokrinolojik Hastalıklar Prevalans |
| UK | United Kingdom |
| USA | United States of America |
| WHO | World Health Organization |
| SD | Standard Deviation |
| TIBC | Total Iron Binding Capacity |

# ABSTRACT

**Gök, FK. (2018). Comparison of Excess Body Weight Loss and Preoperative and Postoperative Vitamin and Mineral Status of Patients Which Underwent Sleeve Gastrectomy Operation in A Private Clinic. Yeditepe University, Institute of Health Science, Department of Nutrition and Dietetics, Master Thesis, İstanbul.**

The aim of this study is to reveal preoperative micronutrient deficiencies, to investigate micronutrient status of the patients who underwent sleeve gastrectomy (SG) at postoperative 3rd and 12th months, to track micronutrient status of bariatric patients using multivitamin supplementation and to assess the correlation between percentage of excess body weight loss (EBWL%) and micronutrient status of the patients. This study is based on data collected from an obesity surgery clinic's routine follow-up program. 229 participants' preoperative and postoperative datas are evaluated. Pre- and postoperative anthropometric measurements and biochemical evaluation of certain micronutrients (iron, ferritin, vitamin $B_{12}$, folic acid, total iron binding capacity (TIBC), hemoglobin, zinc, calcium, vitamin D, vitamin A, vitamin $B_1$, biotin and copper). Although all participants supplemented with showed specific multivitamin and mineral twice a day after surgery, postoperative data analyses micronutrient deficiencies. EBWL% is calculated both for postop 3rd and 12th months. And the mean value of EBWL% at both 3rd and 12th months could be classified as successful regarding literature based cut-off points. The major deficiency detected both preoperatively and postoperatively was vitamin D deficiency (preop; 87%, postop 3rd m; 51%, postop 12th m; 51%). Ferritin, folic acid, vitamin $B_{12,}$ copper deficiencies and low serum hemoglobin were significant findings. Prevalence of postop biotin deficiency was unexpectedly high. Postop EBWL% and serum hemoglobin showed negative correlation. Micronutrient deficiencies after SG can be detected even with presence of multivitamin supplementation and monitorization micronutrient levels for detecting such micronutrient deficiency is very an important aspect of postop follow-up procedure.



**Keywords:** bariatric surgery, sleeve gastrectomy, micronutrient deficiency, excess body weight loss

# ÖZET

**Gök, FK. (2018). Özel Bir Klinikte Sleeve Gastrektomi Operasyonu Geçirmiş Hastaların, Ameliyat Öncesi ve Sonrası Vitamin ve Mineral Düzeyleri ile Fazla Kilo Kaybı Oranlarının Karşılaştırması. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Beslenme ve Diyetetik Programı, Yüksek Lisans Tezi, İstanbul.**

Bu çalışmanın amacı, sleeve gastrektomi (SG) geçirmiş hastaların, ameliyat öncesi ve ameliyat sonrası 3. ve 12. aylardaki vitamin mineral düzeylerini belirlemek, ameliyattan sonra hastaların fazla kilodan kayıp yüzdeleri ile vitamin-mineral düzeyleri arasındaki ilişkiyi değerlendirmektir. Bu çalışma, bir bariatrik cerrahi kliniğindeki hasta takibinde rutin elde edilen veriler kullanılarak tasarlanmıştır. 229 hasta verisi ameliyat öncesi ve sonrası değerlendirilmiştir. Ameliyat öncesi ve sonrası antropometrik ölçümler ve belirli parametrelerin (demir, ferritin, $B_{12}$ vitamini, folik asit, toplam demir bağlama kapasitesi, hemoglobin, çinko, kalsiyum, D vitamini, A vitamini, $B_1$ vitamini, biotin ve bakır) biyokimyasal analizleri değerlendirilmiştir. Ameliyat öncesi eksikliği olan hastalara ameliyat öncesi replasman tedavisi yapılmasına ve hastaların ameliyat sonrası düzenli olarak günde iki kere belirli bir multivitamin takviyesi kullanmış olmalarına rağmen postop süreçte mikro besin öğesi eksiklikleri saptanmıştır. Postop 3. ayda ve 12. ayda fazla kilodan kayıp yüzdeleri hesaplanmıştır. Hastaların ağırlık kayıp ortalamaları literatüre göre değerlendirildiğinde başarılıdır. D vitamini, ameliyat öncesi ve sonrası süreçte saptanan temel mikrobesin eksikliği olarak dikkat çekmektedir (preop; %87, postop 3. ayda ve 12. ayda %51). Ameliyat sonrasında; ferritin, folik asit, $B_{12}$ vitamini, bakır eksiklikleri ve düşük hemoglobin düzeyi en önemli bulgulardır. Biotin eksikliği ameliyat sonrası beklenmedik şekilde yüksek bir sıklığa sahiptir. Ameliyat sonrası hastaların fazla kilodan kayıp yüzdeleri ile hemoglobin düzeyleri arasında negatif korelasyon saptanmıştır. Mikro besin öğesi yetersizliği, ameliyat sonrasında multivitamin desteğine rağmen görülebilmektedir ve mikro besin ögelerinin monitörizasyonu ameliyat sonrası takip sürecinin önemli bir parçasıdır.



**Anahtar kelimeler:** bariatrik cerrahi, sleeve gastrektomi, mikro besin öğesi yetersizliği, fazla kilo kaybı

# 1. INTRODUCTION

Obesity is a favorite topic for social life, science and any field people are in to. It can be deduced from the saying of Hippocrates: "Corpulence is not only a disease itself, but the harbinger of others", standing out that obesity is a medical disorder which also leads to many co morbidities (1).

World Health Organization (WHO), defines obesity as one of the most openly detectable, still most ignored public-health issue which endangers both more or less developed countries (2). Taking attention and recognition of the problems caused by overweight and obesity goes back just 10 years, counter to malnutrition, infectious diseases and underweight because those are dominantly taken attention in the past. Abdominal obesity is defined as waist-to-hip ratio above 0.90 for men and above 0.85 in women or a BMI above 30.0 in 2009 WHO report (3).

Treatment of obesity requires multidisciplinary approach; lifestyle changes, pharmacotherapy and bariatric surgery are treatment methods of obesity. Collected cumulative literature knowledge suggests that bariatric surgery leads to greater weight lost compared with non-surgical treatments of obesity in morbid obese population (4,5). SG is a stand-alone bariatric surgery procedure which has restrictive effect on weight loss. As compared with malabsorptive procedures like Roux-en-Y Gastric Bypass (RYGB) and Biliopancreatic Diversion with Duedonal Switch (BPD/DS) it has lower complication risk and it has similar weight loss results and improvement in co morbidities (6). In USA (United States of America), SG became the most popular bariatric surgery by leaving RYGB, BPD/DS and LAGB (Laparoscopic Adjustable Gastric Band) behind (7). SG has a short history as a single procedure; more data is needed about SG procedure. In order to understand the risk, prevention, and treatment of possible micronutrient deficiencies postop micronutrient level assessment, determination of postop micronutrient requirements and daily intake recommendations are needed.

SG is hypothesized to have less postop micronutrient deficiencies than RYGB because it is not a malabsorptive procedure. Nevertheless nutritional deficiencies may occur after SG due to decreased gastrointestinal secretion and altered food intake. Some studies have reported nutritional status of postop SG patients but results are contradictory (8,9). There are inadequate data especially about mid-long period after SG.

The aim of this study is to reveal preop micronutrient deficiencies, to investigate micronutrient status of the patients who underwent sleeve gastrectomy at postop 3rd months and 12th months, to track micronutrient status of patients using multivitamin supplementation and to assess the correlation between percentage of excess body weight loss (EBWL%) and micronutrient status of the patients.

## 2. GENERAL INFORMATION

### 2.1 Obesity

When calorie intake is superior to energy expenditure, the excess energy is stored as triglycerides form and preserved in adipose tissue. In order to survive in extreme circumstances, like food shortage, energy storage is essential. On the other hand, too much body fat is associated with the risk of mortality and morbidity (10). In other words, being overweight and obese is defined as abnormal or excessive fat accumulation which may impair health (11).

This health impairment causes numerous health problems and day by day many people suffer from these diseases and seek for help or treatment. Obesity has negative effects on public health (Figure 2.1 (12)). Further information of these effects are given in following sections of general information. Treatment and management of obesity is very important topic for society.

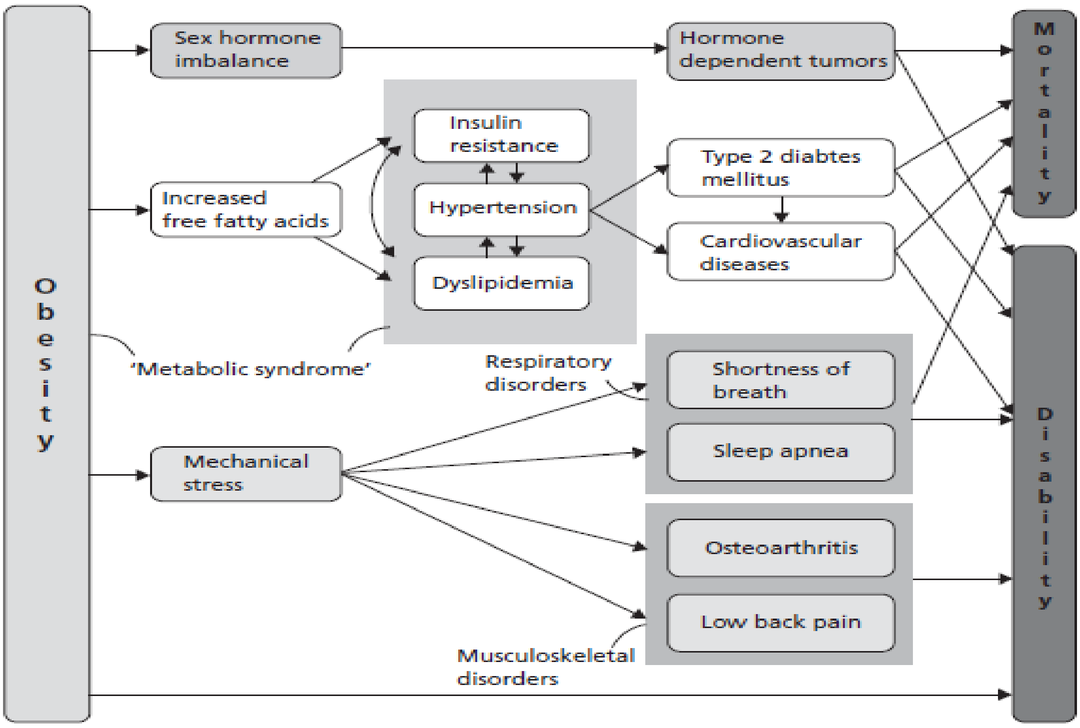


**Figure 2. 1. The Public Health Impact of Obesity** (12)

## 2.2 Prevalence

According to 2016 data, the prevalence of obesity raised almost threefold since 1974. In 2016, 39% of adults aged 18 years and older were overweight, 13% were obese. And all around the world, being obese and overweight take more lives than being underweight. For children aspect, 41 million children under the age of 5 were overweight or obese. And in 2016, over 360 million children and adolescents aged 5-19 were overweight or obese (11). Obesity prevalence of European union countries in 2016 is shown in Figure 2.2 (13).

According the very first survey of TURDEP (Türkiye Diyabet, Hipertansiyon, Obezite ve Endokrinolojik Hastalıklar Prevalans) I, obesity prevalence is also dramatically increasing in Turkish population, as worldwide (14). According to results of TURDEP II, obesity prevalence in Turkish population, 20 years and older, is 31,2%, being overweight prevalence is 37,5% and being overweight and obese prevalence is 68,7% (15). Comparing with the first version of the study TURDEP I (14),published twelve years before TURDEP II (15), prevalence of obesity is increased by 40% in Turkish population. This increase is different regarding sex. In twelve years, obesity increased by 34% in women whereas in men, the rate is 107%. Obesity prevalence increases in all age.

Updated data about Turkish obesity prevalence is from 2016 and the data comes from TUİK (Türkiye İstatistik Kurumu). According to this report, in Turkey, obesity prevalence, in 15 years and older, is 19,6% however in 2014 prevalence was 19,9% in same population (13).

## 2.3 Determination and Classification

Overweight and obese classification is important because classification helps comparing the weight status between and within populations and allows to identify persons and groups at increased risk of mortality and morbidity and also it allows to identify urgency for treatment at community and individual levels (2).

### 2.3.1. Body Mass Index (BMI)

BMI is an index which is very easy to apply and commonly used in order to classify status of being overweight, obese and underweight in adults. It is calculated by dividing weight by square of the height in meters ($kg/m^2$) (2). BMI is also known as Quetelet's Index (5,13).

WHO states that, people whose BMI is higher than 25 kg/m$^2$ are defined as overweight. Whereas, people, whose BMI is higher than 30 kg/m$^2$ are defined as obese (10). The BMI classification is shown in Table 2.1 (2).

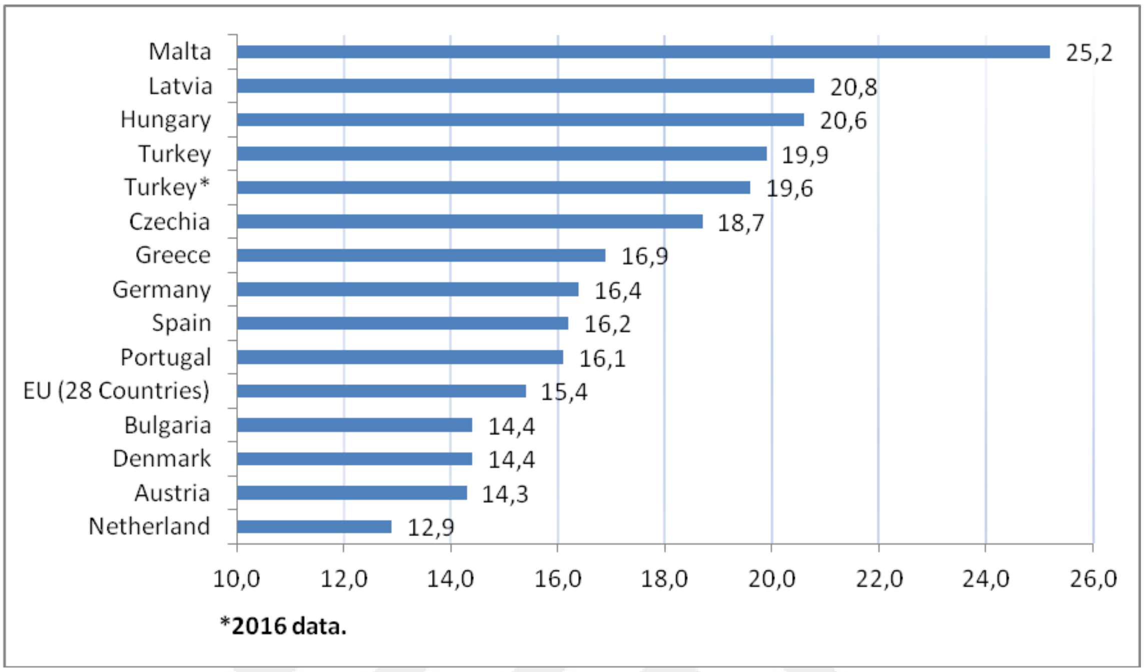


**Figure 2. 2. Obesity prevalence in selected European Union Countries, 2014 (13)**

**Table 2. 1. BMI Classification (2)**

| **Classification** | **Body Mass Index Category** |
|---|---|
| Underweight | <18,5 |
| Normal weight | 18,5-24,9 |
| Overweight | ≥25,0 |
| Preobese | 25,0-29,99 |
| Obese class I | 30,0-34,9 |
| Obese class II | 35,0-39,9 |
| Obese class III | ≥40 |

Despite of the fact that BMI is a key tool for determining obesity, easy to use, cheap and excepted worldwide in clinical researches, it is far fewer useful in clinic as assessment of patients, it miscarry to reflect body composition and adiposity (13- 15).

### 2.3.2. Waist Circumference

There are different standardizations about measuring waist circumference. According to WHO STEP (Stepwise Approach to Surveillance) protocol, waist circumference should be measured at the estimated midpoint between the lower margin of the palpable rib and the head of the iliac crest. And the measurement should be made at the end of a normal expiration (19). National Health Institution (NIH) protocol determines waist circumference at the head of the iliac crest. Measurement should be taken at minimal expiration (20). In literature, there are some studies evaluating waist circumference at the minimum point of the waist (21).

The cut-off points of waist circumference are >80 cm for women and >94 cm for men (3). Indication of increased relative risk for diseases begin with waist circumference more than 102 cm (40 inches) for men and more than 88 cm (35 inches) for women (20).

### 2.3.3. Waist to Hip Ratio

Waist to hip ratio can be measured more correctly than skinfold and this measurement gives information for both abdominal and subcutaneous adipose tissue (22). It is simply calculated by dividing hip circumference to waist circumference (3). Hip circumference should be measured at the widest point of the hip (15,16). Waist to hip ratio is seem to be more solid independent risk factor than BMI (23). The measuring tape should be close-fitting around the measuring area and it should be parallel to the floor (3).

### 2.3.4. Skinfold Measurement

Skinfold thickness to estimate body fatness is first used in 1951 (24). As skinfold measures thickness of skin and subcutaneous fat it is also associated with fat storage. There are equations about skinfold to estimate percentage of body fat (25). But this equations are considered to underestimate the body fat percentage (26). Using skinfold measurement in large populations is feasible (27). A large subscapular skinfold anticipates coronary heart disease (CHD) in men, it is an independent predictor from other cardiovascular risk factors and obesity (28). As skinfold provides more accurate estimation of body fat than BMI (29). Unless, measuring skinfold thickness is more time consuming and difficult to measure in overweight population (30).

## 2.4 Etiology of Obesity

Obesity is induced by behavioral, social, cultural, environmental and genetic factors. This factors result energy imbalance which cause excessive fat deposition. According to WHO Consultation on Obesity, although genes have an significant role in the body weight regulation, the main reasons of remarkable increase of obesity prevalence in past years are environmental and behavioral factors (31). The summary of etiology of obesity is shown below in Table 2.2 (32).

