Malnutrition in Patients with Obesity

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Disclosure

- American Regent: Trace Elements Advisory Board Member

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Learning Objectives

Upon completion of this educational activity, the learner will be able to:

- Identify factors that contribute to malnutrition in patients with obesity
- Apply malnutrition screening and assessment tools for patients with obesity
- Assess risk factors for micronutrient deficiencies for patients with obesity
- Develop a nutrition intervention plan for patients with obesity

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Nutrition Screening

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Nutrition Screening

What is it?

- ASPEN definition: A process to identify an individual who may be malnourished or at risk for malnutrition to determine if a comprehensive nutrition assessment and appropriate intervention are indicated
- Validated tools are available that predict malnutrition or need for nutrition intervention

Why screen?

- Meet requirements of regulatory organizations (e.g., Joint Commission)
- Helps prioritize which patients require a full assessment quickly
  - Can't see all patients on admission
- Identify patients who benefit from aggressive nutrition intervention
- Help identify timing of nutrition support intervention in the ICU

Robinson D et al. American Society for Parenteral and Enteral Nutrition (ASPEN) definition of terms, style, and conventions used in ASPEN Board of Directors-approved documents. May 2018.

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Position of the Academy of Nutrition and Dietetics: Malnutrition (Undernutrition) Screening Tools for All Adults

ABSTRACT

It is the position of the Academy of Nutrition and Dietetics that, based upon current evidence, the Malnutrition Screening Tool should be used to screen adults for malnutrition (undernutrition) regardless of their age, medical history, or setting. Malnutrition (undernutrition) screening is a simple process intended to quickly recognize individuals who may have a malnutrition diagnosis. While numerous malnutrition screening tools are in use, their levels of validity, agreement, reliability, and generalizability vary. The Academy of Nutrition and Dietetics reviewed the body of evidence supporting malnutrition screening tools and determined a single tool for identifying adults in all settings who may have malnutrition, regardless of their age or medical history. The Nutrition Screening for Adults Workgroup conducted a systematic review of the most robust evidence to promote using the highest-quality malnutrition screening tool available.

J Acad Nutr Diet. 2020;120(4):709-713.

POSITION STATEMENT

It is the position of the Academy of Nutrition and Dietetics that, based upon current evidence, the Malnutrition Screening Tool should be used to screen adults for malnutrition (undernutrition) regardless of their age, medical history, or setting.

Skipper A et al. Position of the Academy of Nutrition and Dietetics: malnutrition (undernutrition) screening tools for all adults. J Acad Diet Assoc. 2020

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Malnutrition Screening Tool (MST)

STEP 1: Screen with the MST

1. Have you recently lost weight without trying?

No	0
Unsure	2

If yes, how much weight have you lost?

2-13 lb	1
14-23 lb	2
24-33 lb	3
34 lb or more	4
Unsure	2

Weight loss score: ____

2. Have you been eating poorly because of a decreased appetite?

No	0
Yes	1

Appetite score: ____

Add weight loss and appetite scores

MST SCORE: ____

STEP 2: Score to determine risk

MST = 0 OR 1
NOT AT RISK
Eating well with little or no weight loss

If length of stay exceeds 7 days, then rescreen, repeating weekly as needed.

MST = 2 OR MORE
AT RISK
Eating poorly and/or recent weight loss

Rapidly implement nutrition interventions. Perform nutrition consult within 24-72 hrs, depending on risk.

STEP 3: Intervene with nutritional support for your patients at risk of malnutrition.

Notes: _____

From: https://static.abbottnutrition.com/cms-prod/abbottnutrition-2016.com/img/Malnutrition%20Screening%20Tool_FINAL_tcm1226-57900.pdf accessed 9/6/21

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Malnutrition Universal Screening Tool

(i) BMI (kg/m^2)
0 = >20.0
1 = 18.5–20.0
2 = <18.5

(ii) Weight loss in 3–6 months
0 = <5%
1 = 5–10%
2 = >10%

(iii) Acute disease effect
Add a **score of 2** if there has been or is likely to be no or very little nutritional intake for >5 days

Add scores

Overall risk of undernutrition*

0 Low Routine clinical care†	1 Medium Observe	2 or more High Treat
Repeat screening **Hospital**—every week **Care homes**—every month **Community**—every year for special groups, eg, those >75y	**Hospital**—document dietary and fluid intake for 3 days **Care homes** (as for hospital) **Community**—Repeat screening, eg, from <1 mo to >6 mo (with dietary advice if necessary)	**Hospital**—refer to dietitian or implement local policies. Generally food first followed by food fortification and supplements **Care homes** (as for hospital) **Community** (as for hospital)

- Adequate intake (or improving to near normal)
- Little or no clinical concern

- Inadequate intake or deteriorating
- Clinical concern

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Gut 2003;**52**:vii1-vii12 doi:10.1136/gut.52.suppl_7.vii1

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Mini Nutritional Assessment

MNA®

Nestlé Nutrition Institute

Last name: First name:

Sex: Age: Weight, kg: Height, cm: Date:

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F1 Body Mass Index (BMI) (weight in kg) / (height in m)²
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

IF BMI IS NOT AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2.
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater ☐

Screening score ☐☐
(max. 14 points)

12-14 points: Normal nutritional status
8-11 points: At risk of malnutrition
0-7 points: Malnourished

Save Print Reset

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From: https://mna-elderly.org/forms/mini/mna_mini_english.pdf accessed 9/6/21

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SNAQ

Short Nutritional Assessment Questionnaire

- Did you lose weight unintentionally?
  More than 6 kg in the last 6 months ●●●
  More than 3 kg in the last month ●●
- Did you experience a decreased appetite over the last month? ●
- Did you use supplemental drinks or tube feeding over the last month? ●

● no intervention
●● moderately malnourished; nutritional intervention
●●● severely malnourished; nutritional intervention and treatment dietician

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http://www.fightmalnutrition.eu. Accessed 3/4/12

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Nutrition Risk Screening-2002

Table 1 Initial screening			
		Yes	No
1	Is BMI <20.5?		
2	Has the patient lost weight within the last 3 months?		
3	Has the patient had a reduced dietary intake in the last week?		
4	Is the patient severely ill ? (e.g. in intensive therapy)		
Yes: If the answer is 'Yes' to any question, the screening in Table 2 is performed. **No**: If the answer is 'No' to all questions, the patient is re-screened at weekly intervals. If the patient e.g. is scheduled for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status.			

From Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clin Nutr. 2003;22:415-421

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Nutrition Risk Screening-2002

Table 2 Final screening			
Impaired nutritional status		**Severity of disease (≈ increase in requirements)**	
Absent **Score 0**	Normal nutritional status	Absent **Score 0**	Normal nutritional requirements
Mild **Score 1**	Wt loss >5% in 3 mths or Food intake below 50–75% of normal requirement in preceding week	Mild **Score 1**	Hip fracture* Chronic patients, in particular with acute complications: cirrhosis*, COPD*. *Chronic hemodialysis, diabetes, oncology*
Moderate **Score 2**	Wt loss >5% in 2 mths or BMI 18.5–20.5 + impaired general condition or Food intake 25–60% of normal requirement in preceding week	Moderate **Score 2**	Major abdominal surgery* Stroke* *Severe pneumonia, hematologic malignancy*
Severe **Score 3**	Wt loss >5% in 1 mth (>15% in 3 mths) or BMI <18.5 + impaired general condition or Food intake 0–25% of normal requirement in preceding week in preceding week.	Severe **Score 3**	Head injury* Bone marrow transplantation* *Intensive care patients (APACHE>10).*
Score:	+	**Score:**	=**Total score**
Age	if ≥70 years: add 1 to total score above		=**age-adjusted total score**
Score ≥3: the patient is nutritionally at-risk and a nutritional care plan is initiated **Score <3**: weekly rescreening of the patient. If the patient e.g. is scheduled for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status.			

