



@PhD_Leigh
#BariatricSurgery
#Nutrition

Consequences of Malnutrition in Obesity: Undernutrition Concurrent with Overnutrition

Leigh A. Frame, PhD, MHS

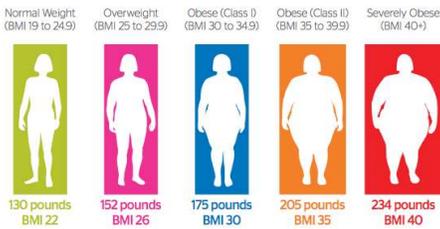
Program Director in Integrative Medicine, Assistant Professor
The George Washington School of Medicine and Health Sciences

© 2018, Leigh A. Frame, All Rights Reserved

LEARNING OBJECTIVES

- For nutrition support health-care professionals (physicians, dietitians, pharmacists, physician assistants, and nurses) to **recognize the significant burden of malnutrition in patients with obesity.**
- For these health-care professionals to be able to **identify the key nutrients to assess and treat in the care of patients with obesity.**
- For these health-care professionals to **distinguish the potential consequences and symptoms of the typical malnutrition seen in patients with obesity,** which will facilitate in the diagnosis and care of these patients.

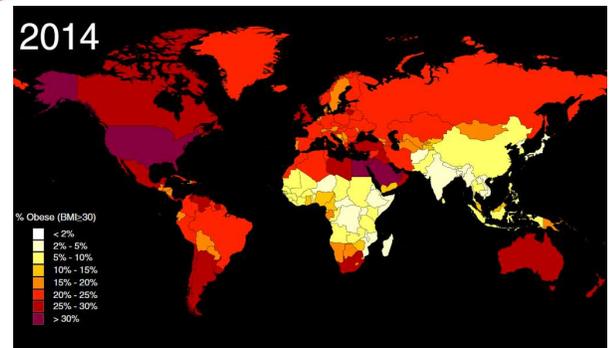
Obesity



Definition:
Body mass index
(BMI) > 30 kg/m²

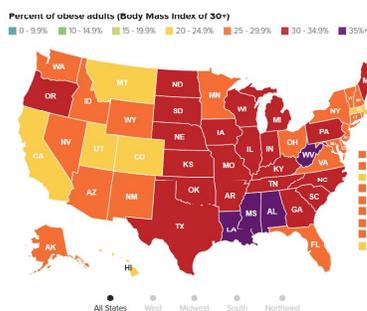
Obesity

1 in 10 adults
worldwide



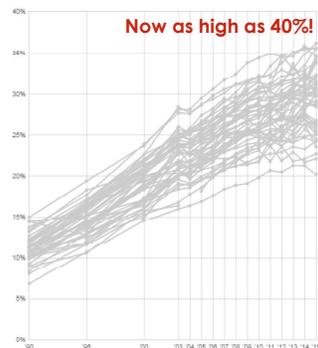
Adult Obesity Rate by State, 2015

Select years with the slider to see historical data. Hover over states for more information. Click a state to lock the selection. Click again to unlock.



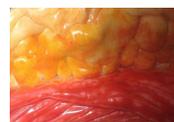
Obesity

Adult obesity rates, 1990 to 2015



Obesity

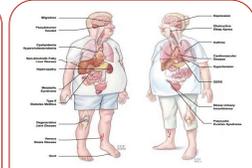
Disease Pathogenesis



Excess Fat Stored
in Adipose Tissue



Chronic
Inflammation

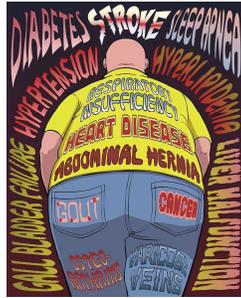


Obesity Related
Comorbidities



Obesity

- **Comorbidities** include:
 - Heart disease
 - Infection
 - Worsening immune function
 - Fatty liver disease
 - Cancer
 - Metabolic syndrome
- **Public Health Burden:**
Epidemic + Costly Comorbidities



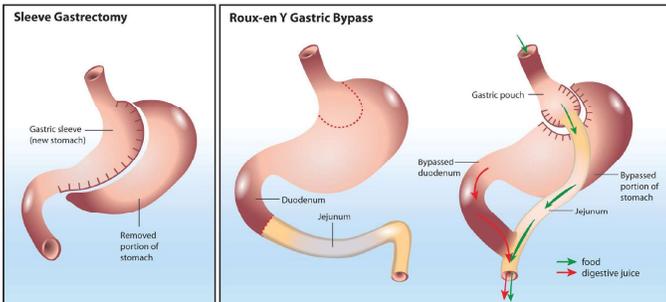
Bariatric Surgery

- Only proven long-term treatment for severe obesity
- **Three Main Principles of Action**
 - **Malabsorption**
Limit the absorption of nutrients and calories
 - **Restriction**
Limit nutrient intake by reducing the size of the stomach
 - **Metabolic**
Limit hunger/improve satiety by altering gut hormones