There are studies highlighting the importance of genes for obesity but regarding obesity elevation in modern world, genetic factors cannot have main role in the current situation because genetic mutation or modifications cannot occur such in a short period of time. And it is possible to say that environmental and behavioral factors are mainly responsible (33). According to a study comparing dizygotic, monozygotic and virtual twins (not related biologically but are at the same age and grow up together from infancy) environmental factors have a bigger effect on body weight and BMI than genetics (34). To sum up, recent obesity increase seems to be caused by behavioral and environmental factors interplaying with genetic background.

The obesity development is related with an impaired energy balance for prolonged time period. Energy balance means equality of energy intake and energy expenditure. Because energy cannot be destroyed or created, if energy intake is greater than energy expenditure, excess energy is stored in body in form of triacyglycerols. Storing excess energy by body fat is very important for our evolution because it is essential for survival of situations like starvation (34). But this evolutionary context, ironically cause obesity in modern world because we can reach food very easily in large amounts any time we want (35).

Despite their function of storage, fat cells are also endocrine cells and they are secreting hormones and growth factors. By this way adipocytes can affect fat metabolism mechanisms by feedback regulations. In 1994 a hormone named leptin was identified which is one of the regulators of that feedback mechanism (36). Larger adipocytes secret more leptin, obesity is related with high leptin levels in plasma (37). Food intake also effects leptin secretion. Calorie restriction for a short period of time causes leptin decrease on the other hand returning back old food intake and nutritional habits restore leptin (38). Leptin does not seem to have a role in the obesity etiology except very uncommon cases of genetic mutation (39).

Food related patterns have a role in obesity. Although there is an increase in awareness of energy intake and fat content of foods, and increasing variety of fat-free, sugar-free foods and beverages, obesity remains increasing. Food industry encourages people overeating by cheap prices, massive portion sizes of food which is high in energy but low in nutrients (40).

It is obvious that energy consumption has elevated over time while energy expenditure has decreased reversely and this cause energy imbalance which contribute to obesity. In modern world, especially in large cities, people have sedentary lifestyle and this lends to increasing in obesity prevalence. According to National Health Survey, physical activity decreases gradually from 12 to 21 ages (41).

**Table 2. 2. Etiology of Obesity (32)**

| |
|---|
| **Environmental causes** |
| Dietary factors |
| Lack of physical activity |
| Lifestyle factors |
| **Neuroendocrine obesity** |
| Hypothalamic obesity |
| Trauma |
| Tumors |
| Inflammation |
| Increased intracranial pressure |
| Surgery |
| Cushing's syndrome |
| Hypothyroidism |
| PCOS (Polycystic Ovary Syndrome) |
| Growth hormone deficiency |
| **Drugs** |
| Antipsychotics |
| Antidepressants |
| Anticonvulsants |
| Steroids |
| Adrenergic antagonists |
| Serotonin antagonists |
| Oral hypoglycemic agents |
| **Genetic and congenital disorders** |
| Prader-Willi syndrome |
| Bardet-Biedl syndrome |
| Leptin deficiency |
| Albright hereditary dystrophy |
| Alstrom-Hallgren syndrome |
| Cohen syndrome |
| Carpenter syndrome |
| Beckwith-Wiedemann syndrome |
| Pseudohypoparathyroidism type 1a |
| **Pregnancy and menopause** |
| **Eating disorders and psychological causes** |
| Bulimia nervosa |
| Stress |
| Anomalous eating habits |
| Depression, lack of confidence, and self-esteem |
| **Social factors** |

In recent years, the gut microbiome has become one of the most popular topics of the scientific resources. This bacteria population in our body can impact our body including having a role in metabolic functions (42). Studies say that gut microbiota can cause increase in energy harvest. Obese people have a different microbiome than lean people and this "obese microbiome" can cause bigger total body fat. More studies are needed to enlightened this topic (43).

### 2.5 Co morbidities and Adverse Health Effects of Obesity

Obesity itself is a disease and it can be also one of the risk factors of other chronic diseases such as non insulin dependent diabetes, congenital heart diseases (CHD) (44). It affects each organ system in body (Figure 2.3 - (45)). Negative health consequences of obesity are effected by location of body weight, sedentary lifestyle, amount of weight gain in adulthood (46).

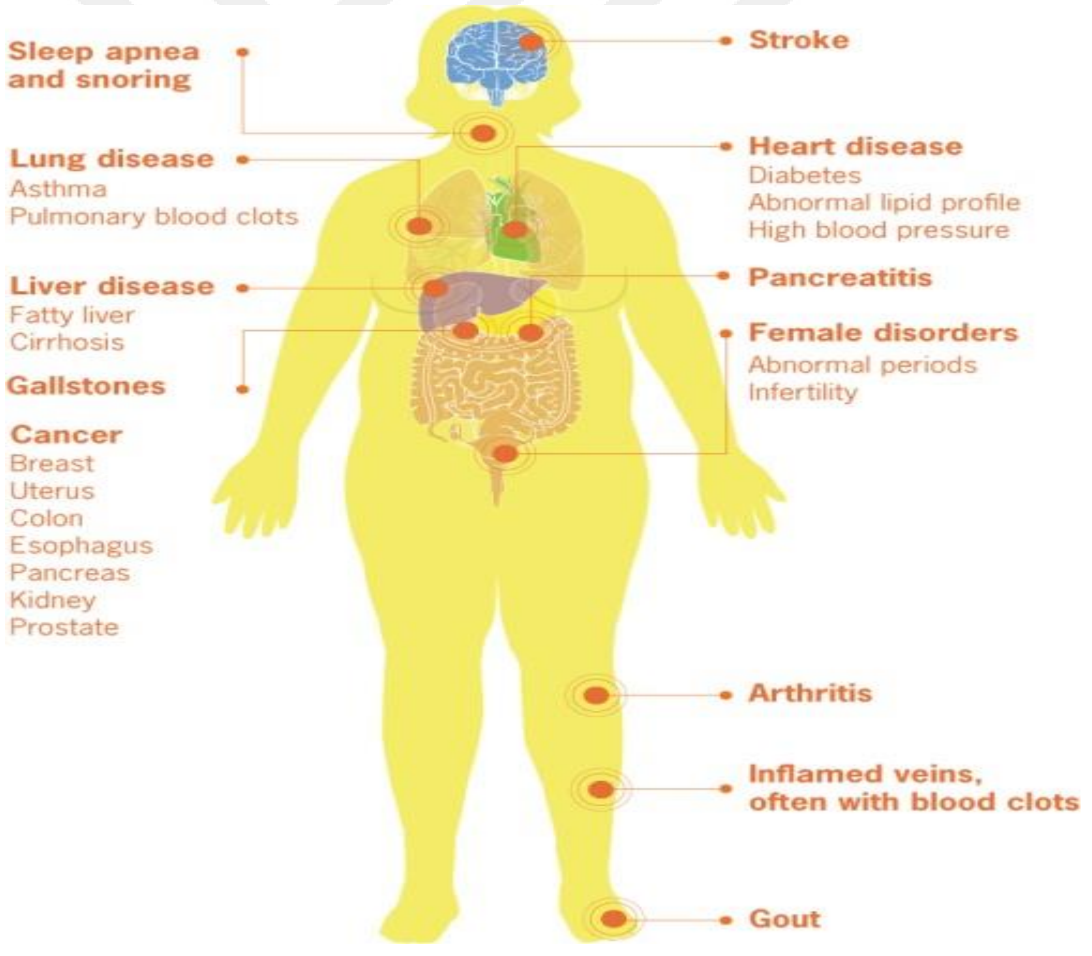


**Figure 2. 3. Medical Complications of Obesity (45)**

As a comparison, abdominal adipose tissue has;

- higher blood flow;
- larger catecholamine-induces lipolyses;
- more amount of (cortisol) glucocorticoid receptors;
- possible more amount of testosterone (androgen) receptors;
- more amount of cells for every unit mass

This distinction between intra-abdominal adipose tissue and subcutaneous adipose tissue points out that, abdominal fat accumulation is more prone to hormonal input and alterations in adipocyte accumulation and metabolism. In addition, intra-abdominal adipocytes are situated above the liver. It can be said that, patients with abdominal obesity has an elevated flow of nonesteroid fatty acid to liver by portal blood (2).

Metabolic syndrome is defined as a condition identified by "diabetes mellitus and/or insulin resistance or glucose intolerance, IGT (impaired glucose tolerance) together with two or more of these conditions; abdominal obesity, elevated arterial pressure, elevated plasma triglycerides and microalbuminuria (3). On the other side as well as physiological effects, obesity also has psychological effects on people.

**2.5.1. Hypertension**

Obese people have five times more risk for developing hypertension than people those have normal weight (47). It can be said that two-thirds of hypertension cases are related to body weight (48). According to a survey runned by Kastarinen et all, it has been stated that more than 85% of hypertension cases up in individuals whose BMI is more than 25 $kg/m^2$ (49).

Releasing angiotensinogen (effects blood pressure, angiotensin precursor) causes an increase in blood pressure with gaining weight. And increase in body weight can contribute to increase in blood volume thus cause an escalation in blood viscosity (50).

Especially saturated fatty acids, dietary fat causes an increase in diastolic and systolic blood pressure moreover hypercholesterolaemia (51). Although high energy diets, contain a lot of fat and refines sugar increase body weight, on the other hand, excessive sugar intake also cause decline in blood pressure (48,49).

The DASH (Dietary Approach to Stop Hypertension) trial states that, blood pressure can be changed by dietary factors aside from body weight. According to DASH diet, increasing fruit and vegetable intake by 200 g/day; decreasing fat intake by

10% energy intake, decreasing salt intake from 10g to 4 g, decrease both systolic and diastolic blood pressure (53).

### 2.5.2. Coronary Artery Disease and Strokes

When BMI is above 21 $kg/m^2$ dyslipidemia gradually evolves. This increase multiply the coronary heart disease risk 3-6 times. Accompany with high triglycerides levels and low HDL (High-density Lipoprotein) levels in the plasma, risk of CHD increases. There is a correlation between abdominal obesity and metabolic syndrome, dyslipidemia and diabetes progression (54).

The prevalence of 70% of women with both hypertension and obesity have left-ventricular hypertrophy, and approximately 14% of women have heart failure (11% in men) are linked to obesity. Obesity effects heart functions likely because of conjunction of factors including atherosclerosis, elevated fat mass, left ventricular mass, diabetes mellitus, dyslipidemia, hypertension and endothelial dysfunction (55).

It is suggested that 10 kg of weight loss will lead to an decrease in total cholesterol concentration. It should be noted that, there is a difference with acute effect of weight loss and long term effect of sustaining body weight with a healthy eating pattern (56).

### 2.5.3. Diabetes

There is a close link between obesity and diabetes. There is a term "diabesty" suggested in 1970's because the researchers came up with this term observing young men who were made to take excess calories for 6 months in order to increase their BMI 28 $kg/m^2$. And their serum triglyceride, fasting glucose and insulin levels were found increased and their glucose tolerance impaired (57).

It has been shown that the risk of diabetes begin with weight gain in childhood (58). 90% of the individuals which have type 2 diabetes have BMI more than 23.0 $kg/m^2$ (59). The risk is even higher for those whose mother had gestational diabetes and who has excessive body weight in childhood, diabetes history in family and abdominal obesity.

### 2.5.4. Cancer

It is suggested that, one of the most significant preventable reason of cancer is obesity. To all of non-smokers, approximately 10% of cancer cases of death are linked to obesity. WHO determined that, quarter to a third of cancers of the endometrium, breast, colon, esophagus and kidney cancers are effected by inactivity and being overweight (60).

**2.5.5. Psychological Effects**

Although researches about in this area suggests indecisive results, standard psychological test scores points difference between obese and non-obese people (61).

Many obese people suffer from body shape dissatisfaction, in fact, this causes avoiding from social interaction. This is more common in women and it can be said that being obese since childhood increases this discomfort (2). Obese people experience depressive symptoms than people with normal weight (32).

According to a meta-analysis there is a mutual interaction found between obesity and depression, obesity was found to elevate the depression risk. Furthermore, depression was found to prognostic of obesity development (62).

Social stigma is another consequence of obesity. Negative attitudes and damaging weight based stereotypes that obese people are unsuccessful, lazy, have poor willpower, unintelligent, are noncompliant with weight loss intervention. These stereotypes turn into prejudice, stigma and discrimination to obese people (63). Unlikely for assumption of stigmatism encourages obese people to a healthy life style and eating behavior, studies have shown that with the increase of obesity epidemic, weight discrimination has increased by the rate of 66% in the past 10 years as obesity prevalence elevates (64). Social stigma promotes unhealthy eating behavior and lifestyle, psychological disorders, stress-induced path physiology and substandard health care and decreased health care utilization in individual basis. Public health consequences of social stigma increase morbidity and mortality (65).

Quality of life is defined as a large multidimensional term that generally contains subjective assessment of both negative and positive features of life (66). Physical, social and mental well-being are accepted for definition of quality of life. Since obesity is associated with increase of psychiatric disorders, it can be said that obesity affects quality of life negatively (67).

**2.6. Treatment**

For obesity management, first step is prevention. But if prevention is not an option, treatment should be initiated (68). For guiding health care professionals for effective obesity treatment, many guidelines are available developed in Europe (66,67), in USA (68,69), in the UK (United Kingdom) (73), and in Turkey (74). These guidelines are being used for defining obesity treatment. Treatment of obesity can be categorized as lifestyle changes, increasing physical activity, dietary modulation, anti-obesity drugs and if necessary bariatric surgery.

**2.6.1. Lifestyle Change**

Multicomponent or comprehensive lifestyle change is the base of obesity treatment of patients (67,71–73). For defining comprehensive lifestyle change three strategies are implemented concurrently. This stages are behavioral or lifestyle training, increasing physical activity and dietary modifications in order to decrease energy intake. According to a systematic review, if this components of lifestyle change are given at least 14 face-to-face séances in 6 months and with treatment continued for 1 year, the mean weight loss is expected as 8 kg (71). Even if it might be considered as a small change in quantitive aspect this weight loss will lead to many improvements in medical aspect such as, betterment in triglycerides, HDL, blood pressure, glycemic control, decreasing risk of development of type 2 diabetes (71).

**2.6.1.1. Dietary Modifications**

In order to lose weight preferred diet must have less energy than required daily energy maintenance (68,75,76). Patient should keep continue to apply the diet program and diet program should present other benefits for health.

Energy reduction for 500 kcal/day of the energy requirement or using 1200-1500 kcal/day for women and 1500-1800 kcal/day for men will be first step for accomplishing the goal. The energy can be increased by 300 kcal/day if the weight of the patient is more than 150 kilograms. Still, reducing dietary energy intake has other health benefits (77,78). Component of diet is another topic to focus on. According to a meta-analyses of low fat versus low carbohydrate diets, it has been shown that, low carbohydrate containing diets are as much successful than low fat diets in terms of metabolic risk improvement and weight loss (82). There are studies comparing diets according to their success but no significant difference was detected. It can be suggested that diet should be decided according to patient’s compliance and presented health benefits (68,80).

In a manner of speaking Mediterranean style diet slightly rise to prominence. In a meta-analysis of 9 studies with 1178 participants, Mediterranean style diets were related to relevant weight loss, and BMI reduction, also decrease in fasting glucose, hemoglobin A1c and fasting insulin (84).

Very low-calorie diets or low calorie diets are explained as diets which are containing 450-800 kcal/day (85). These diets cause more rapid body weight loss. Systematic reviews propose that even weight loss is greater in short time period, weight alteration does not differ that much after 1 year or more to be compared with comprehensive approaches (73,83). Unless there is a need for quick weigh reduction clinically, this very low-calorie diets are not recommended for routine use (76).

**2.6.1.2. Physical Activity**

For obesity management increasing physical activity is a necessary element of comprehensive lifestyle intervention. The UK and USA guidelines suggest to increase aerobic physical activity step by step and achieve the goal of at least 150 min/week, this has benefits apart of weight loss (73,84,85). Evidence suggest that for weight maintenance and prevention of obesity more amount of physical activity (30-45 min/day) is required (68,86).

**2.6.1.3. Psychological Intervention**

Lifestyle change treatment of obesity is based on behavioral changes. And the key component of changing lifestyle is psychological aspect. Awareness of the eating behaviors those are likely associated with obesity is an important step for psychological treatment. Target eating behaviors should be addressed patient specific since the problematic eating behaviors differ from person to person (90).

**2.6.2. Pharmacotherapy**

If lifestyle change does not result in adequate weight loss, pharmacotherapy can be initiated for combined treatment. Pharmacotherapy can be considered if BMI is more than 30 kg/m$^2$ or BMI is more than 27 kg/m$^2$ with weight related health problems (91).

Over last four years many new medications has been authorized by The USA Food and Drug Administration (FDA). Nevertheless it can be said that healthcare professionals hesitate to prescribe medications for obesity treatment, because of combative background of this medications (68,69).

Orlistat, phentermine/topiramate, liraglutide, buprorion/naltrexone and lorcaserin are included present FDA approved drugs for weight loss (91).

During pharmacotherapy, some directions should be followed: Firstly, during usage of anti-obesity drugs, effective lifestyle intervention treatment should accompany. Medication should not be considered that it will result in weight loss by itself. It works to support patient's effort to change eating behavior and create an energy deficit.

Secondly, both practitioner and patient should know about drug and its possible side effects. Third, if expected weight loss occurs after 3-4 months (approximately 3-5% of total body weight) new treatment plan should be initiated (70).

### 2.6.3. Bariatric Surgery

In 1950's, bariatric surgery first began with jejuno-ileal bypass. In 1970's, it was replaced by gastric stapling procedures, for example Roux Y bypass, Biliopancreatic diversion (BPD) and different forms of gastroplasty. Although all procedures result in significant weight loss, bariatric surgery was not preferred by that times population because of risk of complications, invasiveness, risk of death, unrevealed long term effects (92).

As laparoscopic approach became widespread in the last 15 years, by the development of laparoscopic adjustable gastric band (LAGB), safety improved, documentation of clinical effectiveness get better and all this evolvement had let drawn interest (92).