NRS-2002 is based on an interpre-tation of available randomized clinical trials.
*indicates that a trial directly supports the categorization of patients with that diagnosis. Diagnoses shown in *italics* are based on the prototypes given below.
Nutritional risk is defined by the present **nutritional status** and risk of impairment of present status, due to **increased requirements** caused by stress metabolism of the clinical condition.

A nutritional care plan is indicated in all patients who are

(1) severely undernourished (score = 3), or (2) severely ill (score = 3), or (3) moderately undernourished + mildly ill (score 2 + 1), or (4) mildly undernourished + moderately ill (score 1 + 2).

Prototypes for severity of disease
Score = 1: a patient with chronic disease, admitted to hospital due to complications. The patient is weak but out of bed regularly. Protein requirement is increased, but can be covered by oral diet or supplements in most cases.
Score = 2: a patient confined to bed due to illness, e.g. following major abdominal surgery. Protein requirement is substantially increased, but can be covered, although artificial feeding is required in many cases.
Score = 3: a patient in intensive care with assisted ventilation etc. Protein requirement is increased and cannot be covered even by artificial feeding. Protein breakdown and nitrogen loss can be significantly attenuated.

From Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clin Nutr. 2003;22:415-421

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Academy of Nutrition and Dietetics Recommendation

	VALIDITY[a]								
TOOL	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	OVERALL VALIDITY[b]	AGREEMENT[a]	RELIABILITY[a]	GENERALIZABILITY[c]	EVIDENCE GRADE, *STRENGTH*[d]
MST[e]	Moderate	Moderate	Moderate	Moderate	MODERATE	MODERATE	MODERATE	Good	I, *Good/strong*
MUST[f]	Moderate	Moderate	Moderate	High	HIGH	MODERATE	MODERATE	Fair	II, *Fair*
MNA-SF[g]	Moderate	Moderate	Low	Moderate	MODERATE	LOW	MODERATE	Fair	II, *Fair*
SNAQ[h]	Moderate	High	Low	High	MODERATE	—	MODERATE	Fair	II, *Fair*
MNA-SF-BMI[i]	Moderate	Moderate	Moderate	High	HIGH	MODERATE	—	Limited	II, *Fair*
NRS-2002[j]	Moderate	High	Moderate	Moderate	MODERATE	MODERATE	—	Limited	II, *Fair*

[a]Sensitivity, specificity, positive predictive value, negative predictive value cutoffs: High: 90% to 100%, moderate: 80% to ≤89%, low: ≤79%; agreement and reliability κ cutoffs: High: 0.8 to 1; moderate: 0.6 to ≤7.9; low: ≤5.9.

[b]See Figure 3 in Skipper and colleagues[4] for the algorithm to determine the overall validity.

[c]The Workgroup determined generalizability based on usefulness of each tool across the broadest array of adult age groups, locations, diseases, and treatments according to evidence.

[d]Elements considered in the evidence grade include quality of the evidence, consistency of results across studies, quantity of studies, and number of subjects, clinical impact of outcomes, and generalizability to population of interest.[14]

[e]MST=Malnutrition Screening Tool.

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[g]MNA-SF=Mini Nutritional Assessment—Short Form.

[h]SNAQ=Short Nutritional Assessment Questionnaire.

[i]MNA-SF-BMI=Mini Nutritional Assessment—Short Form Body Mass Index.

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Figure 2. Validity, agreement, reliability, generalizability, and strength of evidence of adult malnutrition (undernutrition) screening tools.

Skipper A et al. Position of the Academy of Nutrition and Dietetics: malnutrition (undernutrition) screening tools for all adults. J Acad Diet Assoc. 2020

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Considerations for patients with obesity

- Screening tools that use BMI may underestimate nutrition risk
  - Be aware of this potential bias if one of the tools using BMI is used in your practice
- The Malnutrition Screening Tool (MST) is appropriate for patients with obesity since BMI is not part of the tool

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Nutrition Assessment for Patients with Obesity

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Let's consider some patient scenarios

- 45 yoM with DM2, HTN, and OSA admitted to the medical ICU with PNA and respiratory failure. His BMI is 45 kg/m^2. A consultant sees the patient and documents in the medical record, "this patient is obese – recommend a nutrition holiday."
- 26 yoM with severe asthma was admitted to the medical ICU with respiratory failure. His BMI is 39.5 kg/m^2. Corkscrew hairs were seen on his legs on NFPE and he had an undetectable vitamin C level. Once extubated, he reported being completely overwhelmed in the last semester of his MBA program and his diet was entirely grab and go foods from the university cafeteria or fast foods.
- 60 yoF with a history of RYGB at age 40 (preop BMI 46 kg/m^2, now 32 kg/m^2) was diagnosed with AML and admitted for induction chemotherapy. She has severe nausea and vomiting and is losing weight during the admission. A member of the team says "hey she has more weight to lose, right?"

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What is malnutrition?

Malnutrition:

Adult - acute, subacute or chronic state of nutrition, in which a combination of varying degrees of overnutrition or undernutrition with or without inflammatory activity have led to a change in body composition and diminished function.[29]

Specifically:

- Starvation-related malnutrition: chronic starvation without inflammation (eg, anorexia nervosa)
- Chronic disease-related malnutrition; inflammation is chronic and of mild to moderate degree (eg, organ failure, pancreatic cancer, rheumatoid arthritis or sarcopenic obesity) and
- Acute disease or injury-related malnutrition: inflammation is acute and of severe degree (eg, major infection burns, trauma or closed head injury).[30]

Micronutrient deficiencies are also an important consideration in assessing for malnutrition.

Robinson D et al. American Society for Parenteral and Enteral Nutrition (ASPEN) definition of terms, style, and conventions used in ASPEN Board of Directors-approved documents. May 2018.

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Risk factors for developing malnutrition

- Inadequate energy/protein intake
  - Could be related to various disease states or food insecurity
- Increased energy/protein requirements
- Inflammatory processes
- Impaired nutrient absorption, altered nutrient transport or utilization
  - GI surgery, GI diseases, malignancy, medication side effects, etc.
- Food access
  - Food availability, types of foods consumed

White JV et al. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). JPEN J Parenter Enteral Nutr. 2012
Cristancho C et al. Malnutrition in patients with obesity: an overview perspective. Nutr Clin Pract. 2024

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Patients with obesity are at risk for malnutrition related to all factors!

White JV et al. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). JPEN J Parenter Enteral Nutr. 2012
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Nutrition assessment

- Anthropometric data
  - Height
  - Weight & weight history
- Nutrition-focused physical examination
- Diet/nutrition support history
- Labs

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Challenges: Anthropometric Data

Accurate height?	• Reported or measured?
Accurate weight?	• Bed scale weight vs standing weight? • How large is your patient? • What is the highest weight your scale can measure?
Accurate weight history?	• How many weights are reported or measured? • How many weights are "carried over" from prior clinic visits?