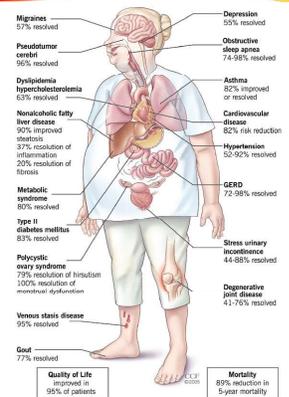
See Appendix A for more information.

Bariatric Surgery



Bariatric Surgery Resolution of Comorbidities

	Roux-en-Y Gastric Bypass (RYGB)	Vertical Sleeve Gastrectomy (VSG)
Excess Weight Loss	60-70%	60%
Type 2 Diabetes Remission	80%	70%



Bariatric Surgery

- **Complications**
 - **Acute**
 - Appropriate candidate selection is key to safety and patient success
 - Very low risk procedure
 - Mortality is **rare** (0.1%)
 - **Diet:** Liquid transitioning to soft foods over many weeks



Bariatric Surgery

- **Long-term**
 - Largely due to **non-adherence** to lifestyle and dietary changes
 - Eat slowly, chew thoroughly
 - Protein 1st! Limit carbs and sugars
 - No soda, no caffeine, sip water constantly

Eating after bariatric surgery (6 months and beyond)

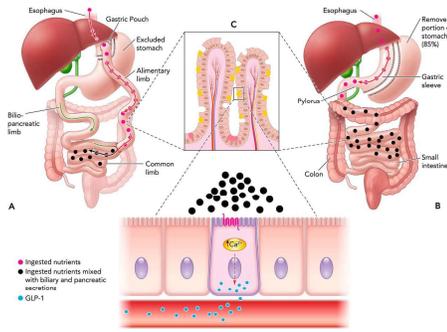
Eat food in the following order:

1. Proteins	2. Vegetables	3. Fruit	4. Starches
Protein shakes, poultry, fish, extra-firm tofu, Greek yogurt, egg whites (60-120 g/d)	Nonstarchy vegetables; avoid potatoes, peas, corn	Fruit with skin you can eat	Whole grains or those high in fiber (≥5 g of fiber/serving or ≥20% of daily value)

Chew food thoroughly to a baby-food consistency. Meals should take at least 30 minutes.

Bariatric Surgery

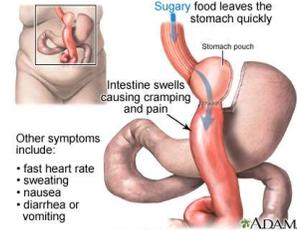
- **Long-term**
 - **Key Symptoms**
 - Nausea/vomiting
 - Acid reflux (GERD)
 - **Malnutrition**
 - **Decreased intake**, especially protein and micronutrients
 - Altered digestion and potentially **decreased absorption** (anatomic changes)
 - Increased risk for deficiencies



See Appendix B for more information

Bariatric Surgery

- **Dumping Syndrome**
 - **Early (10 – 60 min)**
 - Bloating
 - Sweating
 - Dizziness
 - Flushing
 - Painful cramps
 - Nausea/vomiting
 - Diarrhea
 - **Late (1 – 3 hrs)**
 - Hunger
 - Sweating
 - Tiredness
 - Confusion
 - Faintness
 - Possible hypoglycemia



See Appendix C for more information

Diet Quality Prior to Bariatric Surgery

High calorie, high carb, low micronutrition

Diet Composition in Bariatric Surgery Candidates

	Grams / Day		% Calories	
	Study 1	Study 2	Study 1	Study 2
Protein	93.5	114.2	13.9	17
Fats	101.8	110.6	32.5	36
Carbohydrates	386.4	321.6	55.0	47



1) Sanchez A, Rojas P, Basfi-Fer K, et al. Micronutrient deficiencies in morbidly obese women prior to bariatric surgery. *Obes Surg.* 2016; 26: 361-368.

2) Dagan SS, Zelber-Sagi S, Webb M, et al. Nutritional status prior to laparoscopic sleeve gastrectomy surgery. *Obes Surg.* 2016; 26: 2119-2126.

Prevalence of Preoperative Deficiencies

Table 1. Prevalence of Prebariatric Surgery Deficiency by Nutrient.