By the help of bariatric surgery, energy intake decreases in 2 ways; restriction and malabsorption. The restriction is named due to it limits food consumption and thereby daily calorie intake. LAGB and SG are examples for restrictive operations. Malabsorptive procedures have also food intake limitation feature like restrictive procedures but additionally they also have calorie malabsorption feature by bypassing some parts of small intestines or readjusting small intestine in order to separate the food and bile and pancreatic juice flow in gastrointestinal system. All bariatric procedures comprise at least one of these components of weight loss (93). Mechanisms of weight loss by bariatric surgery procedures are shown in Table 2.3 (92).

For morbid obese population, bariatric surgery is currently the most effective approach to succeed in long term weight reduction, increase life expectancy and remission or progression of co morbidities among morbid obese population (5,92).

According to the updated clinical practice guideline of bariatric surgery defines bariatric surgery indications as described below (95):

- Patients have BMI $\geq$35 kg/$m^2$ and beneficial target of weight control and biochemical markers of cardiovascular disease (CVD) risk improvement (Grade A, Best Evidence Levels (BEL)1)

- Patients have BMI $\geq$30kg/m$^2$and and beneficial target of weight control and biochemical markers of CVD improvement (Grade B, BEL 2)
- Patients have BMI $\geq$ 30 kg/m$^2$and and beneficial target of glycemic control in type 2 diabetes and biochemical markers of CVD improvement (Grade C, BEL 3)

Yet more evidence is needed to understand all the mechanisms, despite of new studies published in past few years, improved understanding. Table 2.3 (92) includes some of potential mechanisms of bariatric surgery. The mechanism of weight loss induced by surgery differs from procedure to procedure. For example, LAGB and SG can be classified as restrictive operations, their mechanism don't include malabsorption. On the other hand, RYGB and BPD/DS can be considered as malabsorptive operations. Not all procedures has hormonal outcomes which result in decrease in hunger and increase in satiety.

**Table 2. 3. How do bariatric procedures work? (92)**

| Bariatric Surgery - Options for Weight Loss Effect |
|---|
| 1. Reduce appetite, induce satiety |
| 2. Alter the taste of food |
| 3. Restrict intake |
| 4. Divert nutrients from duedenum |
| 5. Malabsorption of nutrient |
| 6. Increase energy expenditure |
| 7. Aversion effect - dumping, steatorrhoea, vomiting |

Swedish Obese Subjects (SOS) study is a very important research for understanding the effects of bariatric surgery for long term period. In this study, 2010 obese participants underwent different bariatric surgery procedures, gastric bypass (13%), banding (19%), vertical banded gastroplasty (68%). And for comparison, 2037 participants for control group took regular care. The study continued for 20 years. Weight reduction after 2,10,15 and 20 years were -23%, -17%, -16% and -18% in the study group and 0%, 1%, -1%, -1% in the control group. And for mortality results, patients who had bariatric surgery had better metabolic improvements such as reduction in incidence of diabetes, stroke, myocardial infarction and cancer. And also in 10 years, health related quality of life was considerably get better for surgical group (93,94).

### 2.6.3.1. Procedures

In the level of grade A evidence, LAGB, SG, BPD, BPD/DS or related procedures can be performed on patients require weight loss or metabolic control (Figure 2.4 -(95)).

Choosing best bariatric procedure for the patient depends on patient specific goals, treatment target (weight loss with or without metabolic control), patient preferences, personated risk factors and present local-regional expertise (95).

According to American Metabolic and Bariatric Surgery Association (ASMBS) data, it can be seen that the number of bariatric surgery cases increases year by year progressively. And also, immensely increase of SG ratio between other bariatric surgery procedures is taking attention. RYGB used to be considered as gold standard and it was the most preferred procedure in 2012. But after 2013 SG took the throne from RYGB. According to data from 2016, SG was performed 58,1% of all bariatric procedures (7). The estimated 2011-2016 numbers of bariatric surgery in USA can be seen in Table 2.4 (7).

**Table 2. 4. Estimate of Bariatric Surgery Numbers in USA, 2011-2016 (7)**

| Procedures | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** |
|---|---|---|---|---|---|---|
| Total | 158,000 | 173,000 | 179,000 | 193,000 | 196,000 | 216,000 |
| RYGB | 36,7% | 37,5% | 34,2% | 26,8% | 23,1% | 18,7 |
| LAGB | 35,4% | 20,2% | 14% | 9,5% | 5,7% | 3,4% |
| SG | 17,8% | 33% | 42,1% | 51,7% | 53,8% | 58,1% |
| BPD/DS | 0,9% | 1% | 1% | 0,4% | 0,6% | 0,6% |
| Revisions | 6% | 6% | 6% | 11,5% | 13,6% | 13,9% |
| Other | 3,2% | 2,3% | 2,7% | 0,1% | 3,2% | 2,6% |
| Baloons | | | | | 0,3% | 2,7% |
| V-Bloc | | | | | 18 cases | |
| ASMBS total bariatric procedures numbers from 2011-2012-2013-2014-2015 and 2016 are based on the best estimation from available data (/MBSAQIP, National Inpatient Sample data and outpatient estimations.) | | | | | | |

#### 2.6.3.1.1. Laparoscopic Adjustable Gastric Band

This procedure first described in 1993 and it is inspired from open gastric banding procedures (96).

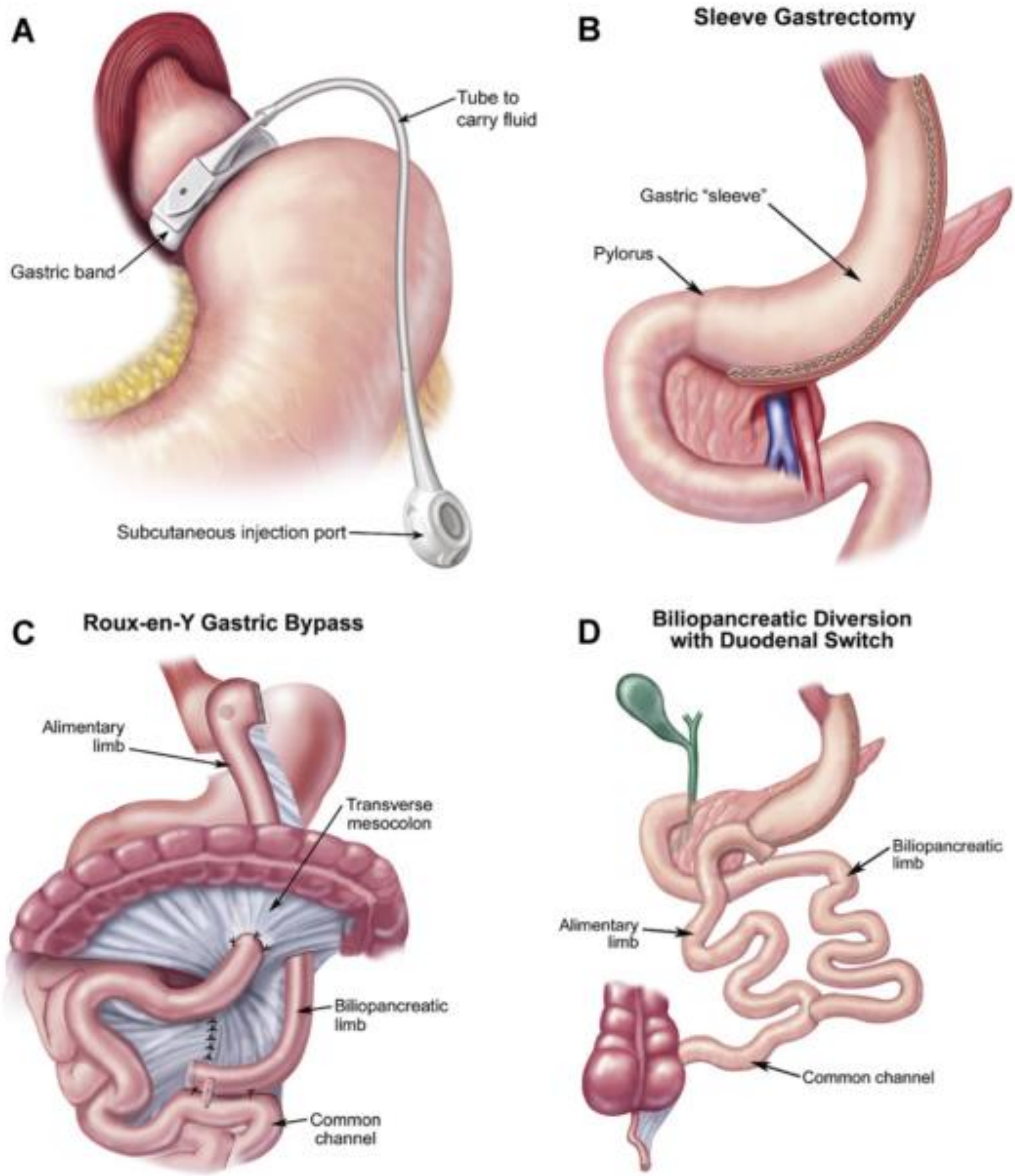


**Figure 2. 4. Common types of bariatric surgery procedures (95)**

In this operation a restrictive balloon like device is placed around the gastric carnia which is approximately 1 cm below from where stomach begins and esophagus ends (See Fig 2.4). This balloon is connected to the subcutaneous port with a tube. By this way the surgeon can adjust the gastric volume if it is necessary (97).

#### 2.6.3.1.2. Roux-en-Y Gastric Bypass

Gastric bypass surgery was firstly demonstrated in 1960's. It was designed to compound malabsorptive, restrictive and behavioral elements of weight loss achievement. Weight loss is also affected by physiologic alteration of gastrointestinal tract. Dumping syndrome, neuroendocrine responses are included to this changes. This changes influence weight loss and plays role on improvement of co morbidities. Validity of RYGB was firstly presented in 1990's (97). RYGB is accepted as gold standard for bariatric surgery because of remission of co morbidities, efficient weight loss and low weight regain rate (98).

**2.6.3.1.3. Biliopancreatic Divertion with or without Duodenal Switch (BPD/DS)**

In the late 1970's, malabsorption was reconsidered for effective weight loss and BPD was described by Scorpinaro (99). Since then after modifications, duedonal switch is appeared in 1993 (100). BPD/DS lessens the most serious complications of BPD for example; peptic ulceration of anastomosis and dumping syndrome (101).

**2.6.3.1.4. Laparoscopic Sleeve Gastrectomy**

Lately, SG is considered as a favorable bariatric method. At the beginning, it was the first step of BPD/DS (97). But afterwards, it was realized that SG results with sufficient weight loss. By the time, its popularity increase because of technical simplicity, good outcomes, feasibility, and resolution of co morbidities (102). Lately according to some opinions, SG is considered as gold standard procedure instead of RYGB. Compared with RYGB, SG is a safer and quicker operation that can be performed in every patient with almost identical beneficial outcomes and decreased long term complication risk (6).

In SG operation, most of the great curvature of the stomach is removed and lesser curvature tube is remained. The fundus and upper part of the stomach (named gastric pacemaker) are ejected. The remaining volume of the stomach is up to 150-200 $cm^3$ (103).

It is a restrictive bariatric surgery operation. But lately, it has been realized that, it has also hormonal outcomes (104). These include accelerated gastric emptying, reducing ghrelin, increasing glucagon-like peptide-1 (GLP-1), cholecystokinin (CCK), and peptide YY (PYY) secretions thus contribute to reduce hunger and increasing satiety (105).

Recently, SG is defined as an effective treatment in patients with BMI >40 $kg/m^2$and BMI> 35$kg/m^2$ combined with co morbities. Even more, it is suggested for patients with BMI <35 $kg/m^2$ with metabolic syndrome (102,103).

#### 2.6.3.2. Nutrition Statement of Bariatric Surgery Candidates

Evidence shows that obesity is associated with nutritional deficiencies, and patients who are candidates for bariatric surgery present with signs of malnutrition. Post-operatively, these can be exacerbated due to reduced intake, maldigestion, malabsorption and possible intolerances with certain food groups (105,106).

Recent studies published in 2017 and 2018 investigates nutrition status of bariatric surgery candidates (107,108). Vitamin D deficiency is the most common deficiency in the obese population. Prevalence vary from 97,5% to 76%. Other most common deficiencies are folic acid, Vitamin $B_{12}$, and iron deficiencies (107,108). As BMI increases, risk of Vitamin D and folic acid deficiencies significantly elevates (109).

#### 2.6.3.3. Preparation for Bariatric Surgery

A registered dietitian experienced in preop and postop bariatric counseling should get in to touch with the patient preoperatively for nutrition evaluation and initiate a nutrition education procedure for keep continuing after surgery (110). Candidates of bariatric surgery should undergo an education. Education should cover causes and complications of obesity, the bariatric surgery procedure that the patient will undergo, its benefits and risks and realistic goal setting for weight loss (Grade A evidence) (92,109). The preop evaluation of the patient should include a physical examination, complete medical history and proper laboratory testing (Grade A evidence) (110).

At least 3 kg of fat loss, 10% of total body weight loss or 5% of EBWL with calorie restriction over 2 weeks before surgery is linked with liver volume reduction (111). A strict preop weight loss regimen for liver volume reduction may be suggested for patients with BMI > 50 kg/m$^2$ who have higher risk. And this weight loss therapy can promote preop glycemic control with obese patients with type 2 diabetes (95).

Registered dietitian should apply medical nutrition therapy for all candidates before the surgery and this therapy should continue after the surgery. Medical nutrition therapy is based on four steps; nutrition assessment, nutrition diagnosis, nutrition intervention and monitoring and evaluation (112).

Studies have shown that, preop weight reduction decreases length of operation, risk for complications, blood loss throughout the surgery and the length of hospital stay (112,113). Preop weight loss was found to be positively linked with postop weight reduction (115).

Considering bariatric surgery candidates has significant micronutrient deficiencies, monitoring micronutrient levels and if necessary supplementation before the operation are recommended (92,107,108).

**2.6.3.4. Nutrition Consultation After Bariatric Surgery**

After surgery, it takes time to consume food in a normal way. The patient does not have full capability of eating and drinking foods he used to have. This is mainly a result of decreased gastric volume but by the time goes it gets better and that is because of oedema caused by surgery goes away. By healing, food volume and tolerance increases (116).

**2.6.3.4.1. Postoperative Diet Progression**

Slow diet progression is recommended due to the long surgical staple line and prevalence of nausea after SG (117).

Most guidelines suggest a postop regimen starts with clear fluids evolving solid food. Although the main key points are similar, different surgery types can influence diet progression (110). The main focuses of nutritional supervision after bariatric surgery are encouraging to take enough energy and nutrients in order to permit repairing and maintaining lean body mass. Patient should not eat foods induce early satiety, reflux and dumping syndrome. And also, it is very important to keep caloric intake low enough to allow quick weight loss proceeds (107,108).

There is no standardized diet regimen for bariatric surgery procedures. Recommendations can differ according to procedures and patients' toleration. Suggested diet progression after RYGB is given in Table 2.5 (110).

Based on Dietary Reference Intakes for adults, patients should meet minimal needs for carbohydrate (130 g/day) and fat (20g/day) (118).

For sure the primary nutritional focus after bariatric surgery is maintaining sufficient amount of protein and fluids, therefore these fat and carbohydrate goals should be achieved as soon as possible with evaluation of patients ability after surgery. It should be noted that, diet progression can be changed by the nutritionist or surgeon according to patients' requirements and tolerance (117).

Meat and meat products, cereals and bread are likely to be associated with low tolerance after LAGB, RYGB and SG (119).

**Table 2. 5. Suggested diet progression for RYGB (110)**

| Stage of diet | Time to begin | Foods/fluids | Guidelines |
|---|---|---|---|
| **Stage I** | Postop day 1 & 2 | Clear fluids<br>N o calories oncarbonated; No caffeine; no sugar; | On first postoperative day, patients undergo a<br>Gastrografin swallow test for leakage; after testing, sips of clear liquids begin |
| **Stage II**<br>**Start supplementation:**<br>multivitamin<br>plus minerals, twice a day (**Chewable)**<br>calcium citrate with<br>vitamin D (**Chewable or liquid**) | Postop day 3<br>(diet for discharge) | **Clear liquids**<br>● Typesof no-sugar or artificially sweetened liquids<br>● Promote having salty fluids at home<br>● Solid liquids: ice pops (sugar-free)<br>**ADD full liquids**<br>● no more than15 g of sugar per serving<br>● Protein-rich liquids (limit added powders no more than 20 g protein per serving) | Patients are rommended to take min 48-64 fluid ounces of total fluids daily: 24-32 ounces or more of clear liquids plus 24-32 ounces of any combination of full liquids:<br>● Skimmed milk added soy or whey protein powder (no more than 20 g protein per serving)<br>● Soy milk or lactose free milk added soy protein powder<br>● Plain light yogurt; Greek yogurt |
| **Stage III** | Postop days 10-14 | Fluid intake could be increased more than 48-64 ounces and full liquids could be replaced with soft, damp, cubed, minced or pureed protein sources, watching acceptance. Examples for protein sources; eggs, soft and damp fish, minced meat and poultry. Broth, light mayonnaise can be used for to moisten the food. Cooked legumes are another alternatives. Low-fat cheese, yoghurt and cottage cheese are dairy alternatives for protein sourced foods. | Foods containing protein should be consumed in 4-6 small meals, in a day. Patients may tolerate just a small amount of food at once. Chewing the food completely before swallowing is very important. Patient should be assist not to eat and drink at the same time. And should wait 30 minutes for drinking fluids after finishing the solid food. Using small plates, forks and spoons will make easy controlling portion size |
| **Stage III** | 4 weeks postop | If protein sources are well tolerated, nice cooked, soft vegetables and soft and skinned fruits could be added in to the diet. Constantly, protein sources should be eaten first. | Drinking enough fluids in order to get rid of dehydration is very necessary for patient during quick weigh reduction |

| Table 2.5 cont. | | | |
|---|---|---|---|
| **Stage III** | 5 weeks postop | Patient should go on with consuming protein sources with some vegetables or fruits.Green-leaved vegetables can be tolerated one month after surgery. Patients should always eat the protein first. | **AVOID** High carbohydrate sources like bread, rice, pasta until patient can take 60 grams of protein daily with normal foods |
| **Stage IV**<br>Daily vitamin plus mineral supplementation. after 2 months postop, can switch to pill form if _11 mm<br>in width and length | As more foods can be tolerated and hunger elevates, patient should eat more balanced foods | Healthy diet with solid foods | a balanced diet, which is consist of sufficient amount of all food groups. To control the portion size small plates and spoons or forks can be used. Calorie needs of the patient can be evaluated according to age, weight and height. |

## 2.6.3.4.2. Protein Intake

Protein intake of patients should be individualized, evaluated and directed by the dietitian, considering patients sex, age and weight. The minimum protein intake of the patient should be 60 g/day, and up to 1,5 g/kg ideal body weight per day would be sufficient. Higher amounts of protein intake, for example, up to 2,1 g/kg ideal weight per day should be valuate on individual basis. Protein intake suggestions are varying, but studies propose that consuming higher levels of protein (80-90 g/day) is associated with decreased loss of lean body mass (119,120). At early postop phase, taking enough protein from foods could be challenging. Considering inability to eat enough protein, protein supplementations can be used (95). Protein supplements are no longer necessary after patient can meet daily needs by food sources (117).