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Challenges: Nutrition Focused Physical Examination

- Can you access key muscle groups?
  - Temporal, interosseous
  - Trapezius, deltoid, pectoralis
  - Quadriceps, gastrocnemius
- Can you evaluate fat wasting accurately?
  - Redundant skin after bariatric surgery
  - Orbital and buccal fat assessments may be better areas of assessment
- Edema assessment
  - LE assessment (vs sacral) might be easiest

Work with RNs and examine when pt is being turned or undergoing other assessments (e.g., wound/pressure injury assessment)

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Challenges: Diet/Nutrition Support History

Can you get a diet history accurately?	• How well can the patient participate in an interview • Engage family/caretakers/people who know pt well to get more information as needed
Was your patient receiving nutrition support?	• Was your patient appropriate for nutrition support and not getting fed • Important for those who work in referral centers
How well were they eating/fed?	• Diet restrictions or intolerances • Consistently receiving nutrition support if indicated

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Micronutrient Deficiencies: Hidden Hunger

- Hidden hunger:
  - A term commonly used to describe individuals who may have had adequate energy consumption but suboptimal micronutrient intakes, placing them at risk for nutrition-related diseases.

Effersdorfer M et al. Hidden hunger: solutions for America's aging populations. Nutrients. 2018.

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Mean Healthy Eating Index: NHANES 2011-2014

Table 2 Mean Healthy Eating Index-2015 component and total scores of US older adults (≥60 years) by sex and weight status, estimated from National Health and Nutrition Examination Survey 2011–2014

	Men (*n* 1462)						Women (*n* 1507)					
	Healthy weight (*n* 378)		Over-weight (*n* 602)		Obese (*n* 482)		Healthy weight (*n* 399)		Over-weight (*n* 453)		Obese (*n* 655)	
HEI-2015 component (maximum score)	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Total fruits (5)	3·0	0·3	2·8	1·2	2·7	0·2	3·6	0·2	3·3	0·2	3·3	0·1
Whole fruits (5)	3·5	0·3	3·5	0·2	3·4	0·3	4·2	0·2	3·9	0·2	3·9	0·2
Total vegetables (5)	3·8	0·1	3·7	0·1	3·7	0·2	4·0	0·1	4·1	0·1	3·9	0·1
Greens and beans (5)	3·7[a]	0·4	3·1[a,b]	0·3	2·4[b]	0·3	3·5	0·3	3·1	0·3	3·1	0·2
Whole grains (10)	4·7	0·5	3·6	0·3	3·5	0·2	4·7	0·5	4·5	0·3	3·5	0·3
Dairy (10)	5·3	0·3	5·8	0·3	5·7	0·3	6·4	0·3	6·4	0·3	6·0	0·3
Total protein foods (5)	4·9	0·02	5·0	0·03	5·0	0·02	4·9	0·04	4·9	0·04	4·9	0·1
Seafood and plant proteins (5)	4·6	0·2	4·4	0·2	4·5	0·2	4·8	0·1	4·5	0·2	4·4	0·2
Fatty acids (10)	6·0	0·5	5·2	0·2	4·9	0·3	5·6	0·5	5·4	0·3	5·2	0·4
Refined grains (10)	7·6[a]	0·4	6·9[a,b]	0·3	6·2[b]	0·3	7·7[a]	0·3	7·2[a]	0·4	5·6[b]	0·3
Na (10)	4·9[a]	0·4	3·7[b]	0·3	2·8[b]	0·3	4·5[a]	0·3	3·7[a,b]	0·2	3·4[b]	0·3
Added sugars (10)	7·4	0·3	7·6	0·3	7·7	0·3	7·6	0·3	7·2	0·2	7·4	0·2
Saturated fats (10)	6·9[a]	0·5	6·1[a,b]	0·3	5·2[b]	0·3	6·3	0·4	5·9	0·3	6·0	0·3
Total score (100)	66·3[a]	2·3	61·2[a,b]	1·1	57·7[b]	1·1	67·7[a]	1·8	64·0[a,b]	1·3	60·6[b]	1·0

[a,b]Mean values within a same row for each sex with different superscript letters were significantly different ($P < 0·016$).

Jun S et al. Older adults with obesity have higher risks of micronutrient inadequacies and lower overall diet quality compared to peers with a healthy weight, National Health and Nutrition Examination Survey (NHANES), 2022-2014. Public Health Nutr. 2020

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Whole fruits (5)	3·5	0·3	3·5	0·2	3·4	0·3	4·2	0·2	3·9	0·2	3·9	0·2
Total vegetables (5)	3·8	0·1	3·7	0·1	3·7	0·2	4·0	0·1	4·1	0·1	3·9	0·1
Greens and beans (5)	3·7[a]	0·4	3·1[a,b]	0·3	2·4[b]	0·3	3·5	0·3	3·1	0·3	3·1	0·2
Whole grains (10)	4·7	0·5	3·6	0·3	3·5	0·2	4·7	0·5	4·5	0·3	3·5	0·3
Dairy (10)	5·3	0·3	5·8	0·3	5·7	0·3	6·4	0·3	6·4	0·3	6·0	0·3
Total protein foods (5)	4·9	0·02	5·0	0·03	5·0	0·02	4·9	0·04	4·9	0·04	4·9	0·1
Seafood and plant proteins (5)	4·6	0·2	4·4	0·2	4·5	0·2	4·8	0·1	4·5	0·2	4·4	0·2
Fatty acids (10)	6·0	0·5	5·2	0·2	4·9	0·3	5·6	0·5	5·4	0·3	5·2	0·4
Refined grains (10)	7·6[a]	0·4	6·9[a,b]	0·3	6·2[b]	0·3	7·7[a]	0·3	7·2[a]	0·4	5·6[b]	0·3
Na (10)	4·9[a]	0·4	3·7[b]	0·3	2·8[b]	0·3	4·5[a]	0·3	3·7[a,b]	0·2	3·4[b]	0·3
Added sugars (10)	7·4	0·3	7·6	0·3	7·7	0·3	7·6	0·3	7·2	0·2	7·4	0·2
Saturated fats (10)	6·9[a]	0·5	6·1[a,b]	0·3	5·2[b]	0·3	6·3	0·4	5·9	0·3	6·0	0·3
Total score (100)	66·3[a]	2·3	61·2[a,b]	1·1	57·7[b]	1·1	67·7[a]	1·8	64·0[a,b]	1·3	60·6[b]	1·0

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Jun S et al. Older adults with obesity have higher risks of micronutrient inadequacies and lower overall diet quality compared to peers with a healthy weight, National Health and Nutrition Examination Survey (NHANES), 2022-2014. Public Health Nutr. 2020

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Prevalence of intakes less than the estimated average requirements or above the adequate intake

Table 3 Prevalence of intakes less than the estimated average requirement (EAR) or above the adequate intake (AI) among US older adults (≥60 years) by sex and weight status, estimated from National Health and Nutrition Examination Survey 2011–2014