Micronutrient	ASMBS 2008 Nutrition Guidelines ⁹	Summary of 9 Reviewed Studies ⁴
Vitamin B1 (thiamin)	15%-29%	0%-6% (n = 4)
Vitamin B12 (cobalamin)	10%-13%	4%-13% (n = 7); 0% in 1 study (receiving supplementation) ¹⁴
Folate (folic acid)	Uncommon	0%-32% (n = 8)
Iron	9%-16% adult women in general population	13%-47% (n = 7); 6% in 1 study (receiving supplementation) ¹⁵
Ferritin		6%-24% (n = 5); 1% in 1 study (receiving supplementation) ¹⁴
Vitamin A	Uncommon, up to 7% in some studies	2%-17% (n = 3); 1 study: 72% elevated ¹⁶
Vitamin D	60%-70% (<20)	22%-71% (<20), 65%-93% (<30, n = 7); 99% (<32) in 1 study ¹⁷ ; 39% with elevated parathyroid hormone in 1 study (vitamin D not measured) ¹⁸
Vitamin E	Uncommon	0%-5% (n = 2)
Vitamin K	Uncommon	Not measured in studies reviewed
Zinc	Uncommon but increased risk of low levels associated with obesity	0%-15% (n = 4)
Copper	Not assessed	0% (n = 1)
Selenium	Not assessed	3%-15% (n = 2)

ASMBS, American Society for Metabolic and Bariatric Surgery.

⁴Chart based on findings in Peterson et al.²⁷ Sanchez et al.²⁸ Dagan et al.²¹ van Rutte et al.²⁴ Lefebvre et al.²³ Dammi-Machado et al.²⁹ Ben-Porat et al.²⁷ Schiavo et al.³⁰ and Schweiger et al.³¹ According to Dagan et al., patients received vitamin and mineral supplementation before baseline testing; therefore, this study was not used as the lowest range for prevalence of deficiency, but results are included.³¹

Frame-Peterson et al., 2017. *Nutrition in Clinical Practice.*

Prevalence of Preoperative Deficiencies

The most common deficiencies in bariatric surgery candidates are in:

1. **Vitamin D**
2. **Iron**
3. **Vitamin B12**
4. **Folate**
5. **Thiamine**
6. **Vitamin A**

Frame-Peterson et al., 2017. *Nutrition in Clinical Practice.*

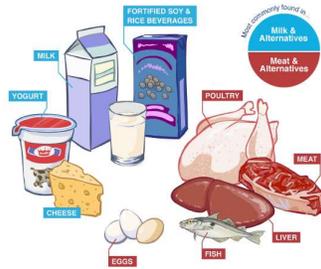
Folate (Folic Acid)

- **Key Contributions**
 - DNA synthesis and repair
 - Cell division and growth
 - Red blood cell formation
- **Risk Factors**
 - Alcoholism
 - Anticonvulsants, oral contraceptives, cancer treatments
 - Small bowel bacterial overgrowth (**possible post-gastric bypass**)
 - Malabsorptive disease / surgery (**bariatric surgery**)
- **Up to 32%** of bariatric surgery candidates are deficient



Vitamin B12 (Cobalamin)

- **Key Contributions**
 - DNA synthesis
 - Neurologic functioning
 - Red blood cell maturation
- **Risk Factors**
 - Small bowel bacterial overgrowth (**possible post-gastric bypass**)
 - Digestive disease (Chron's, Celiac)
 - Malabsorptive surgery / **bariatric surgery**
 - **Meformin, ACE inhibitors, acid reducers, colchicine (gout)**
 - Vegetarian / Vegan
- 6-13% of bariatric surgery candidates are deficient



Thiamine (Vitamin B1)

- **Key Contributions**
 - Digestion and carbohydrate metabolism
 - Nerve and muscle cell electrolyte flow
- **Risk Factors**
 - Alcoholism
 - Vomiting
 - Small bowel bacterial overgrowth (**possible post-gastric bypass**)
 - **Acid reducers**
 - Malabsorption due to caffeine/tannin intake
- Up to 29% of bariatric surgery candidates are deficient



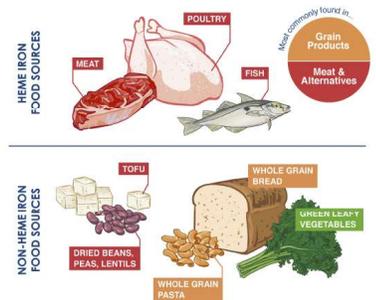
Vitamin A

- **Key Contributions**
 - Eye health and vision, esp. night
 - Cell growth
 - Wound healing
- **Risk Factors**
 - Pancreatic insufficiency
 - Malabsorptive surgery / **bariatric surgery**
- 2-17% of bariatric surgery candidates are deficient