Because of their high glucose content, and possible resulting risk of dumping syndrome, standard oral enteral nutritional supplements are not suitable after bariatric surgery procedures (122).

A recent published systematic review reveals that, patients have difficulties of meeting needs of protein after bariatric surgery (123). The reasons of this situation are intolerance of certain foods like red meat and other protein sources, and noncompliance of protein supplementation in early postop phase (119,120,123).

#### 2.6.3.4.3. Fluid Intake

Consuming enough liquid is essential for patients who are losing weight quickly. In order to meet the bodies fluid needs after SG, fluids should be taken slowly with the goal of at least 1,5 liters per day (95).

Patients should be told to consume liquids and solids separately. Waiting at least 30 minutes between eating solid meal and drinking beverages is recommended. This application is useful to avoid gastrointestinal symptoms, leave space for nutrient-rich foods, and prevent reduced satiety over time (117).

Signs of dehydration are, constipation or hard stool, dizziness when sitting or standing, headache and thirst (125).

#### 2.6.3.4.4. Vitamin Supplementation

Multivitamin supplementation is essential after bariatric surgery. For malabsorptive procedures, especially BPD/DS risk of vitamin deficiencies increases. SG has been found to have less vitamin deficiencies after surgery than RYGB (106,125). However, SG is linked with faster transition of food through the gastrointestinal tract. Also, decreased levels of hydrochloric acid and intrinsic factor secretion may contribute to micronutrient deficiencies (127).

In early postop care, taking 2 adult multivitamin plus minerals (each should contain iron, folic acid, and thiamine) supplementation is recommended for meeting minimal requirements for SG (95). After surgery, multivitamin supplementation should begin with chewable multivitamin plus minerals with portion of 2 tablets per day (1 tablet is for regular adult use) at the second postop week. After 2 months follow up, it may be switched to pill form if <11 mm in with and length (110). Routine vitamin A supplementation is not usually necessary after RYGB or for any purely restrictive procedures (110). Table 2.6. shows micronutrient recommendations for bariatric surgery patients (92,127).

Vitamin D deficiency is a huge concern for both preop and postop period. According to recent published meta-analyses, vitamin D deficiency is linked to obesity, regardless from age. Obese population have greater than 35% prevalence of vitamin D deficiency compared with the healthy population (129). But recent studies published in 2017, point out prevalence of vitamin D in bariatric surgery candidate can be up to 73%-97,5% (108,126). The target serum level of 25(OH)D (25-Hydroxy Vitamin D) is 30≥ng/ml (92,129).

**Table 2. 6. Vitamin supplementation recommendations for bariatric surgery patients (92,127)**

| |
|---|
| **Vitamin D**<br>According to AACE/TOS/ASMBS guidelines, vitamin D supplementation of 3.000 IU/day recommended as Grade A evidence (95). If there is a severe malabsorption, vitamin D dose can be up to 50.000 IU 1-3 times weekly to daily (Grade A, BEL 1)(95). |
| **Calcium**<br>1200-1500 mg/d of calcium citrate is recommended for all surgical types in early routine postop care (95). In case of deficiency, repletion therapy varies by surgical procedure (Grade C, BEL 3). For BPD/DS, 1800-2000 mg/d, for LAGB, SG, RYGB, 1200-1500 mg/d calcium in divided doses is recommended for repletion |
| **Vitamn B12**<br>B12 supplementation dose differ from route of application; 350-500 µg daily if supplement is taken by orally by tablets, liquids or sublingual, 1000 µ daily if supplement is taken by parenteral (intramuscular or subcutaneous) (128). |
| **Iron**<br>The daily iron intake via multivitamin and additional supplementation should be 45-60 mg for menstruating women who undergo bariatric surgery with history of anemia to prevent deficiency (128). For repletion recommendation, oral supplementation should increase up to 150-300 mg/d as elemental iron 2-3 times daily (Grade B, BEL 2) (128). |
| **Vitamin A**<br>For BPD/DS 10,000 IU/D vitamin A should be taken (Grade B, BEL) ,for LAGB,5000 IU/d of vitamin A should be taken (Grade C, BEL 3) and for RYGB and SG, 5000-10,00 IU/D of vitamin A should be taken (Grade D, BEL 4) in order to prevent deficiencies (128) |
| **Thiamine**<br>For supplementation, to prevent thiamine deficiency, doses above the RDA is suggested, meaning of, all bariatric patients should take at least 12 mg/d thiamin (Grade C, BEL 3) (128). Treatment of thiamin deficiency should be initiated with suspected patients. Repletion therapy for thiamin deficiency varies from route of application and severity of deficiency. For oral therapy 100 mg of thiamin 2-3 times daily is recommended until symptoms resolve. For intravenous therapy, 200 mg 3 times daily to 500 mg once or twice daily for 3-5 days and followed by 250 mg/d for 3-5 days or until symptoms resolve. And finally, 100 ml/d should be considered continually or until risk factors have been resolved (Grade D, BEL 4). And for intramuscular therapy, 250 ml once daily for 3-5 days or 100-250 mg of monthly injection is recommended (Grade C, BEL 3) (128). |
| **Folic Acid**<br>Supplementation of folic acid for preventing deficiency is recommended 400-800 µg/d coming from multivitamin. Women in childbearing age should take 800-1000 µg/d of oral folic acid (Grade B, BEL 2) (128). For repletion, 1000 µg/d of oral folic acid supplementation is recommended for all bariatric surgery patients age (Grade B, BEL 2) (128) |
| **Zinc**<br>For BPD/DS multivitamin and minerals should contain 200% of the RDA, for RYGB, multivitamin and minerals should contain 100-200% of the RDA, for SG or LAGB multivitamin and minerals should contain %10000 of the RDA are recommended (Grade C, BEL 3) (128). For repletion, there is dose related recommendation due to lack of evidence. Oral zinc intake twice a day with the dose of 60 mg but it should be reconsidered. Repletion doses should be wisely chosen in order not to induce copper deficiency. (Grade D, BEL 3) (128). |
| **Copper**<br>For BPD/DS or RYGB multivitamin and minerals should contain 200% of the RDA, for SG or LAGB multivitamin and minerals should contain 100% of the RDA (Grade C, BEL 3). For repletion, recommended doses differ from severity of the deficiency (Grade C, BEL 3). In case of mild/moderate deficiency (with low hematologic signs) 3-8 mg/d oral copper sulfate or gluconate is recommended until signs returns to normal range. In case of severe deficiency, 2-4 mg/d copper should be initiated intravenously for six days or until symptoms are resolve, serum levels return normal range (Grade C, BEL 3) (128). |

For $B_{12,}$ supplementation recommended as needed to maintain $B_{12}$ levels in normal range levels. $B_{12}$ deficiency is reported 2-18% in obese population, 6-30% in people using proton pump inhibitors (128). Routine screening is recommended due to $B_{12}$ deficiency is seen in up to >%20 in both RYGB and SG (95). All bariatric surgery patients should take $B_{12}$ supplementation (Grade B, BEL 2) (128).

For fat soluble vitamins, malabsorptive procedures need more supplementation due to fat malabsorption. Screening for vitamin A is recommended for patients who undergo BPD/DS regardless symptoms. And patients should undergo vitamin A screening with symptoms of protein-energy malnutrition (Grade B, BEL 2) (128).

Thiamin (vitamin B1) is a very important vitamin for bariatric surgery patients. It's importance starts with the preop phase. Routine screening is recommended preoperatively (Grade C, BEL 3) (128).

Folic acid deficiency is very common in obese population (109). Therefore, preop screening is recommended for candidates (Grade B, BEL 2). Also, postop screening is recommended for all patients and special attention is required for women with childbearing age (Grade B, BEL 2) (128).

Preop zinc screening is recommended for RYGB and BPD/DS bariatric surgery candidates (Grade D, BEL 3). Obese population have lower serum zinc levels than normal weighted people, therefore preop supplementation might be necessary (Grade C, BEL 3) (128). Zinc deficiency prevalence reported 24-28% in bariatric surgery candidates. For prevention, all bariatric surgery patients should take amount of zinc more than RDA levels and the dosage differs from procedures. (128).

Routine preop copper monitorization is recommended for RYGB and BPD/DS bariatric surgery candidates (Grade D, BEL 4) (95). Prevalence of copper deficiency is shown as high as 70% in women who are candidate for BPD. For preventing deficiency, all bariatric surgery patients should take copper within multivitamin and mineral supplementation with the minimum level of RDA requirements, and precise amount is based on the procedure (see Table 2.6).

Running blood test for patients helps personalize supplementation by revealing patients actual needs and proved plasma deficiencies (122).

**2.6.3.4.5. Nutritional Pyramid for Postop Bariatric Surgery Patients.**

There are guidelines for nutritional management of bariatric surgery patient but no specific recommendations are made for long term in reaching weight loss goal and adapting healthier nutritional behavior. In 2010, Moizé et al. designed a nutrition pyramid for RYGB patients. It is designed based on guidelines and clinical studies as reference (131).

Especially for long-term results, it shown that dietary pattern is associated with patients' food choices. Energy intake is closely related with weight loss and it should be minded for long term after surgery (131,132).

The pyramid is not designed for energy intake protocol for RYGB patients, its main focus is creating negative energy balance that yield desirable weight loss and maintaining adequate protein intake (Figure 2.5 (131)).

There is no certain guidance for carbohydrate intake but studies show that carbohydrate intake is close to 45% in patients underwent RYGB (94,131). And concentrated sweets and sugary food should be limited in order to keep energy intake at negative range and avoid dumping syndrome. In a study, Colleen et al. pointed six mutual habits of post bariatric surgery patients succeed to maintain their weight loss at least 74% (135). One of them is eating just two portions of starch/bread in a day. So limiting grain sourced products should be taken in consideration. To sum up, collected knowledge from studies states 40-45% of daily calories coming from carbohydrates and 14g/1,000 calories of fiber intake could be enough for RYGB (136).

According to surveys assessing dietary patterns of RYGB patients, patients who do not regain weight avoid from foods with high fat and high calorie content (137). Dietary fat intake should be around 30% of dietary intake, not only quantity but the quality is also important for in terms of fat. Omega 3 fatty acids should be considered in order to prevent deficiency (131).

- **Base of the Pyramid**

In the pyramid, supplementation, physical activity and water intake located at the base of the pyramid in order to highlight the importance of these components.

- **First Level of the Pyramid: Low-Fat, High-Protein Food**

Four to six portions of this food group should be consumed in a day. These foods are: Low-fat meat (portion size is 60 g for chicken, pork, beef), fish (portion size for blue fish is 60 grams, for white fish is 85 grams), fat-free or low fat dairy products (portion sizes; hard cheese: 60 gr, soft cheese 80 gr, milk: 140 gr, yoghurt 115 gr), legumes (portion size: 80 gr), eggs (one large, 50 gr)

- **Second Level of the Pyramid: Low-Calorie, High-Fiber Foods**

Two to three portions for this food group should be consumed. These foods are: Fruits (low sugar fresh fruits like melon, watermelon, apple, strawberry 140 gr, high sugar fresh fruits like grapes apricot, banana, nectarine 70 gr), all types of vegetables (85 gr), vegetable oil (1 teaspoon).

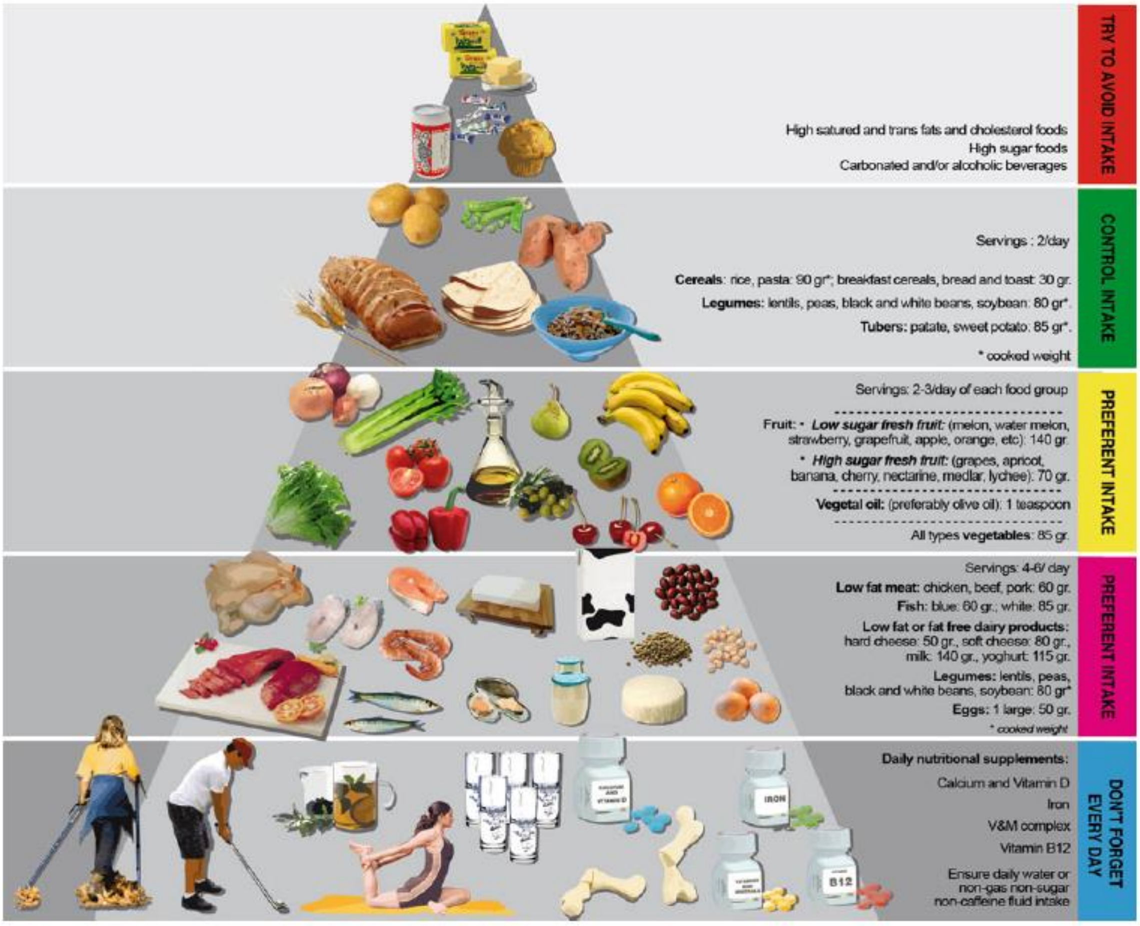


**Figure 2. 5. Nutritional Pyramid for Postop RYGB Patients (131)**

- **Third Level of the pyramid: Cereals and grains**

Two portions in a day should be consumed. These foods are: Cereals (rice, pasta 90 gr, breakfast cereals, bread and toast: 30 gr), legumes (portion size: cooked weight 80 gr), tubers ( potato, sweet potato 85 gr).

- **Fourth Level of Pyramid: Energy-Dense Foods**

In order to provide negative energy balance in a healthy eating style after surgery, avoiding energy-dense foods is a key point. Foods containing high fat, high sugar and carbonated and/or alcoholic beverages should be avoided.

Although this pyramid is designed for RYGB patients, as mentioned above, nutrition after bariatric surgery is commonly similar in between different surgical procedures hence this pyramid would be a reference for other bariatric surgery procedures like sleeve gastrectomy by keeping in mind the main differences of malabsorptive and restrictive procedure.

**2.6.3.4.6. Weight Loss After Bariatric Surgery**

Bariatric surgery is the most effective way for weight lost, weight maintenance and easing obesity related co morbidities compared with non-surgical interventions among morbid obese people (91). In the past, malabsorptive procedures were chosen because of their weight lost rate was greater than restrictive procedures but recently, especially SG is found to be as successful as RYGB. Their early and long term of postop results are very similar (138). One month after SG, 18% to 30% of average EBWL can be accepted (139). At the end of postop 3th months, 37% to 41%, at the end of postop 6th months 54% to 61%, and at the end of the 1 year after the surgery 58% to 70% of EBWL can be expected from a patient (101,138,139).

Some patients can reach their weight goal within 1 to 2 years after SG and keep their weight by retaining their daily calorie intake 1.000-1.200 kcal/day (104). For patients who could not reach their weight reduction goal, additional visits to bariatric facilitate with bariatric team members is required (110).

Success of the treatment is measured by evaluating EBWL% after SG. Loosing %50 of excess body weight (EBW) maintaining or giving more can be defined as successful (141). In other words, "success" is defined for bariatric surgery as, reduction in 50-75% of EBW, 20-30% reduction of primary weight and accomplishing BMI < 35 $k/m^2$ (142).