	Men (*n* 1462)						Women (*n* 1507)					
	Healthy weight (*n* 378)		Over-weight (*n* 602)		Obese (*n* 482)		Healthy weight (*n* 399)		Over-weight (*n* 453)		Obese (*n* 655)	
	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE
From food sources alone												
Ca (% <EAR)	46·0	2·8	44·0	2·8	42·0	2·9	74·0	3·6	78·0	3·6	82·0	3·5
Mg (% <EAR)	51·0[a]	2·5	63·7[b]	2·9	73·9[c]	2·7	45·7[a]	4·6	57·4[a,b]	3·5	64·4[b]	3·1
K (% >AI)	40·0[a]	3·0	28·0[b]	3·1	22·0[b]	3·4	40·0[a]	4·3	35·0[a,b]	3·6	27·0[b]	2·3
Zn (% <EAR)	23·5	4·2	20·3	4·7	27·2	4·0	17·4	3·9	21·1	4·9	26·6	3·4
Vitamin A (% <EAR)	43·0	3·1	26·0*	14·4	51·0	5·8	27·0	6·4	37·0	3·3	39·0	5·2
Folate (% <EAR)	9·0[a,b]	2·5	4·0*[a]	2·0	13·0[b]	3·2	16·0	3·6	23·0	4·4	22·0	2·8
Vitamin B_6 (% <EAR)	12·0	2·3	5·5*	2·7	10·3	3·2	18·2[a]	4·2	23·0[a,b]	5·1	33·7[b]	2·7
Vitamin B_{12} (% <EAR)	4·4*	2·1	1·1*	0·7	4·4*	1·9	8·0	2·7	4·9*	2·1	7·5	2·7
Vitamin C (% <EAR)	43·7[a]	2·3	52·9[a,b]	3·8	56·3[b]	3·6	37·6	3·9	38·0	3·3	47·1	3·3
Vitamin D (% <EAR)	88·8	2·6	94·8	2·4	94·0	2·1	93·0[a]	2·1	97·9[a,b]	0·9	98·6[b]	0·8
Vitamin E (% <EAR)	67·3[a]	3·0	77·2[a,b]	3·8	85·6[b]	3·4	86·2	3·4	91·4	3·0	91·8	2·4
From total intakes												
Ca (% <EAR)	36·0	2·8	33·0	2·3	31·0	2·7	38·0	3·2	44·0[a]	3·5	56·0[b]	3·7
Mg (% <EAR)	44·0[a]	3·0	53·8[b]	2·6	61·0[b]	3·0	34·0[a]	4·3	43·0[a,b]	3·2	52·6[b]	3·2
K (% >AI)	41·0[a]	3·0	29·0[b]	3·1	24·0[b]	3·3	42·0[a]	4·3	36·0[a,b]	3·5	28·0[b]	2·3
Zn (% <EAR)	16·4	3·2	14·4	3·5	18·5	3·7	11·0	2·7	12·0	3·0	19·6	2·7
Folate (% <EAR)	7·0	2·1	3·0*	1·7	8·0	2·0	10·0	2·5	12·0	2·8	17·0	2·4
Vitamin B_6 (% <EAR)	8·6	2·1	4·6*	2·2	6·0	2·1	12·5[a]	3·2	13·6[a]	2·7	22·8[b]	2·7
Vitamin B_{12} (% <EAR)	3·0	1·2	1·0*	0·5	3·0*	1·4	4·0	1·0	2·0*	1·0	6·0	2·0
Vitamin C (% <EAR)	29·0	4·4	37·0	3·6	32·0	3·0	24·0[a,b]	4·0	21·0[a]	3·1	31·0[b]	2·3
Vitamin D (% <EAR)	48·0	3·9	53·1	2·8	51·1	3·3	33·0[a]	3·1	39·4[a,b]	3·4	49·4[b]	3·2

*Relative standard error over 40 %; estimates may not be statistically reliable.
[a,b]Mean values within a same row for each sex with different superscript letters were significantly different ($P < 0·016$).

Jun S et al. Older adults with obesity have higher risks of micronutrient inadequacies and lower overall diet quality compared to peers with a healthy weight, National Health and Nutrition Examination Survey (NHANES), 2022-2014. Public Health Nutr. 2020

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Prevalence of intakes less than the estimated average requirements or above the adequate intake: key points

Men with obesity had inadequate intake of	Women with obesity had inadequate intake of	Older women with obesity had inadequate intake of	Older adults in general had inadequate intake of
• Magnesium • Vitamin C • Vitamin E	• Vitamin B6 • Vitamin D	• Calcium • Vitamin B6 • Vitamin D	• Calcium • Magnesium • Vitamin C • Vitamin D

Jun S et al. Older adults with obesity have higher risks of micronutrient inadequacies and lower overall diet quality compared to peers with a healthy weight, National Health and Nutrition Examination Survey (NHANES), 2022-2014. Public Health Nutr. 2020

29

What about bariatric surgery?

30

Changes in Metabolic and Bariatric Surgery: 1993-2016

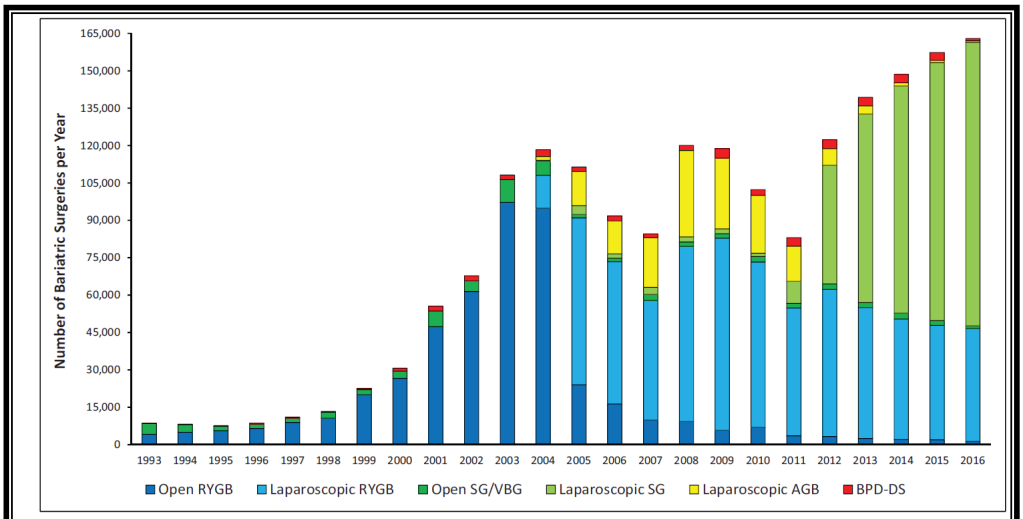


FIGURE 1. Number and types of inpatient primary bariatric surgery procedures in the United States—1993 to 2016.