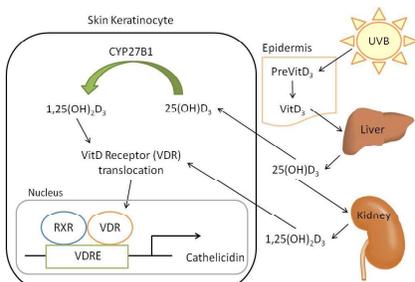


Iron

- **Key Contributions**
 - Oxygen transport
 - Hemoglobin and myoglobin
 - Cellular function
- **Risk Factors**
 - Insufficient gastric acid from **acid reducers** or **bariatric surgery**
 - **Woman of child bearing age** (bariatric surgery is currently performed mostly in women)
- 13-47% of bariatric surgery candidates are deficient



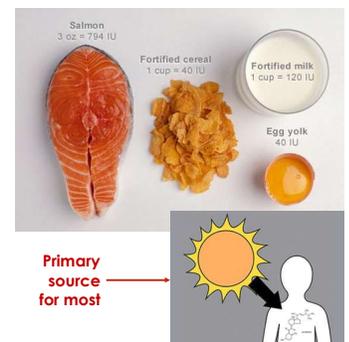
Vitamin D: Metabolism



Abbreviations: RXR = retinoid X receptor, VDRE = vitamin D response element

Vitamin D: Requirements

- New DRI released in 2010
 - 600 IU for ages 1 to 70 years
 - 800 IU for the elderly
 - 400 IU for infants
- Still under debate
 - Extraskeletal effect
 - Statistical error in current estimate: Reduced variance (Study averages vs. individual values)

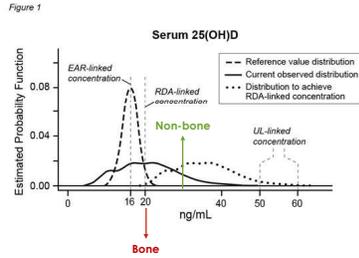


Institute of Medicine 2010, Ross 2011, Veugeters 2014

Vitamin D: Deficiency

Risk Factors

- Sun Angle (> 35°)
 - Winter (Fall / Spring)
 - Distant from equator (US/Canada)
- Sun Exposure
 - Skin pigmentation (melanin)
 - Sunscreen: SPF15 blocks > 95% of vitamin D production
 - Night shift
 - Office work
 - Veiling / umbrella use
- Obesity
- Malabsorption (supplementation)

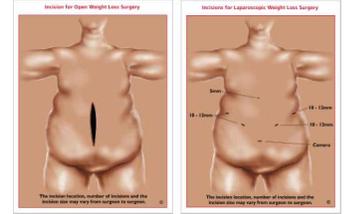


Vitamin D and Bariatric Surgery

Up to 93% of bariatric surgery candidates are deficient

Key Areas of Concern Post-op

- Recovery and healing (immune system)
 - Poor wound healing
 - Increased risk of infection
- Bone loss
- Enduring deficiency with limited absorption of supplements



Vitamin D: Summary

Problem

- A **key** micronutrient for **successful bariatric surgery**
- Highest deficiency** rates in candidates (all micronutrients)
- Exacerbated by **poor absorption & decreased intake after** the procedure

Solution

- Optimal supplementation & dosing is **still unclear** and **confounded** by lifestyle factors (sun angle and exposure)
- Supplementation is **safe & effective**
- Screening & titrating status** is the best approach

Micronutrition Summary

Problem

- Bariatric surgery candidates are an **at-risk** population for micronutrient **deficiency**
- Chief Concern:** Vitamin D & iron
- Significant Concern:** Thiamine, vitamin B12, folate, & vitamin A
- Deficiency in **multiple micronutrients** concurrently is common
- Pre-op deficiencies** seems to **predict post-op** deficiencies

Micronutrition Summary

Solution

- Repletion** through **supplementation** may be achieved as quickly as a **few weeks**
- The typical **preparation** period before **bariatric surgery** is on the order of **months**
- Upon presenting** for bariatric surgery, patients should have a **nutritional evaluation**

American Society for Metabolic and Bariatric Surgery (ASMBS) Guidelines

"...all patients should undergo an appropriate **nutrition evaluation**, including micronutrient measurements, **before any bariatric surgical procedure**. In comparison with purely restrictive procedures, more extensive perioperative nutrition evaluations are required for malabsorptive procedures."