According to latest meta-analysis, there is no significant association between long term EBWL% and duration of follow-up, sex, baseline BMI, bougie size and age (143). Although, studies say bougie size is not associated with long-term weight reduction surgical guidelines suggest optimal bougie size is 32-36 Fr (102) .In one year follow-up, for better weight loss results, smaller bougie seems to be more effective (144).

Weight regain is a common problem after bariatric surgery. Weight reduction happens to almost every patient regardless of the rate achieves successful criteria or not, but in long term, weight regain can be sign of failure in lifestyle lack of physical activity, lack of dietary behavior change and lack of follow up (145). Table 2.7 includes causes and prevention of weight regain after bariatric surgery (146).

**Table 2. 7. Causes and prevention of weight regain after bariatric surgery (146)**

| |
|---|
| **Causes** |
| Noncompliance with dietary and lifestyle recommendations |
| Physiological factors (variations in response to surgery) |
| Surgical/anatomic issues |
| Hormonal/metabolic changes |
| **Prevention** |
| Optimizing patient selection criteria |
| Realistic preop expectations |
| Consideration of benefits of bypass vs. restrictive procedures |
| Adherence to scheduled visits |

### 2.6.3.4.7. Complications of Bariatric Surgery

Complications after bariatric surgery depends on various causes based on patient dependent and surgery dependent. Table 2.8. shows main complications that can be seen after bariatric surgery (147).

Almost 30% of the patients are at risk of nutritional complications after bariatric surgery, often micronutrient or macronutrient deficiencies or both. For all surgical types, nutritional deficiency etiology can be explained as; decreased food intake, malabsorption and modified food choices, hydrochloric acid and intrinsic factor, possible nausea and vomiting soon after surgery, food avoidance due to intolerance, wrong food choices. Hence it is very important to take multivitamin plus mineral supplementation after SG to avoid deficiencies (146–148).

#### 2.6.3.4.7.1. Micronutrient Deficiencies

Micronutrients has specific absorption sites in gastrointestinal track (Figure 2.6-(147)). Understanding physiology of absorption in gastrointestinal track can help to estimate potential deficiencies. Vitamin D, vitamin B12, iron and calcium deficiencies are the most common deficiencies after bariatric surgery. The repletion therapies of the deficiencies are explained in detail above (See Section 2.6.3.4.4. Vitamin Supplementation). Considering decreased dietary intake, SG patients, need life-long multivitamin supplementation (151). Nutrient levels should be monitored.

**Table 2. 8. Long-term bariatric surgery complications (147)**

| | |
|---|---|
| **Nutrition related complications** | |
| Malnutrition | Dehydration |
| Nausea and vomiting | Vitamin and mineral deficiencies |
| Anemia | Dumping syndrome |
| **Gastrointestinal related complications** | |
| Abdominal pain | Gallstones |
| Intestinal obstructions | Anastomotic strictures |
| Marginal ulcers | Diarrhea |
| Constipation | Incisional hernias |
| Gastritis | LAGB erosions |
| LAGB prolapse | Weight loss failure |

Untreated deficiencies may cause malnutrition and possible permanent symptoms/complications. Table 2.9 lists specific micronutrients and clinical deficiency symptoms (152).

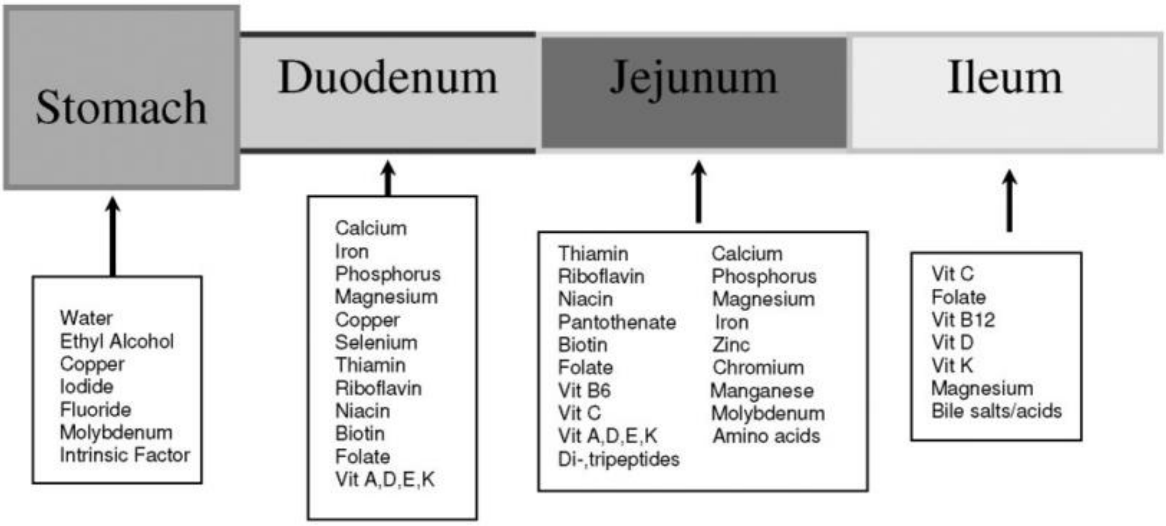


**Figure 2. 6. Sited of nutrient absorption in the gastrointestinal track (147)**

**Table 2. 9. Clinical symptoms of micronutrient deficiencies (152)**

| Vitamin | Deficiency state | Symptoms |
|---|---|---|
| Thiamine (vitamin B1) | Beriberi | Neuropsychiatric: aggression, hallucinations, confusion, ataxia, nystagmus, paralysis of the motor nerves of the eye<br>Neurologic or 'dry' beriberi: convulsions, numbness, muscle weakness and/or pain of lower and upper extremities, brisk tendon reflexes<br>High-output cardiac or 'wet' beriberi: tachycardia or bradycardia, lactic acidosis, dyspnoea, leg oedema, right ventricular dilatation<br>Gastroenterologic: slow gastric emptying, nausea, vomiting, jejunal dilatation or megacolon, constipation |
| Riboflavin (vitamin B2) | Ariboflavinosis | Anaemia, dermatitis, stomatitis, glossitis |
| Niacin (vitamin B3) | Pellagra | Diarrhoea, confusion, dermatitis, ataxia |
| Pantothenic acid (vitamin B5) | Pantothenic acid deficiency | Depression, infections, orthostatic hypotension, paraesthesias, foot drop, gait disorder |
| Pyridoxine (vitamin B6) | Pyridoxine deficiency | Dermatitis, neuropathy, confusion |
| Folic acid (vitamin B9) | Folate deficiency | Weakness, weight loss, anorexia |
| Cobalamin (vitamin B12) | Pernicious anaemia | Depression, malaise, ataxia, paraesthesias |
| Ascorbic acid (vitamin C) | Scurvy | Malaise, myalgias, gum disease, petechia |
| Biotin (vitamin B7) | Biotin deficiency | Loss of taste, seizures, hypotonia, ataxia, dermatitis, hair loss |
| Vitamin A | Vitamin A deficiency | Night blindness, itching, dry hair |
| Vitamin D | Osteomalacia (in adults) Rickets (in children) | Arthralgias, depression, fasciculations, myalgias |
| Vitamin E | Vitamin E deficiency | Anaemia, ataxia, motor speech disorder, muscle weakness |
| Vitamin K | Vitamin K deficiency | Bleeding disorder |
| Calcium | Osteoporosis | Usually absent |
| Iron | Iron-deficiency anaemia | Fatigue, shortness of breath, chest pain |
| Zinc | Hypozincaemia | Skin lesions, nail dystrophy, alopecia, glossitis |
| Copper | Hypocupraemia | Usually absent |
| Selenium | Keshan disease | Dyspnea, fatigue, leg swelling |

Vitamin D is the most common deficiency pre- and postoperatively. Many studies state Vitamin D deficiency is ranging from 50-80% after bariatric surgery (150,151). For SG, Vitamin D deficiency is found around 36-38% in some studies (152,153).

Intrinsic factor and hydrochloric acid production is decreased after SG because of removing most of the stomach including fundus and most of the body of the stomach.

$B_{12}$ deficiencies can be expected after SG because, 99% of $B_{12}$ in foods is released by intrinsic factor (154,155). Moreover, iron absorption can also be affected because of altered hydrochloric acid levels (138,155). At 1 year and 3 years after SG, vitamin $B_{12}$ and iron deficiencies have been reported (140). After SG, $B_{12}$ deficiency is reported as 9-13% (153,156). Iron deficiency is reported 11-47% after postop 1 year (150,153,156).

Folic acid deficiency is expected to be less common after SG because SG is less invasive than RYGB or BPD/DS. But folic acid stores are consumed frequently if the intake is insufficient (160).

It is important to know that anemia can appear as a result of some micronutrient deficiencies or a combination of multiple deficiencies. Deficiencies in folic acid and vitamin B12 may result in the development of macrocytic anemia. Copper, vitamin A, E and zinc deficiencies are alternative potential reasons of anemia after bariatric surgery and it is better to consider their deficiency if the anemia is not corrected despite appropriate replacement of folic acid, vitamin B12, and/or iron (148).

Preop zinc deficiency rate is 24,6% and postop 1 year zinc deficiency rate reported 5% in some studies (152,158). It has been reported that after bariatric surgery, zinc deficiency increase with 6% per year. Furthermore, up to 30% of patients have low serum zinc levels preoperatively, and this was built to sequestration in adipose tissues (158,159). SG patients may be at risk for zinc deficiency as one study on SG patients cited 34 % postop zinc deficiency (154).

It has been reported that up to 18% of patients have copper deficiency after bariatric surgery, commonly several months after the surgery (162). Copper deficiency reveals itself with hematological (leucopenia, anemia) and neurological signs (ataxia, neuropathy, myelopathy) (163).

The most potentially devastating micronutrient deficiency occurring in the hospitalized post–bariatric surgery patient is thiamine (vitamin B1) deficiency (164).

Thiamin cannot be synthesized by humans, and it is absorbed in the proximal small bowel primarily. Stores of thiamine are low in the body, therefore, sufficient dietary intake is essential. After bariatric surgery, thiamine deficiency may appear clinically in 2 main forms: beriberi and Wernicke-Korsakoff syndrome (148). Beriberi is a disease caused by thiamine deficiency. It can appear with cardiac (wet beriberi) and neurologic symptoms (dry beriberi) or both (165). Most of the cases develop dry beriberi (beriberi with neurological symptoms) within postop 4-12 weeks (166). But there is a case report of a beriberi diagnose 10 years after RYGB (167).

Considering decreased dietary intake, SG patients, need life-long multivitamin supplementation. Nutrient levels should be monitored. Untreated deficiencies may cause malnutrition and possible permanent symptoms/complications (151).

**2.6.3.4.7.2. Protein-Energy Malnutrition (PEM)**

The primary absorption areas of protein is mid-ileum and jejenum so procedures which bypass this areas increase risk of postop PEM. Because most common bariatric interventions are not bypassing these gastrointestinal areas PEM is generally caused by decreased food intake. Reduction in pepsinogen and hydrochloric acid may also promote PEM. Some postop situations (such as, depression, chronic vomiting, diarrhea, alcohol consumption) may worsen PEM. Generally, reduction of appetite lasts for 1-3 months after surgery and patients feel full very quickly in between 8 weeks postoperatively and therefore, amount of food they can take is very limited. As a result, in order to meet the protein needs of the body, taking high quality protein supplements is very important. Whey protein is especially highlighted because it has been shown that whey protein provide stronger satiety than casein and other milk protein (168).

In order to take complete protein from foods, mixing different protein sources is mandatory to obtain protein digestibility corrected amino acid (PDCAA) score closest to 100, which means the protein source includes all of essential amino acids (117,160).

Symptoms of PEM are alopecia, low serum albumin levels (3,5 g/dL), decreased weight loss, edema (169). Because of longer half-life serum albumin level is not a reliable marker to determining PEM (170). Since it has half-life of 1-2 days, prealbumin is a better marker of protein deficiency (171).

SG has lower rate of PEM than malabsorptive procedures. After SG, patients who as maladaptive eating behaviors are tend to PEM since SG do not cause any protein malabsorption. Severe PEM should be managed branch-chain amino acid based modular protein supplements, ultimately, enteral feeding (172).

# 3. MATERIAL AND METHOD

For recruitment, data of the participants who underwent sleeve gastrectomy procedure in Istanbul Bariatrics, a private clinic in Istanbul between March 2014-February 2017 were included this study. After ethical approval from Acıbadem University with ADATEK- 2018/3 number and 01.03.2018 data (Appendix 1).

Data of 229 participants are evaluated in this study. Anthropometric measurements and biochemical analyses are investigated. The subject inclusion and exclusion criteria's of the study are,

- To have had a sleeve gastrectomy procedure in Istanbul Bariatrics Clinic,
- Not to had have another bariatric surgery procedure before
- To be a volunteer
- To be over 18 years old
- To be under 65 years old
- Not to have any missing records of anthropometric and biochemical data.

Preop anthropometric measurements were obtained in clinic during participants' first clinical evaluation. SECA 703 model of device was used for weight and height determination in both preop and postop anthropometric measurement . Preop weight of records the participants were the values which were obtained without any intervention. For determination of EWBL% at 3rd and 12th months, weight of the participants are put into perspective in kilograms. Data is collected by using the records for weight of each participant at clinic preoperatively and postoperatively, participants were weighted at clinic using same device at approximate date of postop 3rd or 12th months if possible or self-report data were collected by phone sessions. And according to these weight data, EBWL% is calculated for each participant.

BMI was calculated as weight in kilograms divided by height per square meter. BMI classification is determined by WHO cut-off points (11).The percentage of EWBL% was calculated as [(baseline weight − postop weight)/(baseline weight − IBW)] × 100. The ideal body weight (IBW) was calculated according to weight equaled to a BMI of 25 $k/m^{2,}$ regarding clinic's routine evaluation.

Participants had dietitian consultation both preoperatively and postoperatively. Low calorie liquid diet was instructed to the participants at least one week before surgery. According to preop biochemical test results, if there was a micronutriet deficiency, repletion therapy was initiated immediately as the clinic's routine. Postop dietary treatment was followed according to ASBMS 2013 updated guideline (95). Routine multivitamin plus mineral supplementation was recommended for each participant as a routine in the clinic. All participants were told to take 2 portion of chewable multivitamin plus mineral supplementation starting with 2 days after surgery. Routine recommended chewable multivitamin plus mineral supplement is Solgar Kangavites®. (contains 2,500 IU of vitamin A palmitat, 80% beta-caroten, 60 mg of vitamin C, 100 IU of vitamin D, 15 IU of vitamin E, in D-alfa tokoferil succinate form, 0,75 mg of thiamine, 0,85 mg of riboflavin, 10 mg of niacin in niacinamide form, 1 mg of vitamin $B_6$ in pyridoxine HCL form, 1000 mcg of folic acid, 3 mcg of vitamin $B_{12}$ in cobalamin form, 50 mcg of biotin, 5 mg pantothenic acid in D-calcium pantothenat form, 64 mg of calcium in calcium carbonate form, 2,5 mg of iron in iron fumarat form, 22,5 mg of iodine in potassium iodure form, 32 mg of magnesium in magnesium oxide form, 1,5 mg of zinc in zinc oxide form, 2,5 mcg of selenium in L-selenomethionine form, 0,025 of mg copper in copper gluconate form, 0,25 mg of manganese in manganese sulfate form, 5 mcg of chrome in chelated form, 0,5 mg of choline in choline bitartrate form) As participants were able to tolerate, chewable formed supplement is replaced with 2 portions of pill formed supplement, Solgar VM 2000® (contains 2,5 mg of beta carotene, 50 mg of thiamine, 50 mg of riboflavin, 50 mg of niacin, 50 mg of pantothenic acid, 5 mg of vitamin $B_6$ in pyridoxine HCL form, 200 mcg of folic acid, 50 mcg of vitamin $B_{12,}$ 150 mg of vitamin C, 200 IU of vitamin D, 10IU of vitamin E, 50 mcg of biotin, 75 mcg of iodine, 12,5 mcg of chrome, 64 mg of calcium, 50 mg of inositol, 0,5 mg of boron, 32 mg of magnesium, 20,5 mg of choline, 5 mg of iron, 750 mcg of copper, 1 mg of manganese, 7,5 mg of zinc, 12,5 mcg of selenium). Appropriate supplementation was recommended by staff of clinic if a patient had a postop micronutrient deficiency.

Preop and postop 3rd months and 12th months blood test records are evaluated in this study. In Table 3.1 preop blood test parameters are shown. Table 3.2 shows postop 3rd and 12th months parameters.

Micronutrient deficiencies were diagnosed by blood tests. Laboratory values were evaluated and determined as deficient if the value did not reach the reference values. Routine postop blood test records were evaluated.

Serum iron, ferritin, total iron binding capacity, hemoglobin, vitamin $B_{12}$, folic acid, vitamin D, calcium tests were run by Roche brand Cobas Biochemistry and

Hormonal Integra 4000 Analyzer device. Zinc and copper tests were run by Agilent brand Atomic Absorption device. Vitamin A and vitamin $B_1$ (thiamine) - Agilent brand HPLC device. Biotin test was run by Triturus brand Eliza device. Reference ranges were determined according to used device's reference ranges. Table 3.3 includes reference ranges of each parameter.