Campos GM et al. Changes in utilization of bariatric surgery in the United States from 1993 to 2016. Ann Surg. 2020

31

Changes in Metabolic and Bariatric Surgery: 2011-2022

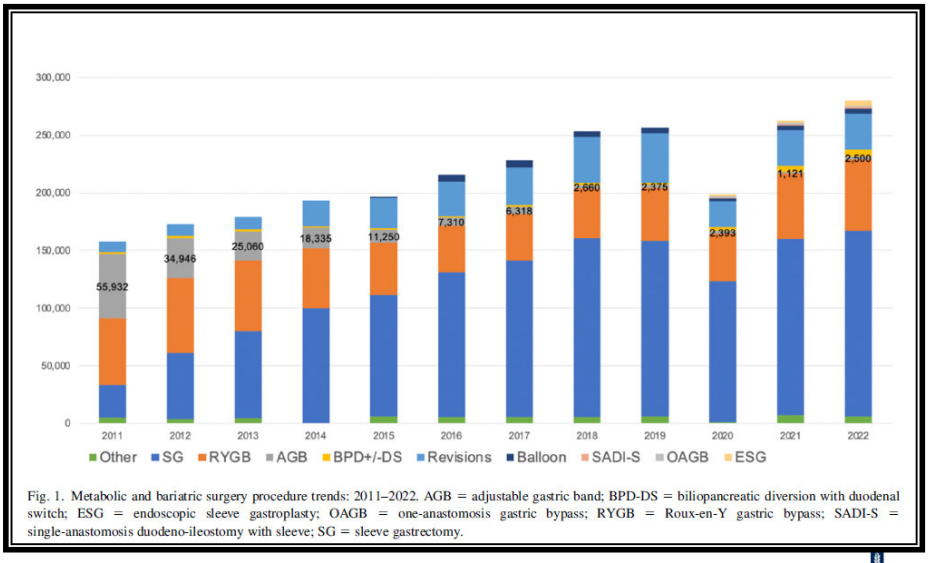
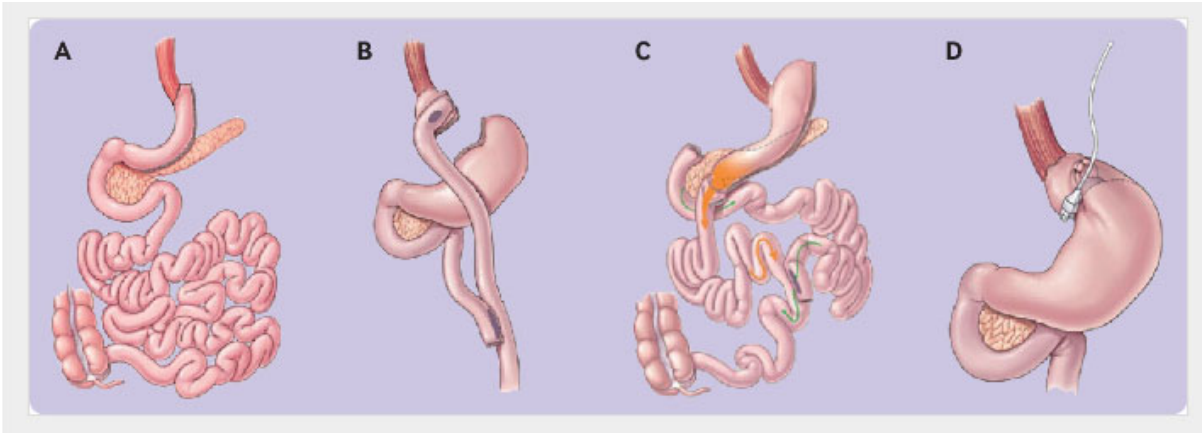


Fig. 1. Metabolic and bariatric surgery procedure trends: 2011–2022. AGB = adjustable gastric band; BPD-DS = biliopancreatic diversion with duodenal switch; ESG = endoscopic sleeve gastroplasty; OAGB = one-anastomosis gastric bypass; RYGB = Roux-en-Y gastric bypass; SADI-S = single-anastomosis duodeno-ileostomy with sleeve; SG = sleeve gastrectomy.

Clapp B et al. American Society for Metabolic and Bariatric surgery 2022 estimate of metabolic and bariatric procedures performed in the United States. Surgery for Obes Rel Dis. 2024.

32

Common Metabolic/Bariatric Procedures



A: sleeve gastrectomy; B: Roux-en-Y gastric bypass; C: biliopancreatic diversion; D: adjustable gastric banding. Adapted from American Society for Metabolic and Bariatric Surgery. Bariatric Surgery Procedures (https://asmbs.org/patients/bariatric-surgery-procedures)

Courcoulas AP et al. Long term outcomes of metabolic/bariatric surgery in adults. BMJ 2023

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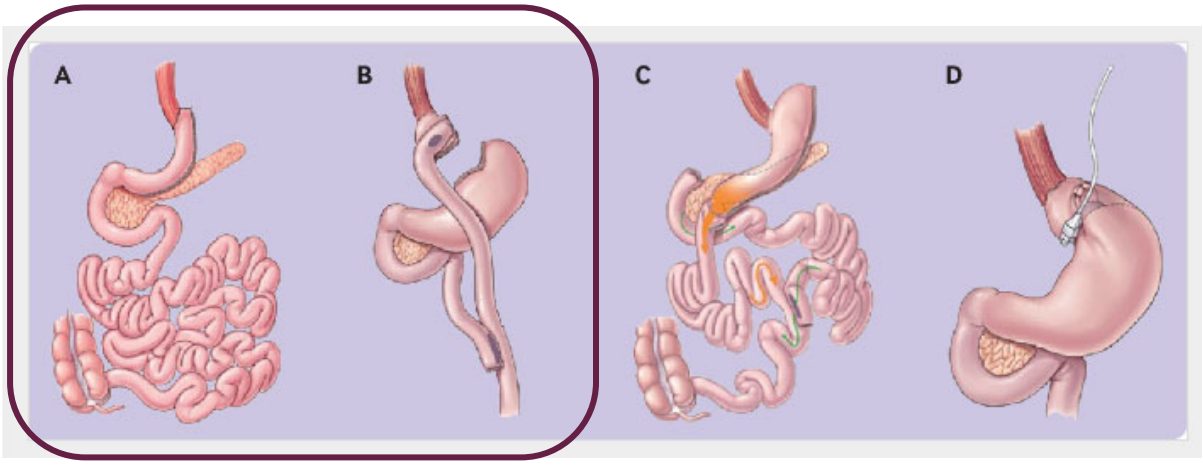
Common Metabolic/Bariatric Procedures



A: sleeve gastrectomy; B: Roux-en-Y gastric bypass; C: biliopancreatic diversion; D: adjustable gastric banding. Adapted from American Society for Metabolic and Bariatric Surgery. Bariatric Surgery Procedures (https://asmbs.org/patients/bariatric-surgery-procedures)

Courcoulas AP et al. Long term outcomes of metabolic/bariatric surgery in adults. BMJ 2023

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High Risk Nutrients after Metabolic/Bariatric Surgery

Micronutrient	SG	RYGB
Calcium	X	X
Iron	X	X
Vitamin B_{12}	X	X
Folate		X
Thiamin		X
Vitamin D*	X	X
Zinc		X
Copper		X

Aarts et al. Obes Surg. 2011; Aills, et al. SOARD, 2008; Gehrer, et al. Obes Surg. 2010; Mechanik, et al. SOARD. 2013; Moize, et al. JAND, 2013.