Table 2. Preoperative Screening Checklist for Bariatric Surgery.

Screening Category	Recommendations
Routine Laboratory Tests	<ul style="list-style-type: none"> Fasting blood glucose Fat panel Kidney function Liver profile Urine analysis Prothrombin time/INR Blood type Complete blood count Alc* Thyroid-stimulating hormone^b Iron studies B12 Folate acid 25-vitamin D
Recommended Nutrients	<ul style="list-style-type: none"> Iron studies B12 Folate acid 25-vitamin D
Nutrients to Consider ^c	<ul style="list-style-type: none"> Red blood cell folate Homocysteine Methylmalonic acid Thiamin Vitamin A Vitamin E Vitamin B6 Parathyroid hormone Zinc Copper*

INR, international normalized ratio. Data from Mechanick JJ, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient—2013 update: cosponsored by American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic and Bariatric Surgery. *Surg Obes Relat Dis.* 2013;9:158-191. doi:10.1016/j.soard.2012.12.010.

*With suspected prothrombotic or diabetic.

^bWith symptoms or increased risk of thyroid disease.

^cMore extensive testing in patients undergoing malabsorptive procedures and/or based on symptoms and risk (may consider zinc, copper, selenium, B6).

*Interpret with caution

Table 2: Frame-Peleson et al., 2017, *Nutrition in Clinical Practice*.

Added in update: [Farrist et al., 2017, *Surgery for Obesity and Related Diseases*](#)

Conclusions

- **Problem**
 - Despite energy density, the diet of bariatric surgery candidates is typically of poor nutrition quality (does not meet RDAs)
 - At-risk population for malnutrition in micronutrients (perhaps protein)
- **Standardization is needed**
 - Nutritional assessment
 - Micronutrient cutoffs for deficiency / insufficiency
- **What should you do?**
 - Conduct nutrition assessment at baseline
 - Implement supplementation where necessary
 - This may improve surgical outcomes

Questions & Acknowledgements

- **The Johns Hopkins Center for Bariatric Surgery**
 - Director: Michael Schweitzer, MD, FACS
 - Dietitian: Suzanne Carobrese, RD, LDN, CDE
 - Grad Student: Robin D. Megill, MSPH
- **Learn More**
 - *Nutrition in Clinical Practice* Podcast (7:13 min)
http://traffic.libsyn.com/sagenutrition/NCP_August_2017_Podcast.mp3
 - Recent Review in *Nutrition in Clinical Practice*
<http://journals.sagepub.com/doi/full/10.1177/0884533617712701>

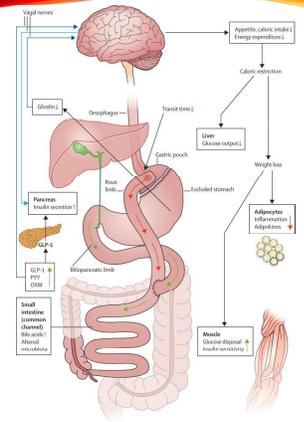
- 1) A bariatric surgeon asks for a consult on a patient preparing to undergo weight-loss (bariatric) surgery. What is the likelihood of this patient having a micronutrient deficiency?
- A) 25% or less
B) 33% to 50%
C) About 50%
D) 75% or more

- 2) Which of the following is not one of the key micronutrients to consider assessing during the consult for this patient preparing to undergo bariatric surgery?
- A) Folate
B) Vitamin B12
C) Thiamine
D) Vitamin E
E) Vitamin A
F) Iron
G) Vitamin D

- 3) Which of the following is not a potential consequences of malnutrition in this patient acutely and chronically after undergoing bariatric surgery?
- A) Increased weight loss
B) Poor healing (wound, anastomosis)
C) Poor immunity (infection)
D) Increased inflammation

Appendix A

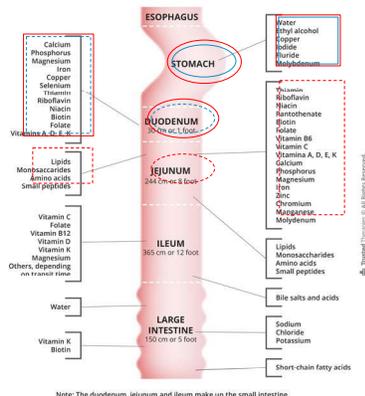
Bariatric Surgery Mechanisms of Action



Appendix B

Sites of Nutrient Absorption

- Altered in RYGB
- Altered in VSG
- - - To lesser extent/indirectly



Note: The duodenum, jejunum and ileum make up the small intestine.

Appendix C

Dumping Syndrome after Bariatric Surgery