**Table 3. 1. Preop blood tests**

| |
|---|
| Serum Iron |
| Ferritin |
| Total Iron Bounding Capacity |
| Hemoglobin |
| Vitamin $B_{12}$ |
| Folic Acid |
| Vitamin D |
| Copper |

**Table 3. 2. Postop 3rd and 12th months blood test parameters**

| |
|---|
| Serum Iron |
| Ferritin |
| Total Iron Bounding Capacity |
| Hemoglobin |
| Vitamin $B_{12}$ |
| Folic Acid |
| Vitamin D |
| Copper |
| Vitamin A |
| Biotin |
| Vitamin $B_1$ (Thiamine) |
| Calcium |
| Zinc |

**Table 3. 3. Biochemical parameters**

| Biochemical Parameters | Reference Range |
|---|---|
| Serum Iron | 37-145 µg/dL |
| Ferritin | 10-160 ng/dL |
| Total Iron Bounding Capacity | 228-428 µg/dL |
| Hemoglobin | 11,7-16 g/dL |
| Vitamin $B_{12}$ | 197-771 pg/mL |
| Folic Acid | 3,89-26,80 ng/mL |
| Vitamin D ( 25-OH- Vitamin D) | 30-140 ng/mL |
| Copper | 80-155 µg/dL |
| Vitamin A | 316-820 µg/L |
| Biotin | Avitaminosis<100 ng/L |
| | Optimal Intake 100-250 ng/L |
| | Adequate Intake >250 ng/L |
| Vitamin $B_1$ (Thiamine) | 35,0-99,0 ng/mL |
| Calcium | 8,5-10,5 mg/dL |
| Zinc | 70-145 µg/dL |

All data assessed in SPSS v22.0 statistics program. Frequency analyses, descriptive statistics, independent - Samples T- Test, correlation analyses (Pearson), One-WAY ANOVA analysis were implemented. The relation between scales are shown with correlation analysis, correlation factor is shown with Pearson correlation factor. Correlation analysis shows strength of relation between parameters. Negative or positive correlation factor shows direction or the relation. If this factor is smaller than 0,4 the relation is accepted as weak, between 0,4-0,6 is accepted as normal and 0,6-1,0 is accepted as strong relation.

# 4. RESULTS

In this study, 59% (n= 134) of the participants were women, 41% (n=95) of the participants were men.

Assessing BMI classification of the participants, 3% of participants were class 1, 28% were class 2 and 69% were class 3 obese (Table 4.1).

**Table 4. 1. BMI classification**

| BMI* | n | % |
|---|---|---|
| Class I | 8 | 3,0 |
| Class II | 63 | 28,0 |
| Class III | 158 | 69,0 |
| *Body Mass Index | | |

When descriptive statistics of BMI were assessed, mean BMI value of the women was 45,89 kg/m$^2$, mean BMI value of men was 43,56 kg/m$^2$ and mean value in general was 44,53 kg/m$^2$. Maximum and minimum BMI values of men were 32,04 kg/m$^2$ and 70,55 kg/m$^2$ respectively and maximum and minimum BMI values of women were 31,88 kg/m$^2$ and 67,04 kg/m$^2$ respectively (Table 4.2).

**Table 4. 2. Descriptive statistics of BMI according to sex and general situation**

| | BMI* | | | |
|---|---|---|---|---|
| Sex | Mean | S.D. | Minimum | Maximum |
| Women | 43,56 | 7,48 | 32,04 | 70,55 |
| Men | 45,89 | 6,09 | 31,88 | 67,04 |
| General | 44,53 | 7,02 | 31,88 | 70,55 |
| *Body Mass Index | | | | |

Even if it is not an excepted cut-off point, there were 46 participants who had BMI value over 50 kg/m$^2$. 50% of these were men and %50 are women (Table 4.3).

**Table 4. 3. Sex distribution of participants with BMI>50**

| BMI*>50 | | |
|---|---|---|
| Sex | n | % |
| Women | 23 | 50,0 |
| Men | 23 | 50,0 |
| Total | 46 | |
| *Body Mass Index | | |

After surgery, weight loss is evaluated by EBWL%. At postop 3rd month EBWL% of the participants was 49,2% ±14,36 and at postop 12th month EBWL% of the participants was 87,6%±21,25 (Table 4.4).

**Table 4. 4. Postop EBWL% of the participants at 3rd and 12th months**

| EBWL% | Mean (%) | Standard Deviation |
|---|---|---|
| EBWL% at postop 3rd month | 49,2 | 14,36 |
| EBWL% at postop 12th month | 87,6 | 21,25 |

By comparison of EBWL% according to sex (Table 4.5), EBWL% at 3rd month did not show any significant difference between men and women (t: 0,791; p.0,430>0,05). The mean value of EBWL% at 3rd month in women was 50,06 % as the mean value of EBWL% at 3rd month in men was 48,53%.

On the other hand, EBWL% at 12th month showed statistically significant difference between men and women (t: 2,681; p: 0,008≤0,05). The mean value of EBWL% at 12th month in women (90,68%) was found to be greater than the mean value of EBWL% at 12th month in men (83,36%).

**Table 4. 5. Variation of EBWL% according to sex**

| EBWL% | Women | | Men | | t | p |
|---|---|---|---|---|---|---|
| | Mean (%) | S.D. | Mean (%) | S.D. | | |
| EBWL% at postop 3rd month | 50,06 | 14,65 | 48,53 | 13,99 | 0,791 | 0,430 |
| EBWL% at postop 12th month | 90,68 | 22,43 | 83,36 | 18,77 | 2,681 | **,008*** |
| *p≤0,05; Independent - Samples T- Test | | | | | | |

Table 4.6 shows evaluation of the micronutrients which are included routine blood test both preoperatively and postoperatively. In this study, iron deficiency was 4,4% postoperatively (n: 227), 5% at postop 3rd month (n: 227) and 3% at postop 12th month (n: 226). Ferritin deficiency was 6% postoperatively (n: 226), 7% at postop 3rd month (n: 226) and 9% at postop 12th month (n: 226). High levels of serum total iron binding capacity was 5% preoperatively (n: 224), 1% at postop 3rd month (n: 222) and 9% at postop 12th month (n: 222). Low levels of serum hemoglobin were found at 6% preoperatively (n: 225), 6,3% at postop 3rd month (n: 221) and 11% at postop 12th

**Table 4. 6. Evaluation of the levels of biochemical parameters -1**

| | Preop | | postop 3rd month | | postop 12th month | |
|---|---|---|---|---|---|---|
| **Iron** | n | % | n | % | n | % |
| Deficient | 10 | 4,4 | 11 | 5,0 | 7 | 3,0 |
| Optimal | 205 | 90,3 | 208 | 92,0 | 187 | 84,0 |
| Excessive | 12 | 5,3 | 8 | 3,0 | 30 | 13,0 |
| **Ferritin** | | | | | | |
| Deficient | 13 | 6,0 | 16 | 7,0 | 19 | 9,0 |
| Optimal | 157 | 69,0 | 141 | 62,0 | 145 | 65,0 |
| Excessive | 56 | 25,0 | 69 | 31,0 | 58 | 26,0 |
| **TIBC**[a] | | | | | | |
| Deficient | 8 | 4,0 | 29 | 13,0 | 30 | 13,0 |
| Optimal | 204 | 91,0 | 190 | 86,0 | 188 | 85,0 |
| Excessive | 12 | 5,0 | 3 | 1,0 | 4 | 2,0 |
| **Hemoglobin** | | | | | | |
| Deficient | 14 | 6,0 | 14 | 6,3 | 24 | 11,0 |
| Optimal | 196 | 87,0 | 193 | 87,3 | 188 | 84,0 |
| Excessive | 15 | 7,0 | 14 | 6,3 | 12 | 5,0 |
| **Vitamin $B_{12}$** | | | | | | |
| Deficient | 8 | 3,6 | 5 | 2,2 | 17 | 7,0 |
| Optimal | 207 | 92,4 | 208 | 92,4 | 199 | 88,0 |
| Excessive | 9 | 4,0 | 12 | 5,3 | 11 | 5,0 |
| **Folic Acid** | | | | | | |
| Deficient | 8 | 3,6 | 7 | 3,2 | 18 | 8,0 |
| Optimal | 213 | 95,9 | 213 | 96,4 | 199 | 91,0 |
| Excessive | 1 | ,5 | 1 | ,5 | 2 | 1,0 |
| **Vitamin D** | | | | | | |
| Deficient | 191 | 87,0 | 114 | 51,0 | 114 | 51,0 |
| Optimal | 28 | 13,0 | 107 | 48,0 | 110 | 49,0 |
| Excessive | 0 | 0,0 | 1 | 1,0 | 0 | 0,0 |
| **Copper** | | | | | | |
| Deficient | 6 | 5,0 | 9 | 5,0 | 23 | 11,0 |
| Optimal | 114 | 86,0 | 162 | 90,0 | 177 | 87,0 |
| Excessive | 12 | 9,0 | 9 | 5,0 | 3 | 2,0 |

[a]Total iron binding capacity

month (n: 224). Vitamin $B_{12}$ deficiency was found in 6% preoperatively (n: 224) ), 6,3% at postop 3rd month (n: 225) and 11% at postop 12th month (n: 227). Folic acid deficiency was determined in 3,6% preoperatively (n: 228), 3,2% at postop 3rd month (n: 221) and 8% at postop 12th month (n: 219). Vitamin D deficiency was found in %87 preoperatively (n: 219), 51% at postop 3rd month (n: 222) and 51% at postop 12th month (n: 224). Copper deficiency was found in 5% preoperatively (n: 134), 5% at postop 3rd month (n: 180) and 11% at postop 12th month (n: 203).

There was a negative linear correlation between age and EBWL% at 3rd month (r:-,173) and EBWL% at 12th month (r:-,344). Increase in age, decreases EBWL% value at both postop 3rd and 12th months

Investigating the relation between preop micronutrients parameters and age (Table 4.7), there was a positive linear correlation between vitamin D (r:0,209; p<0,01), folic acid (0,148; p<0,05), copper (r:0,122) and vitamin $B_{12}$ (r:0,153; p<0,01) levels and age.

**Table 4. 7. Correlation between age and preop micronutrient parameters**

| Micronutrients | Age | |
|---|---|---|
| | r | p |
| Iron | ,092 | ,169 |
| TIBC[a] | ,013 | ,843 |
| Ferritin | ,034 | ,609 |
| Hemoglobin | -,050 | ,459 |
| Vitamin $B_{12}$ | **,153*** | **,022** |
| Folic Acid | **,148*** | **,027** |
| Vitamin D | **,209**** | **,002** |
| Copper | **,122** | **,162** |
| *p<.05, **p<.01, Pearson correlation | | |
| [a]Total iron binding capacity | | |

Comparison of preop micronutrients levels with BMI classification (class I, class II and class III obesity) (See Table 4.8); serum ferritin (F: 3,555; p: 0,020) and hemoglobin (F: 5,631; p: 0,004) showed significant difference between BMI classification groups (p<.05). By assessing group difference by Tukey's HSD comparison test, participants classified as class III obesity had significantly higher mean serum levels of hemoglobin and ferritin values compared with class II obesity group.

**Table 4. 8. Comparison of preop micronutrient levels with BMI classification**

| Preop micronutrients | BMI[1] | | | | | | F | p |
|---|---|---|---|---|---|---|---|---|
| | Class I | | Class II | | Class III | | | |
| | Mean | S.D. | Mean. | S.D. | Mean. | S.D. | | |
| Iron | 101,63 | 31,31 | 89,86 | 45,87 | 84,50 | 29,31 | 1,311 | 0,272 |
| TIBC[a] | 61,33 | 45,82 | 95,08 | 143,53 | 141,27 | 133,86 | 3,555 | **,020*** |
| Ferritin | 304,1 | 49,0 | 341,1 | 65,4 | 334,4 | 57,5 | 1,415 | 0,245 |
| Hemoglobin | 14,36 | 1,54 | 13,36 | 1,39 | 14,11 | 1,57 | 5,631 | **,004*** |
| Vitamin $B_{12}$ | 531,8 | 154,0 | 425,5 | 182,8 | 412,3 | 222,3 | 1,256 | 0,287 |
| Folic Acid | 8,94 | 2,11 | 8,71 | 4,25 | 8,28 | 3,06 | 0,448 | 0,639 |
| Vitamin D | 26,067 | 18,940 | 19,926 | 11,035 | 18,571 | 13,050 | 1,297 | 0,275 |
| Copper | 105,20 | 14,08 | 119,36 | 23,43 | 117,80 | 31,62 | 0,516 | 0,598 |

[1]One-way ANOVA test, *p<.05

[a]Total iron binding capacity

Analyzes of link between EBWL% of participants in 3rd month after surgery and micronutrient values showed that; there was a negative linear relation between hemoglobin value and EBWL% (r: - ,192; p: ,004≤0,1). Meaning; as EBWL% increases, serum hemoglobin level decreases (See Table 4.9).

There was a negative linear relation between HGB value and EBWL% at 12th month (r: -,208; p: ,002≤0,1) and there was positive linear relation between biotin value and EBWL% (r: ,158; p: ,026≤0,5) (See Table 4.10). This means, as EBWL% increases, HGB decreases but biotin level increases.

Assessment of the correlation between micronutrient levels and 3rd month EBWL% of men and women (see Table 4.11) showed that there was an negative linear correlation between 3rd month EBWL% of women and hemoglobin (r:-,220) and vitamin $B_{12}$ (r:-,218) levels at postop 3rd month (p≤0,01). The increase of 3rd month EBWL% affects the decrease in serum hemoglobin and vitamin $B_{12}$ levels at postop 3rd month.

There was significant a positive linear correlation between 3rd month EBWL% of men and serum iron (r: ,218) level; negative correlation between 3rd month EBWL% of men and serum calcium level (r:-,309) at postop 3rd month (p≤0,05). The increase of

**Table 4. 9. Correlation analysis between postop 3rd and 12th month EBWL% and micronutrient levels**

| Micronutrients | 3rd month EBWL% | | 12th month EBWL% | |
|---|---|---|---|---|
| | r | p | r | p |
| Iron | ,064 | ,339 | ,054 | ,421 |
| TIBC[a] | -,049 | ,471 | ,043 | ,521 |
| Ferritin | -,040 | ,546 | -,095 | ,159 |
| Hemoglobin | **-,192**** | **,004** | **-,208**** | **,002** |
| Vitamin $B_{12}$ | -,097 | ,149 | -,017 | ,800 |
| Folic Acid | -,021 | ,757 | -,002 | ,982 |
| Zinc | -,036 | ,595 | -,069 | ,311 |
| Calcium | -,079 | ,239 | ,046 | ,495 |
| Vitamin D | -,061 | ,364 | ,006 | ,929 |
| Vitamin A | -,044 | ,524 | -,117 | ,092 |
| Vitamin $B_1$ | -,028 | ,684 | -,126 | ,072 |
| Biotin | -,062 | ,377 | **,158*** | **,026** |
| Copper | -,081 | ,278 | -,123 | ,081 |
| *p≤0,05; **p≤0,01, Pearson Correlation | | | | |
| [a]Total iron binding capacity | | | | |

**Table 4. 10. Correlation analysis between postop 12rth month EBWL% and micronutrient levels**

| Micronutrients | | |
|---|---|---|
| | r | p |
| Iron | ,054 | ,421 |
| TIBC[a] | ,043 | ,521 |
| Ferritin | -,095 | ,159 |
| Hemoglobin | **-,208**** | **,002** |
| Vitamin $B_{12}$ | -,017 | ,800 |
| Folic Acid | -,002 | ,982 |
| Zinc | -,069 | ,311 |
| Calcium | ,046 | ,495 |
| Vitamin D | ,006 | ,929 |
| Vitamin A | -,117 | ,092 |
| Vitamin $B_1$ | -,126 | ,072 |
| Biotin | **,158*** | **,026** |
| Copper | -,123 | ,081 |
| *p≤0,05; **p≤0,01, Pearson correlation | | |
| [a]Total iron binding capacity | | |

3rd month EBWL% affects the decrease in serum calcium and increase in serum iron levels.

**Table 4. 11. Correlation analysis of 3rd month EBWL% and serum micronutrient levels according to sex**

| 3rd month EBWL% | | | | |
|---|---|---|---|---|
| Micronutrients | Women | | Men | |
| | r | p | r | p |
| Iron | ,023 | ,793 | **,218*** | **,035** |
| TIBC[a] | -,048 | ,590 | -,070 | ,505 |
| Ferritin | -,124 | ,156 | ,141 | ,175 |
| Hemoglobin | **-,220*** | **,012** | -,165 | 0,117 |
| Vitamin $B_{12}$ | **-,218*** | **,012** | ,113 | 0,278 |
| Folic Acid | -,102 | ,252 | ,116 | ,271 |
| Zinc | -,014 | ,877 | -,046 | ,663 |
| Calcium | ,036 | ,681 | **-,309**** | **,002** |
| Vitamin D | -,082 | ,358 | -,048 | ,647 |
| Vitamin A | -,079 | ,384 | ,020 | ,849 |
| Vitamin $B_1$ | -,093 | ,316 | ,078 | ,078 |
| Biotin | -,049 | ,598 | -,105 | ,332 |
| Copper | -,154 | ,121 | -,008 | ,946 |
| *p≤0,05; **p≤0,01, Pearson correlation | | | | |
| [a]Total iron binding capacity | | | | |

Assessment of the correlation between micronutrient levels and 12th month EBWL% of men and women (see Table 4.12) showed that there was an negative linear correlation between 12th month EBWL% of women and copper (r:-,207) levels at postop12th month (p≤0,05). The increase of 12th month EBWL%, affects the decrease in serum copper levels at postop 12th month.

There was significant a positive linear correlation between 12th month EBWL% of men and calcium level (r: ,253) at postop 12th month (p≤0,05). The increase of 12th month EBWL%, affects the increase in serum calcium levels.

Not all of the micronutrient levels were analyzed preoperatively, calcium, biotin, vitamin $B_1$, vitamin A and zinc were analyzed at postsoperative 3rd month and12th months. As a result, vitamin A deficiency was found in 31% of the patients (n: 211) at

**Table 4. 12. Correlation analysis of 12th month EBWL% and serum micronutrient levels according to sex**

| 12th month EBWL% | | | | |
|---|---|---|---|---|
| Micronutrients | Women | | Men | |
| | r | p | r | p |
| Iron | ,094 | 0,285 | ,170 | 0,100 |
| TIBC[a] | ,076 | 0,394 | -,081 | 0,440 |
| Ferritin | -,110 | 0,216 | ,115 | 0,273 |
| Hemoglobin | -,125 | 0,160 | -,153 | 0,140 |
| Vitamin $B_{12}$ | -,072 | 0,412 | ,045 | 0,664 |
| Folic Acid | -,055 | 0,539 | ,055 | 0,602 |
| Zinc | -,134 | 0,131 | -,007 | 0,947 |
| Calcium | ,042 | 0,630 | **,253*** | **0,015** |
| Vitamin D | -,057 | 0,522 | ,085 | 0,415 |
| Vitamin A | -,076 | 0,403 | -,127 | 0,247 |
| Vitamin $B_1$ | -,176 | 0,055 | -,004 | 0,972 |
| Biotin | ,170 | 0,074 | ,168 | 0,124 |
| Copper | **-,207*** | **0,024** | -,144 | 0,192 |
| *p≤0,05; **p≤0,01, Pearson correlation | | | | |
| [a]Total iron binding capacity | | | | |

3rd month postoperatively, 15% of the patients (n: 207) at postop 12th month. Biotin deficiency was found in 62% of the patients (n: 205) at postop 3rd month and 57% at postop 12th month (n: 197). Vitamin $B_1$ deficiency was found in 5% of the patients (n: 207) in postop 3rd month and 3% (n: 204) in postop 12th month. Low serum calcium levels were determined in 3% of the patients (n: 225) in postop 3rd month and none of the patients (n: 222) had low serum calcium at postop 12th month. At postop 3rd month, zinc deficiency was determined in 11% of the patients (n: 218), at postop 12th month, 16% of the patients (n: 219) had low serum zinc levels (Table 4.13).