35

Riboflavin (Vitamin B_2) Deficiency

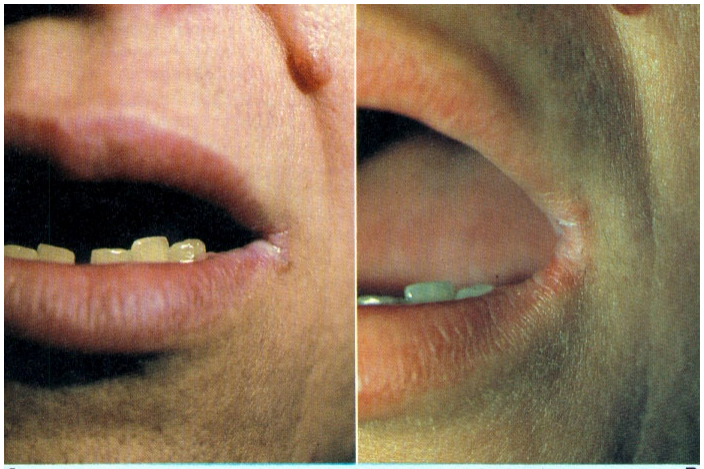

Fig. 6-9 Angular stomatitis of riboflavin deficiency before (**A**) and after (**B**) therapy.

Weinsier RL and Morgan SL. Fundamentals of Clinical Nutrition. Mosby-Year Books. 1993.

36

Niacin (Vitamin B_3) Deficiency—Pellagra

Weinsier RL and Morgan SL. Fundamentals of Clinical Nutrition. Mosby-Year Books. 1993.

37

Another Pellagra

The dermatitis is seen in areas exposed to the sun

From: http://dermatlas.med.jhmi.edu/derm/IndexDisplay.cfm?ImageID=1866182611 accessed 3/4/12

38

Riboflavin (Vitamin B_2) & Pyridoxine (Vitamin B_6) Deficiency

Friedli A, Saurat J-H. Images in Clinical Medicine: Oculo-orogenital syndrome—a deficiency of vitamins B2 and B6. N Engl J Med. 2004;350:1130

39

Riboflavin (Vitamin B_2) & Pyridoxine (Vitamin B_6) Deficiency

Note: cheilosis can be a sign of B2, B6, folate, and/or B12 deficiency

Friedli A, Saurat J-H. Images in Clinical Medicine: Oculo-orogenital syndrome—a deficiency of vitamins B2 and B6. N Engl J Med. 2004;350:1130

40

Biotin (Vitamin B_7) Deficiency

Fig. 6-6 Alopecia before (**A**) and after (**B**) biotin therapy in a patient on long-term total parenteral nutrition without biotin.

Weinsier RL and Morgan SL. Fundamentals of Clinical Nutrition. Mosby-Year Books. 1993.

41

B_{12} Deficiency: Smooth, "beefy red" tongue

From: http://www.dentistry.leeds.ac.uk/biochem/lectures/nutrition/Intro/B12%20deficiency.jpg, accessed 4/7/07

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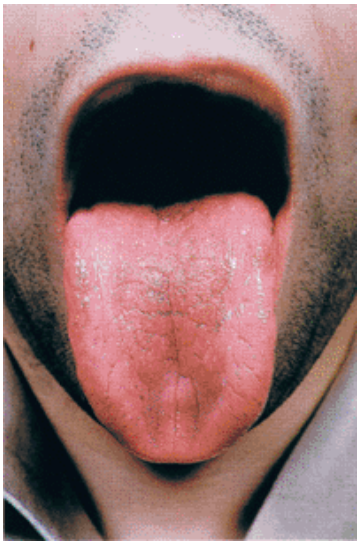
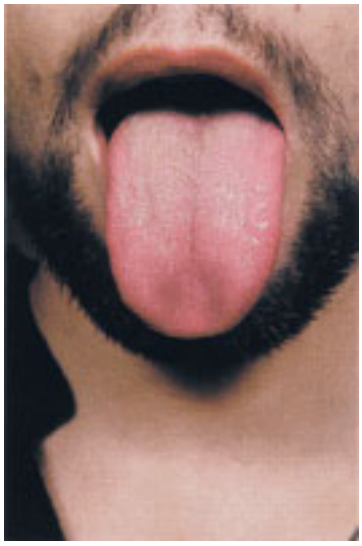
B_{12} Deficiency: Before & After Treatment





Heimberger DC et al. Clinical manifestations of nutrient deficiencies and toxicities: a resume. In: Modern Nutrition in Health & Disease. 2006;597-612

43

Vitamin C Deficiency

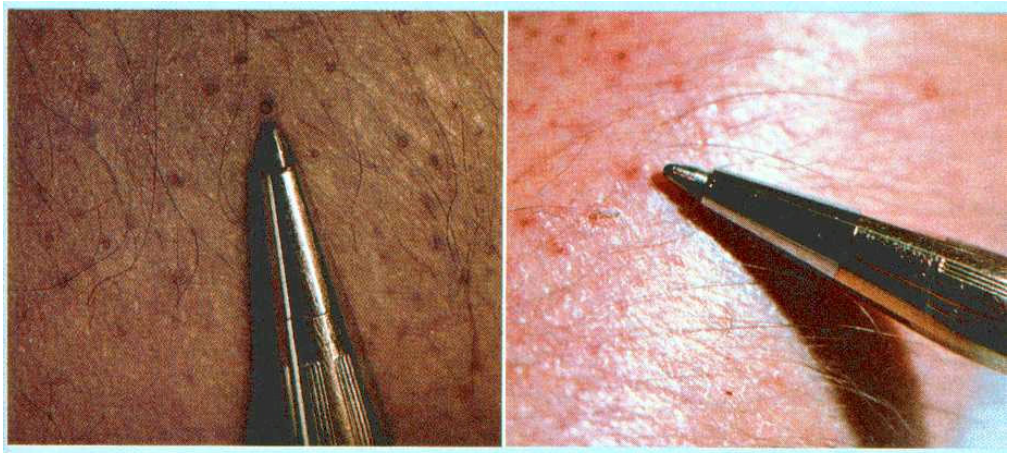


Fig. 6-2 A, Corkscrew hairs in scurvy. B, Perifollicular petechiae in scurvy.

Weinsier RL and Morgan SL. Fundamentals of Clinical Nutrition. Mosby-Year Books. 1993.

44

Vitamin C Deficiency

(From Taylor KB, Anthony LE: Clinical nutrition, New York, 1983, McGraw-Hill.)

45

Vitamin A Deficiency

Fig. 1a Headlights of an approaching car as seen by a normal individual or one with vitamin A-deficiency.

Fig. 1b Wide stretch of road as seen by a normal individual after the approaching car has passed.

Fig. 1c View of the road as seen by a vitamin A-deficient subject after the approaching car has passed. Only a few feet directly in front of the car are visible and one cannot see the road sign at all.

Weinsier RL and Morgan SL. Fundamentals of Clinical Nutrition. Mosby-Year Books. 1993.

46

Vitamin A Deficiency

Fig. 6-1 Follicular hyperkeratosis in vitamin A deficiency.

Weinsier RL and Morgan SL. Fundamentals of Clinical Nutrition. Mosby-Year Books. 1993.

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Micronutrient Deficiencies Wrap Up

- Keep micronutrients at top of mind when assessing patients with obesity
- Be thorough with your diet history
  - Ask about fruits and vegetables
  - Access to food/food insecurity
  - Who cooks/who shops?
- Don't let a history of metabolic/bariatric surgery get buried
  - My experience – for patients who have had surgery in the 80s/90s or even early 2000s, it gets missed or forgotten!