According to the analyze of correlation between micronutrients levels of the participants at postop 3rd month and 12th month and their age ; there was a positive linear correlation between vitamin $B_{12}$ (r: 0,162; p<0,05) and folic acid (r:0,335; p<0,01) levels. At 12th month postoperatively, data showed that there was a positive linear correlation between vitamin $B_{12}$ (r:0,199; p<0,01), folic acid (r:0,291; p<0,01), vitamin D (r:0,189; p<0,01), vitamin A (r:0,267; p<0,01) and vitamin $B_1$ (r:0,289; p<0,01). (See Table 4.14)

**Table 4. 13. Evaluation of the levels of biochemical parameters -2**

| | postop 3rd month | | postop 12th month | |
|---|---|---|---|---|
| **Vitamin A** | n | % | n | % |
| Deficient | 66 | 31,0 | 31 | 15,0 |
| Optimal | 143 | 68,0 | 167 | 81,0 |
| Excessive | 2 | 1,0 | 9 | 4,0 |
| **Biotin** | n | % | n | % |
| Deficient | 127 | 62,0 | 113 | 57,0 |
| Excessive | 78 | 38,0 | 84 | 43,0 |
| **Thiamine (vitamin $B_1$)** | n | % | n | % |
| Deficient | 11 | 5,0 | 6 | 3,0 |
| Optimal | 163 | 79,0 | 178 | 87,0 |
| Excessive | 33 | 16,0 | 20 | 10,0 |
| **Calcium** | n | % | n | % |
| Deficient | 6 | 3,0 | 0 | 0,0 |
| Optimal | 216 | 96,0 | 219 | 99,0 |
| Excessive | 3 | 1,0 | 3 | 1,0 |
| **Zinc** | n | % | n | % |
| Deficient | 24 | 11,0 | 36 | 16,0 |
| Optimal | 191 | 88,0 | 180 | 82,2 |
| Excessive | 3 | 1,0 | 3 | 1,4 |

By assessing the link between serum micronutrient levels and BMI classification at postop 3rd month (Table 4.15), significant difference was seen between BMI classification groups and serum ferritin (F: 4,413; p: 0,013), hemoglobin (F:13,565; p:0,000) and biotin (F: 3,695; p: 0,027) levels (p<.05). By assessing group difference by Tukey's HSD comparison test, patients classified as class III obesity had significantly higher mean serum levels of hemoglobin and ferritin values compared with class II obesity group and for biotin, patients classified as class III obesity had significantly higher mean serum levels of biotin values compared with other BMI classification groups.

**Table 4. 14. Correlation of age and micronutrient levels at postop 3rd & 12th months**

| Micronutrients | Age | | | |
|---|---|---|---|---|
| | postop 3rd month | | postop 12th month | |
| | r | p | r | p |
| Iron | ,100 | ,131 | ,039 | ,558 |
| TIBC[a] | -,105 | ,117 | -,131 | ,051 |
| Ferritin | ,047 | ,478 | ,064 | ,345 |
| Hemoglobin | -,060 | ,372 | ,045 | ,506 |
| Vitamin $B_{12}$ | **,162*** | **,015** | **,199**** | **,003** |
| Folic Acid | **,335**** | **,000** | **,291**** | **,000** |
| Zinc | -,088 | ,198 | ,005 | ,941 |
| Calcium | -,009 | ,893 | -,128 | ,057 |
| Vitamin D | ,021 | ,750 | **,189**** | **,005** |
| Vitamin A | ,134 | ,051 | **,267**** | **,000** |
| Vitamin $B_1$ | ,110 | ,116 | **,289**** | **,000** |
| Biotin | ,065 | ,357 | ,098 | ,169 |
| Copper | ,033 | ,657 | ,105 | ,135 |
| *p<.05, **p<.01, Pearson correlation | | | | |
| [a]Total iron binding capacity | | | | |

By assessing the link between serum micronutrient levels and BMI classification at postop 12th month (See Table 4.16), significant difference was seen between BMI classification groups and serum ferritin (F: 4,227; p: 0,016), hemoglobin (F:5,852; p:0,002) and biotin (F: 3,733; p: 0,026) and vitamin $B_{12}$ (F:12,472; p:0,000) levels (p<.05). By assessing group difference by Tukey's HSD comparison test, participants classified as class III obesity had significantly higher mean serum levels of hemoglobin and ferritin values compared with class II obesity group, Participants classified as class II obesity had significantly higher mean serum levels of biotin values compared with class III obesity group. And participants classified as class I obesity had significantly higher mean serum levels of vitamin $B_{12}$ values compared with both class II and class III obesity groups.

**Table 4. 15. Comparison of postop 3rd month micronutrient levels with BMI classification**

| Postop 3month | BMI[1] | | | | | | F | p |
|---|---|---|---|---|---|---|---|---|
| | Class I | | Class II | | Class III | | | |
| | Mean | S.D. | Mean | S.D. | Mean | S.D. | | |
| Iron | 110,14 | 48,20 | 84,12 | 31,44 | 84,87 | 28,53 | 2,457 | 0,088 |
| TIBC[a] | 275,86 | 77,00 | 295,37 | 56,01 | 288,91 | 59,70 | 0,47 | 0,626 |
| Ferritin | 62,06 | 61,93 | 97,71 | 112,41 | 142,27 | 119,75 | 4,413 | **,013*** |
| Hemoglobin | 13,73 | 1,14 | 13,15 | 1,23 | 14,22 | 1,43 | 13,565 | **,000*** |
| Vitamin $B_{12}$ | 477,3 | 161,9 | 393,7 | 153,8 | 418,7 | 191,3 | 0,855 | 0,426 |
| Folic Acid | 12,38 | 4,29 | 10,34 | 3,84 | 9,78 | 4,43 | 1,464 | 0,234 |
| Zinc | 92,00 | 14,42 | 86,46 | 15,03 | 88,22 | 21,46 | 0,313 | 0,732 |
| Calcium | 8,70 | 1,79 | 9,47 | 1,12 | 9,50 | ,76 | 2,844 | 0,06 |
| Vitamin D | 31,04 | 14,79 | 30,20 | 13,79 | 34,42 | 30,20 | 0,597 | 0,551 |
| Vitamin A | 422,72 | 155,93 | 399,59 | 150,67 | 370,10 | 171,53 | 0,866 | 0,422 |
| Vitamin $B_1$ | 53,55 | 12,77 | 71,82 | 31,48 | 75,22 | 33,31 | 1,409 | 0,247 |
| Biotin | 188,0 | 74 | 224,0 | 138 | 312,0 | 253 | 3,695 | **,027*** |
| Copper | 120,20 | 30,08 | 121,49 | 27,93 | 115,34 | 23,74 | 1,119 | 0,329 |
| [1]One-way ANOVA test, *p<.05 | | | | | | | | |
| [a]Total iron binding capacity | | | | | | | | |

**Table 4. 16. Comparison of postop 12th month micronutrient levels with BMI classification**

| Postop 12th month | BMI[1] | | | | | | F | p |
|---|---|---|---|---|---|---|---|---|
| | Class I | | Class II | | Class III | | | |
| | Mean | S.D. | Mean | S.D. | Mean | S.D. | | |
| Iron | 136,75 | 60,55 | 101,70 | 41,50 | 106,04 | 35,40 | 2,986 | 0,053 |
| TIBC[a] | 294,38 | 47,17 | 306,50 | 64,04 | 278,46 | 65,69 | 4,227 | **,016*** |
| Ferritin | 58,16 | 66,12 | 79,50 | 89,51 | 126,13 | 103,87 | 5,852 | **,002*** |
| Hemoglobin | 13,13 | 1,79 | 12,95 | 1,54 | 13,73 | 1,65 | 5,225 | 0,006 |
| Vitamin $B_{12}$ | 817,8 | 804,6 | 404,2 | 157,4 | 372,3 | 220,4 | 12,472 | **,000*** |
| Folic Acid | 9,90 | 6,03 | 9,89 | 5,76 | 9,18 | 4,75 | 0,459 | 0,632 |
| Zinc | 88,375 | 15,042 | 83,034 | 24,341 | 89,078 | 56,833 | 0,322 | 0,725 |
| Calcium | 9,48 | ,51 | 9,56 | ,46 | 9,54 | ,41 | 0,13 | 0,878 |
| Vitamin D | 29,3 | 8,3 | 34,7 | 19,2 | 33,4 | 17,5 | 0,365 | 0,694 |
| Vitamin A | 509,01 | 186,80 | 480,20 | 180,18 | 491,75 | 183,09 | 0,13 | 0,878 |
| Vitamin $B_1$ | 50,74 | 14,34 | 62,63 | 21,18 | 67,95 | 31,50 | 1,826 | 0,164 |
| Biotin | 319,61 | 327,17 | 405,23 | 309,73 | 293,05 | 221,42 | 3,733 | **,026*** |
| Copper | 96,5 | 15,0 | 106,7 | 24,7 | 104,5 | 20,4 | 0,833 | 0,436 |

[1]One-way ANOVA test, *p<.05

[a]Total iron binding capacity

# 5. DISCUSSION and CONCLUSION

There were evaluated 229 participants this study and 59% of the participants were women. BMI and combination with co morbidities is a criteria for surgery. 3% of the participants were classified as obese class I, 28% obese class II and 69% obese class III. Even if WHO did not mentioned in cut-off points, super obesity become getting mentioned in literature (126)., 20% of the participants had BMI higher than 50 kg/m$^2$ (n: 46). 50% of them were women (n:23).

Aiming for long-term weight loss, co morbidity and quality of life improvement, bariatric surgery is very effective treatment among morbid obese population (173). Mean postop EBWL% at postop 3rd month was 49,2% and at postop 12th month was 87,6%. These percentages meet the successful weight loss criteria even further the EBWL% values of the participants were greater than the expected weight loss (37-41% for postop 3rd month and 58-70% postop 12th month.) (102,138,141,172,173). EBWL% at postop 3rd month did not differ by sex, but at postop 12th month, it is shown that the women lost more weight (EBWL 90,68%) than men (EBWL 83,36%). According to literature, there is no significant link between weight loss and sex (143). On the other hand Anderson et al showed men and women had similar weight loss rates in the beginning after postop second year men had more weight loss than women (175).

Generally, prior researches have reported in sufficient and sometimes contradictory results about prevalence of micronutrient deficiencies before or after surgery. Moreover, there is no formulated specific recommendations for this group of patients in order to avoid deficiencies (95).

It is known that, obese population has micronutrient deficiencies, due to consuming lack of nutrient dense foods even if they contain a lot of calories. These micronutrient deficiencies are commonly, vitamin D, folic acid, thiamine, iron and vitamin $B_{12}$ (174,175). This study also confirms frequent micronutrient deficiencies in obese people.

Despite the fact that SG has been thought as a risk for vitamin and trace element deficiencies development altered gastric acid production and weight loss induced by restriction could promote copper, vitamin $B_1$ and $B_6$, folic acid deficiencies (177). Majority of studies on this topic have been stated at the first year after SG (155,177). As to be thought, the common conclusion of these studies is that, RYGB is more vulnerable to develop micronutrient deficiencies compared with SG, and the most frequent deficiency is vitamin D. Vitamin D deficiency is maybe the only consistent deficiency among other micronutrients. In this study, 87% of the patients had vitamin D deficiency preoperatively (plasma level<30 ng/mL). The data from the literature shows similar findings as Rutte et al. examined 200 bariatric surgery candidates and 81% of the patients had vitamin D deficiency, but the reference value in that study was 20 ng/mL, since value of serum vitamin D should be >30 ng/mL, the real prevalence of vitamin D deficiency should have been higher than reported (153,177). Other studies report preop vitamin D deficiencies in 60% to 80% of patients, therefore this study's findings about preop vitamin D deficiency is consistent with other studies (179,180). In this study group, vitamin D deficiency was decreased from 87% to 51% in postop 3rd month and remained same in postop 12th month. Rutte et al. found a decrease at 12th month, from 81% to 36% similarly (155). Unlikely, Gehrer et al. stated a peak from 23% to 32%, compared with preop values with values of postop 2 year (154). No consensus on optimum serum vitamin D levels for bariatric surgery patients is present. In order to sidestep from increase in PTH and resultant bone loss, recent recommendations highlight the range of 30-35 ng/mL (181).

In this study, despite of supplementation of advised multivitamin includes vitamin D and repletion was made in case of deficiency, vitamin D deficiency still had a significant prevalence. According to a prospective 2 year follow-up study, high dose vitamin D supplementation was found necessary to reach the reference range, independently from the type of the procedure (182).

Iron deficiency was detected in 4,4% of the participants preoperatively in this study. In reviewed literature, there are variant findings for iron deficiency. Toh et al. found iron deficiency in 15,7% of 200 participants preoperatively (153). Peterson et al. subjected 58 bariatric surgery candidates, and showed in 36,2% of these participants had iron deficiency (183). In a retrospective study investigated preop data analyses of 1538 participants underwent bariatric surgery, Al-Mutawa et al. showed in 35% of the participants had iron deficiency preoperatively (108). The preop iron deficiency found in this study is substantially lower than those stated by other researches mentioned above. In this study's finding, postop iron deficiencies after bariatric surgery reported 5% in postop 3rd month and 3% postop 12th month. Damms-Machado et al. reported iron deficiency in 29% preoperatively, 39,3% postop 3rd month and in 4,3% postop 12th month (107). In contrast, Zarshenas et al. found no iron deficiency preoperatively and at postop 6th month. At 1 year iron deficiency was 1% and again 0% at postop 2 and 3 years (8). Decreased immune function and sensitivity for infectious diseases are associated with iron deficiency (184). Therefore iron deficiency should be well assessed both pre- and postoperatively.

Ferritin is an acute phase reactant and acute and chronic inflammation marker (185). Ferritin deficiency is found 6% of the participants (n: 229). This result is similar to findings in van Rutte et al. (7%) (155) and Zarshenas. et al. (6%) (8). In this study, postop deficiencies at 3rd month and 12th month were 7% and 9% respectively. Saif et al. presented same results in their study as they did not find any ferritin deficiencies preoperatively but at first year, third year ferritin deficiencies were 8,6% and 15,8% respectively. At fifth year, ferritin deficiency decreased to 5,6% of the participants (186). Zarshenas. et al. also reported a increase in ferritin deficiency postoperatively as (6% preoperatively) at 6th month 11%, at 1 year 11%, at 2 year 15% and at 3 year 24% (8). There are numerous studies reported higher prevalence of ferritin and $B_{12}$ deficiency (152,176,185).

Preop vitamin $B_{12}$ deficiency prevalence was 3,6% in this study and postop 3rd month and 12th month. $B_{12}$ deficiencies reported in 2,2% and 7% respectively. In other studies Damms et al. found 9,3% of the participants had low serum $B_{12}$ levels (107). Aarts et al. found $B_{12}$ deficiency in 9% of the participants and at 1 year 9% of the participants (156). They also noted that a normal individual has an average $B_{12}$ storage of 2 mg which will be enough for 2 years in case of inadequate intake (156). Considering morbid obese individuals have an increased risk of having vitamin $B_{12}$ deficiency preoperatively or decreased storage level should be considered because of inadequate intake. After SG, vitamin $B_{12}$ intake could become insufficient since the decreased hydrochloric acid production that is needed to unchain vitamin $B_{12}$ bounds (154,155). In contrast, Pellitero et al. didn't find any $B_{12}$ deficiencies postoperatively whereas preop deficiency was 6,9% of the participants (127). And they described as followed; $B_{12}$ deficiency was detected preoperatively, but at long term patients didn't develop de novo deficiency. In theory, after bariatric surgery, vitamin $B_{12}$ hepatic stores are enough to maintain the normal serum levels for months or even years. Despite of the fact that it is reported that a development deficiency prevalence at 1 year after SG compared to presurgery (187). This case is more usual after malabsorptive procedures like RYGB than SG. For RYGB patients, intramuscular $B_{12}$ supplementation is an accepted recommendation by present guidelines, but yet not for SG patients (155).

Low levels of serum hemoglobin can be considered as anemia. In this study's findings, 6% of the participants had low serum hemoglobin levels preoperatively. Van Rutte et al. found similar results by 6,5% of the participants (155). Zarshenas et al. investigated 91 participants preoperatively and found in 4% of low hemoglobin (8). Al-Mutawa et al. showed considerably high level of prevalence of anemia (low serum hemoglobin level) as 20% of the participants (108). But same study found low levels of 51% serum iron, 28% ferritin in participants, as these findings are far higher than this study's findings. Low serum hemoglobin level is not just linked to iron deficiency. Other micronutrient deficiencies like ferritin, vitamin $B_{12}$ and copper could also promote anemia development even in case of regular oral multivitamin consumption. Preop folic acid and hemoglobin deficiencies were predictors for the existence of these deficiencies 1 year after SG significantly (159).