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Assessing lab data

- Circulating proteins
  - We all still get questions about albumin and prealbumin
  - Have your one-liner ready about negative acute phase proteins!
- Assessing micronutrient status
  - Confirm findings on nutrition focused physical examination
  - Further evaluation if concerned for nutritional anemia
- Measures of hydration status

aspen American Society for Parenteral and Enteral Nutrition

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Putting it all together – Academy/ASPEN Indicators of Malnutrition

TABLE 2 Characteristics to diagnose moderate malnutrition

Characteristic	Acute illness– or injury-related malnutrition	Chronic disease–related malnutrition	Social- or environmental-related malnutrition
Weight loss	1%–2% in 1 week, 5% in 1 month, or 7.5% in 3 months	5% in 1 month, 7.5% in 3 months, 10% in 6 months, or 20% in 1 year	5% in 1 month, 7.5% in 3 months, 10% in 6 months, or 20% in 1 year
Energy intake	<75% for >7 days	<75% for ≥ 1 month	<75% for ≥3 months
Body fat	Mild depletion	Mild depletion	Mild depletion
Muscle mass	Mild depletion	Mild depletion	Mild depletion
Fluid accumulation	Mild	Mild	Mild
Grip strength	Not applicable	Not applicable	Not applicable

Adapted with permission from White JV, Guenter P, Jensen G, Malone A, Schofield M; Academy Malnutrition Work Group; A.S.P.E.N. Malnutrition Task Force; A.S.P.E.N. Board of Directors. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: Characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). *JPEN J Parenter Enteral Nutr*. 2012;36(3):275-283.

Malone A, Mogensen KM. Key approaches to diagnosing malnutrition in adults. Nutr Clin Pract. 2022;37(1):23-34

aspen American Society for Parenteral and Enteral Nutrition

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Putting it all together – Academy/ASPEN Indicators of Malnutrition

TABLE 3 Characteristics to diagnose severe malnutrition

Characteristic	Acute illness– or injury-related malnutrition	Chronic disease–related malnutrition	Social- or environmental-related malnutrition
Weight loss	>2% in 1 week, >5% in 1 month, or >7.5% in 3 months	>5% in 1 month, >7.5% in 3 months, >10% in 6 months, or >20% in 1 year	>5% in 1 month, >7.5% in 3 months, >10% in 6 months, or >20% in 1 year
Energy intake	≤50% for ≥5 days	≤75% for ≥1 month	≤50% for ≥1 months
Body fat	Moderate depletion	Severe depletion	Severe depletion
Muscle mass	Moderate depletion	Severe depletion	Severe depletion
Fluid accumulation	Moderate-to-severe	Severe	Severe
Grip strength	Not recommended in the intensive care unit	Reduced for age/gender	Reduced for age/gender

Adapted with permission from White JV, Guenter P, Jensen G, Malone A, Schofield M; Academy Malnutrition Work Group; A.S.P.E.N. Malnutrition Task Force; A.S.P.E.N. Board of Directors. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). *JPEN J Parenter Enteral Nutr*. 2012;36(3):275-283.

Malone A, Mogensen KM. Key approaches to diagnosing malnutrition in adults. Nutr Clin Pract. 2022;37(1):23-34

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Putting it all together: GLIM Criteria for the Diagnosis of Malnutrition

Step 1: screen patients for malnutrition risk with a validated screening tool. Then move to this table:

Table 3. Phenotypic and Etiologic Criteria for the Diagnosis of Malnutrition.

Phenotypic Criteria[a]			Etiologic Criteria[a]	
Weight Loss (%)	Low Body Mass Index (kg/m^2)	Reduced Muscle Mass[b]	Reduced Food Intake or Assimilation[c,d]	Inflammation[e,f,g]
>5% within past 6 months, or >10% beyond 6 months	<20 if <70 years, or <22 if >70 years Asia: <18.5 if <70 years, or <20 if >70 years	Reduced by validated body composition measuring techniques[b]	≤50% of ER > 1 week, or any reduction for >2 weeks, or any chronic GI condition that adversely impacts food assimilation or absorption[c,d]	Acute disease/injury[e,g] or chronic disease-related[f,g]

Need 1 phenotypic & 1 etiologic criteria to be diagnosed with malnutrition

Jensen GL et al. GLIM criteria for the diagnosis of malnutrition: a consensus report from the global nutrition community. JPEN J Parenter Enteral Nutr. 2019;43(1):32-40

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Putting it all together: GLIM Criteria for the Diagnosis of Malnutrition

After determining if the patient has malnutrition, determine the severity:

Table 4. Thresholds for Severity Grading of Malnutrition Into Stage 1 (Moderate) and Stage 2 (Severe) Malnutrition.

	Phenotypic Criteria[a]		
	Weight Loss (%)	Low Body Mass Index (kg/m^2)[b]	Reduced Muscle Mass[c]
Stage 1/moderate malnutrition (requires 1 phenotypic criterion that meets this grade)	5%–10% within the past 6 months, or 10%–20% beyond 6 months	<20 if <70 years, <22 if ≥70 years	Mild-to-moderate deficit (per validated assessment methods; see below)
Stage 2/severe malnutrition (requires 1 phenotypic criterion that meets this grade)	>10% within the past 6 months, or >20% beyond 6 months	<18.5 if <70 years, <20 if ≥70 years	Severe deficit (per validated assessment methods; see below)

Jensen GL et al. GLIM criteria for the diagnosis of malnutrition: a consensus report from the global nutrition community. JPEN J Parenter Enteral Nutr. 2019;43(1):32-40

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Critically ill patients with obesity: those with and without malnutrition

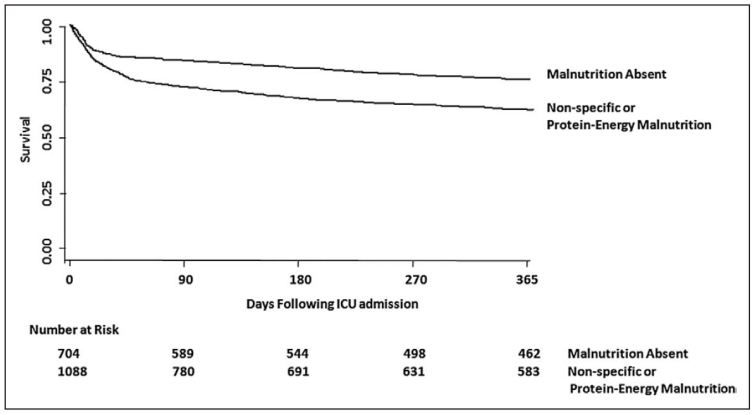

Figure 2. Time-to-event curves for mortality in patients with body mass index ≥ 30.0 kg/m^2 (n = 1,799). Unadjusted event rates were calculated with the use of the Kaplan-Meier methods and compared with the use of the log-rank test. Categorization of nutrition status is per the secondary analyses. The global comparison log-rank p value is < 0.0001.

Robinson MK et al. Crit Care Med 2015

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Developing the Intervention

55

ASPEN Clinical Guidelines: Nutrition Support of Hospitalized Adult Patients with Obesity

Question 2: How Should Energy Requirements Be Determined in Obese Critically Ill or Hospitalized Non-ICU Patients? (Table 4)

Recommendation

2a. In the critically ill obese patient, if indirect calorimetry is unavailable, energy requirements should be based on the Penn State University 2010 predictive equation or the modified Penn State University equation if the patient is over the age of 60 years (strong).