Folic acid deficiency is accepted one of the most common deficiencies in obese population. In this study, 3,6% of the participants had folic acid deficiency preoperatively. Van Rutte et al. examined 200 participants before bariatric surgery and found 24% of the participants has low folic acid levels (155). According to a study published in 2016, 5,4% of participants had folic acid deficiency (183). Reversely, Toh et al. showed none of the participants had folic acid deficiency preoperatively (153). With evaluating this information, folic acid deficiency before bariatric surgery /or in obese population has large range of findings and the finding of this study makes correspondence with other studies. Findings about postop folic acid deficiency could be evaluated as incomplete since different sided results. In this study's findings, folic acid deficiency in postop 3rd month and postop 12th month were 3,2% and 8% respectively. As an example of resembling data, Damms-Machado et al. examined 54 participants before and after bariatric surgery, reported folic acid deficiency in preop, postop 3rd and 12th months as; 5,5% (n=54), 9,5% (n=41) and 13,8%(n=30) respectively (107). Pellitero et al. stated presurgical folic acid deficiency 16,3% and folic acid deficiency remained almost the same at postop first year (17,6%) and showed a decrease in 2 years (8,8%), finally at fifth year, no folic acid deficiency was detected (127).

Prevalence of preop copper deficiency in obese population has limited data because of lack of studies. In this research, prevalence of copper deficiency was detected 5% of the participants preoperatively. Sanches A et al. reported no copper deficiency before surgery, but participants for the study was just women (188). Pellitero et al. found copper deficiency in 0,5% of participants preoperatively (127). This study's finding of copper deficiency is higher than prior studies. Postoperatively, participants had copper deficiency at 3rd and 12th months, 5% and 11% respectively. Papamargaritis et al. found copper deficiency, during follow-up ranging from 0 to 5% with no important change in mean serum concentration (189). As mentioned above, Pellitero et al. found 0,5% copper deficiency preoperatively and despite of the good multivitamin compliance, deficiency prevalence increased at 1 and 2 years after surgery (3,4% and 10,8% respectively) (127). At postop fifth year it remained at same levels (9,6%) without any signs of neurological damage. It should be noted that specific copper supplementation is hard to find in Turkey. Copper presents as an ingredient in multivitamins or similar nutritional supplements. Repletion therapy in case of deficiency should be well-managed (See section 2.6.3.4.4).

Not all micronutrients were tested preoperatively in this study; some vitamin/minerals were only analyzed after surgery in order to determine the deficiencies. In study's selected participants, zinc deficiency was detected at postop 3rd month and postop 12th month in 11% and 16% respectively. Van Rutte et al. found zinc deficiency in 5% of the participants after postop first year, there were no deficiency preoperatively (155). Papamargaritis et al. reported zinc deficiency in 7% preoperatively; and postoperatively, rates of deficiency ranged from 7 to 15% with no noteworthy change in mean concentrations (189). According to literature zinc deficiency seems to increase by the time after surgery, especially at 18 month follow up (190) Similarly, Moizé et al. analyzed zinc deficiency after SG and found an increase in zinc deficiency prevalence (preop: 8,1%, pod 6$^{th}$ month: 31,8%, 1 year: 39,3%, 2 year: 25%, 4 year: 47,6%, 5 year: 12,5%) (191). Reduction in acidic environment of the stomach is thought to be the main mechanism causing decreased zinc absorption after RYGB and SG (189).

Thiamine (vitamin $B_1$) deficiency is an important topic after surgery. In this study, thiamine deficiency before surgery was not examined and is found in 5% and 3% at postop 3rd and 12th months respectively. Data about thiamine deficiency after SG is limited. Pellitero et al. found in 3,4% at before surgery and 5,1%, 1,7% and 0% at postop 1 year, 2 year and 5 year respectively (127). Majority of the participants reveal thiamine deficiency within postop 1-3 months because of hyperemesis (166). Since routine screening of thiamine is not recommended by last guideline of ASMBS (95), screening or supplementation could be considered in case of persistent vomiting, rapid weight loss, parenteral nutrition, extreme alcohol intake and neurophaty (159).

Vitamin A is not analyzed usually before and after bariatric surgery so present data is limited. In this study, vitamin A is just analyzed postoperatively, and deficiency was found at 3rd month in 31% and at 12th month in 15% of the participants. It can be said that, it is logical to expect serum vitamin A deficiency preoperatively because obese people has numerous vitamin deficiencies. Differently, Damm's et al. found 0% vitamin A deficiency in preop SG participants and just one patient developed vitamin A deficiency at postop 3rd month (107). Boyce et al. found no deficiencies before surgery and 1% at 12 months in RYGB patients (192). This study's finding about vitamin A deficiency is higher than the literature data. A study about vitamin A reserves and severity of nonalcoholic fatty liver disease in the class III obesity found vitamin A deficiency in 35,9% of the participants postoperatively (193). Since vitamin A is a fat-soluble vitamin, deficiency could be expected in malabsorptive procedures. Despite of the fat that SG is not a malabsorptive but restrictive procedure, vitamin A deficiency can be more than expected like in this study's findings.

Biotin (vitamin $B_7$), is an coenzyme of five mammalian carboxylases. Unexpectedly, biotin deficiency was determined 62% and 57% of the participants at postop 3rd and 12th months respectively. There is a case report of a patient after sleeve gastrectomy with loss of taste due to biotin deficiency (194).

Investigating the relation between participants' preop micronutrient levels and age in this study; as age increases, preop mean values of vitamin D, copper, folic acid and vitamin $B_{12}$ increases. Ben-Porat et al. reported no association between age and preop serum micronutrient levels (159). Krzizek et al. reported micronutrient deficiencies and determined age range relation, findings pointed out that, participants in lowest age range had folic acid deficiency more often (109). Second age group had lower ferritin levels. Peterson et al. (183) reported vitamin D was correlated with age negatively (183). Whereas, Toh et al. (153) said there was no significant association between vitamin D levels and age and BMI (153). According to assessment of mean values of 3rd and 12th month micronutrient levels and age, at 3rd month, there was a positive association between age and serum vitamin $B_{12}$ and folic acid levels. At 12th month, in addition to vitamin $B_{12}$ and folic acid, vitamin D, vitamin A and vitamin B1 are also positively associated with age. Similarly, Ben-Porat et al. (159) found older age as a negative risk factor for deficiency of vitamin D at the end of the follow-up (159). It might be depending on higher compliance of older participants. It is known that adolescent have low adherence to multivitamin supplementation (195).

BMI and EBWL% are thought to be affecting micronutrient levels both preoperative and postoperatively. In this study, it is found that, preoperatively, as BMI increases mean value of serum hemoglobin and TIBC increases significantly. Unlike the most of studies, there was no correlation between preop BMI classification and preop serum vitamin D levels in our study (128,182,195). Toh et al. also stated no correlation between BMI and serum vitamin D levels (153). Similarly, Zarshenas et al. found no correlation between BMI and vitamin D levels at each time point (8). On the other hand, this study's findings showed that class III obesity had significantly higher serum hemoglobin and TIBC than class II obesity. Antithetically, Ben-Porat et al found a significant elevated risk of anemia in patients who were bariatric surgery candidates with super obesity (BMI>50) (159). Speaking of the postop micronutrient levels, hemoglobin levels was negatively associated with EBWL% at 3rd month. And at postop 12th month, negative association between hemoglobin levels and EBWL% continued, and positive association between serum biotin level and EBWL% developed. In current literature, only one study examined weight loss and micronutrient status correlation, Zarshenas et al. found intense weight loss is associated with higher ferritin levels (8). Still, at first and second years association was medium and weak at third year. Correlation between micronutrient levels and weight loss has been hardly studied; this study's finding is valuable. But it is clear that more researches are required to make a statement.

In this study, 59% of the participants were women and 41% were men. According to the analyzes of EBWL% both in at 3rd and 12rt month, women had higher EBWL% values than men. This might be related by good diet and life style recommendation compliance of women. Association between micronutrient levels and sex has contradictory findings, Ben-Porat et al. found that women had increased risk of iron deficiency and low serum ferritin levels preoperatively (159). And men had higher risk for preop anemia. But at postop follow-up period, sex is not a predictor of iron deficiency or low ferritin level. Also it is mentioned that menstruating women did not have risk for iron deficiency (159).

In conclusion, this study's findings confirms that EBWL% after SG is effective and reaches criteria of successful for weight loss bariatric surgery (142) and this study's finding about EBWL% at 3rd and 12th months is higher than comparable studies (5,139,143). Accepting the fact that most of the bariatric surgery candidates have micronutrient deficiency would help to understand the identity of the target population. Even if it is a restrictive procedure and tend to have mild micronutrient deficiencies than RYGB, significant micronutrient deficiencies occur after SG (154). Monitoring and evaluating micronutrients is very essential for after all of the bariatric surgery procedures. Detection and treatment of deficiencies before the surgery is very important to prevent worsening and treatment of these pre-existing deficiencies. These deficiencies occur because of increased oxidative stress and elevated requirements of micronutrient caused by metabolic modification. Supplementation after the surgery is a key recommendation for postop follow-up since supplementation compliance seems to be effective for avoiding micronutrient deficiency development (192). Most prevalent deficiency was vitamin D and it persisted throughout the follow up period even though repletion was recommended in case of deficiency. High doses of vitamin D can be useful with starting before operation if deficiency exists. Copper deficiency is an underestimated condition which might provoke serious symptoms. Biotin is an unopened mystery for bariatric surgery patients because current literature is very limited. This study's findings reveal serious prevalence of biotin deficiency postoperatively. Despite of repletion therapy after 3rd month, it remained almost same at postop 12th month. Biotin deficiency in obese population is unknown so it is hard to decide if deficiency existed preoperatively or developed postoperatively. Health care professionals treating bariatric surgery patients should be aware of the risk for micronutrient deficiencies. Standardization of supplementation and evaluation in postop follow-up period is needed. Further studies are required to answer the questions about preop micronutrient status and repletion treatment.

This study has some limitations. All patients were scaled by a specific scale in the clinic preoperatively. Postoperatively, if the patient did not came to routine control appointment at a nearest time to their postop 3rd and 12th month, postop weight data collected by self-report. Patients might tend to underestimate their weight (197).

Participants are recommended to take multivitamin plus mineral tablets and assumed taking multivitamin supplementation and repletion therapy thoroughly. Not all micronutrients are assessed preoperatively. Especially significant deficiencies of biotin, zinc and vitamin A require preop assessment.

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# 7. APPENDICES

## Appendix 1: Ethical Approval

ACIBADEM
ÜNİVERSİTESİ

SAYI: ATADEK-2018/3
KONU: Etik Kurul Kararı

Sayın Diyetisyen Fatma KAHRAMAN GÖK , Prof. Dr. Mehmet Ali Yerdel

Sorumluluğunu yürüttüğünüz **"Özel Bir Klinikte Sleeve Gastrektomi Operasyonu Geçirmiş Hastaların, Ameliyat Öncesi ve Sonrası Vitamin ve Mineral Düzeyleri ile Fazla Kilo Kaybı Oranlarının Karşılaştırması"** başlıklı proje 01.03.2018 tarih 2018/3 Sayılı Atadek Toplantısında görüşülmüş olup 2018-3/22 karar numarası ile tıbbi etik yönden uygun bulunmuştur.

Prof.Dr. İsmail Hakkı ULUS
ATADEK Başkanı

**ACIBADEM MEHMET ALİ AYDINLAR ÜNİVERSİTESİ**
**TIBBİ ARAŞTIRMALAR DEĞERLENDİRME KURULU (ATADEK)**

**Etik onay istenen tıbbi araştırmanın başlığı:**

Özel Bir Klinikte Sleeve Gastrektomi Operasyonu Geçirmiş Hastaların, Ameliyat Öncesi ve Sonrası Vitamin ve Mineral Düzeyleri ile Fazla Kilo Kaybı Oranlarının Karşılaştırması

**Etik onay istenen tıbbi araştırmanın yürütücüsü (sorumlusu):**

Diyetisyen Fatma KAHRAMAN GÖK , Prof. Dr. Mehmet Ali Yerdel

**Karar:**

**Kabul (Etik olarak uygun)** (X) **Revizyon** ( )* **Etik olarak uygun değil** ( )**

**Toplantı Tarihi:**01.03.2018 **Karar Numarası:** 2018-3/22

| | | Karara | Karara |
|---|---|---|---|
| **Kurul Üyesi-Unvan Ad-Soyad** | **İmza** | **Katılıyorum** | **Katılmıyorum*** |
| Prof. Dr. İsmail Hakkı Ulus (Başkan) | [signature] | (X) | ( ) |
| Prof. Dr. Güldal Süyen (Başkan Yrd) | | ( ) | ( ) |
| Prof.Dr. Mert Ülgen | [signature] | (X) | ( ) |
| Doç.Dr. Ükke Karabacak | [signature] | (X) | ( ) |
| Prof.Dr. A.Elif Eroğlu Büyüköner | | ( ) | ( ) |
| Doç.Dr. Berrin Karadağ | [signature] | (X) | ( ) |
| Yrd.Doç.Dr. Fatih Artvinli | [signature] | (X) | ( ) |
| Yrd.Doç.Dr. Günseli Bozdoğan | [signature] | (X) | ( ) |

**Appendix 2: Constant Form**

Asgari bilgilendirilmiş Gönüllü Olur Formu

Katılımınızı talep ettiğim bu çalışma, bir araştırmadır.

Bu araştırma kapsamında, bariatrik cerrahi geçirmiş hastaların ameliyat öncesi ve ameliyat sonrası 3. ay ve 1. yıldaki vitamin ve mineral değerleri ile fazla kilo kayıp yüzdeleri karşılaştırması yapılmak istenmektedir.

Bu araştırmaya katılımınız için sizden herhangi bir üzret talep edilmeyecektir ve ya size herhangi bir ücret ödenmeyecektir. Sizden beklenen sadece bu onam formunu imzalamanızdır. Araştırmada kullanılmak üzere size herhangi bir soru sorulmayacaktır, anket doldurmanız istenmeyecektir. İstanbul Bariatrics İleri Laparoskopi Kliniğinde ilk muayenizde doldurulan anamnez formundaki bilgiler kullanılacaktır. Ayrıca ameliyat öncesi ve sonrası rutin kan tahlillerinizden elde edilecek veriler araştırmaya dahil edilecektir.

Alınan hiçbir bilgi araştırma kapsamı dışında hiçbir kimseyle paylaşılmayacaktır. Elde edilen bilgiler, Etik Kurul, kurum ve diğer sağlık otoritelerinin orjinal tıbbi kayıtlarına doğrudan erişimleri oalcaktır. Fakat, bu gönüllü onam formunun imzalanmasıyla bu bilgiler gizli tutulacaktır.

Bu çalışmaya katılmayı reddedebilirsiniz, çalışmanın herhangi bir aşamasında katılım onajınızdan vazgeçebilirsiniz.

Elde edilen veriler ile sleeve gastrektomi geçirmiş kişilerin ameliyat öncesi ve sonrası vitamin mineral düzeyleri ile fazla kilo kaybı yüzdeleri arasında bir ilişki olup olmadığı incelenecek ve elde edilen sonuç doğrultusunda bu alanda çalışan profesyonellere yol göstermesi açısından yapılabilecekler konusunda bilgi verilecektir.

Araştırıcı: Dyt. Fatma KAHRAMAN

Yeditepe Üniversitesi Beslenme ve Diyetetik Enstitüsü

Danışman: Yrd. Doç. Dr. Binnur Okan Bakır

Yeditepe Üniversitesi Beslenme ve Diyetetik Bölümü Öğretim Üyesi

Bilgilendirilmiş Gönüllü Onam Formundaki bütün açıklamaları okudum. Bana, yukarıda konusu ve amacı belirtilen araştırma ile ilgili açıklamalar,yukarıda adı belirtilen diyetisyen tarafından yapıldı. Araştırmaya gönüllü olarak katıldığımı, istediğim zaman gerekçeli ya da gerekçesiz olarak araştırmadan ayrılabileceğimi biliyorum. Söz konusu araştırmaya hiçbir baskı ve zorlama olmadan kendi rızamla katılmayı kabul ediyorum.

Ad, Soyad:

Tarih:

İmza:

# 8. CURRICULUM VITAE

**Kişisel Bilgiler**

| **Adı** | Fatma | **Soyadı** | Kahraman Gök |
|---|---|---|---|
| **Doğum Yeri** | Selçuklu | **Doğum Tarihi** | 06.08.1989 |
| **Uyruğu** | T.C. | **TC Kimlik No** | 50038476452 |
| **E-mail** | dyt.fatmakahraman@gmail.com | **Tel** | 05557222907 |

**Öğrenim Durumu**

| **Derece** | **Alan** | **Mezun Olduğu Kurumun Adı** | **Mezuniyet Yılı** |
|---|---|---|---|
| **Lisans** | Beslenme ve Diyetetik | Yeditepe Üniversitesi | 2013 |
| **Lise** | | Sırrı Yırcalı Anadolu Lisesi | 2008 |

| **Bildiği Yabancı Dilleri** | **Yabancı Dil Sınav Notu (#)** |
|---|---|
| İngilizce | 75 |

**İş Deneyimi (Sondan geçmişe doğru sıralayın)**

| **Görevi** | **Kurum** | **Süre (Yıl - Yıl)** |
|---|---|---|
| Diyetisyen | Acıbadem Üniversitesi Atakent Hastanesi | 2017- Halen |
| Diyetisyen | Istanbul Bariatrics İleri Laparoskopi Kliniği | 2013-2017 |

**Bilgisayar Bilgisi**

| **Program** | **Kullanma becerisi** |
|---|---|
| Microsoft Office | Çok iyi |
| Statistical Package for the Social Sciences (SPSS) | İyi |

**Bilimsel Çalışmaları**

| |
|---|
| Şen O, Kahraman F. Role of Surgery Between Body Mass Index 30-35 Patients. *J Gen Surg- Spec Top*. 2015;8(3):85-90 |
| Erdem, Z. ve Kahraman, F. Bariatrik hastaların diyetlerinin izlenmesi. İçinde Temel Beslenme ve Diyetetik (2015). (1.Baskı, sy.355- 382). Ankara: Güneş Tıp Kitabevi. |

**Diğer (Görev Aldığı Projeler/Sertifikaları/Ödülleri)**

| |
|---|
| Metabolik ve Bariatrik Cerrahi Derneği (2015) Yönetim Kurulu Başkan Yardımcısı |