Evidence Grade: High.

2b. In the hospitalized obese patient, if indirect calorimetry is unavailable and the Penn State University equations cannot be used, energy requirements may be based on the Mifflin–St Jeor equation using actual body weight (weak).

Evidence Grade: Moderate.

Choban et al, JPEN 2013

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ASPEN Clinical Guidelines: Nutrition Support of Hospitalized Adult Patients with Obesity

The MSJ[58] equations are as follows:

- Men (kcal/day) = 5 + 10 × Weight (kg) + 6.25 × Ht(cm) – 5 × Age(y)
- Women (kcal/day) = –161 + 10 × Weight (kg) + 6.25 × Ht(cm) – 5 × Age(y)

Choban et al, JPEN 2013

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ASPEN Clinical Guidelines: Nutrition Support of Hospitalized Adult Patients with Obesity

The PSU equations[53] are as follows:
Younger obese patients:

- RMR (kcal/d) = MSJ(0.96) + Tmax(167) + VE(31) – 6212

Older obese patients:

- RMR (kcal/d) = MSJ(0.71) + Tmax(85) + VE(64) – 3085
- ○ Where MSJ = Mifflin–St Jeor equation (below); V_E = minute ventilation (L/minute); T_{max} = maximum temperature in prior 24 hours in degrees C

Choban et al, JPEN 2013

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ASPEN Clinical Guidelines: Nutrition Support of Hospitalized Adult Patients with Obesity

Question 3: Are Clinical Outcomes Improved With Hypocaloric, High Protein Diets in Hospitalized Patients With Obesity? (Tables 5-6)

Recommendation

3a. Clinical outcomes are at least equivalent in patients supported with high protein hypocaloric feeding to those supported with high protein eucaloric feeding. A trial of hypocaloric high protein feeding is suggested in patients who do not have severe renal or hepatic dysfunction (weak). Hypocaloric feeding may be started with 50%-70% of estimated energy requirements or < 14 kcal/kg actual weight. High protein feeding may be started with 1.2 g/kg actual weight or 2-2.5 g/kg ideal body weight, with adjustment of goal protein intake by the results of nitrogen balance studies.

Evidence Grade: Low.

3b. Hypocaloric low protein feedings are associated with unfavorable outcomes. Clinical vigilance for adequate protein provision is suggested in patients who do not have severe renal or hepatic dysfunction (weak).

Evidence Grade: Low.

Choban et al, JPEN 2013

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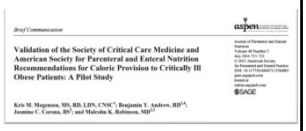
Energy requirements for critically ill patients with obesity

- 2009 SCCM/ASPEN guidelines:
  - Feed 60-70% measured resting energy expenditure or
  - 11-14 kcal/kg actual weight or
  - 22-25 kcal/kg ideal body weight
- Study conducted at BWH in 2011
  - Compared indirect calorimetry in 31 patients with obesity to the SCCM/ASPEN guidelines as well as two other predictive equations; separated by BMI ≤ 50 kg/m^2 and >50 kg/m^2
    - 11-14 kcal/kg actual weight correlated with 60-70% MREE for BMI ≤ 50 kg/m^2
    - 22-25 kcal/kg IBW correlated with 60-70% MREE for BMI > 50 kg/m^2

If you have indirect calorimetry – use it!!


Validation of the Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition Recommendations for Caloric Provision to Critically Ill Obese Patients: A Pilot Study

McClave SA et al. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: : Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). JPEN 2009;277-316

Mogensen KM, Andrew BY, Corona JC, Robinson MK. Validation of the Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition recommendations for caloric provision to critically Ill obese patients: a pilot study. JPEN 2016;40:713-721

McClave SA et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) . JPEN J Parenter Enteral Nutr. 2016;40(2):159-211

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Protein Requirements

- Non-ICU setting
  - ASPEN Guidelines:
    - *At least 1.2 g/kg actual weight or 2-2.5 g/kg ideal body weight*
  - Various Obesity Society Guidelines:
    - *60g/day minimum*
    - *1.5-2.1 g/kg IBW based on individual clinical situation*

Choban P et al. A.S.P.E.N. Clinical guidelines: nutrition support of hospitalized adult patients with obesity. JPEN J Parenter Enteral Nutr. 2013;37(6):714-744.
Mechanick JI et al. Clinical practice guidelines for the perioperative nutrition, metabolic, and nonsurgical support of patients undergoing bariatric procedures – 2019 update. Obesity. 2020;28:1-58

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Protein Requirements

- In critical illness, more protein is mobilized in patients with obesity
- Need to provide adequate protein to preserve lean body mass while restricting calories

Class of obesity	Protein provision
Class 1 and 2 (BMI 30-39.9 kg/m^2)	≥2 g/kg IBW
Class 3 obesity (≥40 kg/m^2)	≥2.5 g/kg IBW

McClave SA et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) . JPEN J Parenter Enteral Nutr. 2016;40(2):159-211

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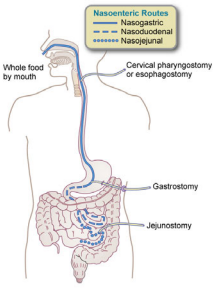
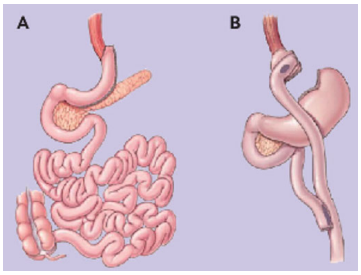
Route of feeding

- In theory, should be easy – follow typical EN and PN guidelines
- A word on enteral access:
  - Short-term enteral access should be straightforward, but be cautious with patients who have had bariatric surgery…



From Krause's Food and Nutrition Therapy, 12th edition.



Courcoulas AP et al. Long term outcomes of metabolic/bariatric surgery in adults. BMJ 2023

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Micronutrient supplementation

- Assure RDIs are met with appropriate EN volume; provide multivitamin/mineral preparation if needs are not met
- Provide standard multivitamins and trace elements in PN
- Provide supplemental thiamin for at-risk patients (refeeding syndrome, severe vomiting)
- Check micronutrient levels for suspected deficiencies and provide repletion doses in cases of deficiency (could be a separate talk!)

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Additional considerations

- Patients with obesity shouldn't stay on hypocaloric, high-protein nutrition forever
- As patients improve and start moving into the chronic phase, give more calories and less protein
- Less literature to guide us in this area
- If you have indirect calorimetry, increasing calories toward the measured energy expenditure is a good start

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Additional considerations

- At BWH, we give 18-20 kcals/kg of actual weight and give at least 1g protein/kg of actual weight
- Others use predictive equations and subtract calories (e.g. 500 calories to promote some weight loss) if indicated
- Ideally, adjust the nutrition support regimen before the patient transfers to rehab
- Monitor improvement in strength, endurance, wound healing
- May need additional energy and protein if not making progress

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Conclusions

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Conclusions

- Patients with obesity can develop malnutrition, just like any other patient
- Use an appropriate screening tool to determine if a full nutrition assessment is indicated
- A careful nutrition focused physical examination is important to assess for fat/muscle wasting and to assess for micronutrient deficiencies
- A detailed diet recall is important to assess for inadequate micronutrient intake
- Patients with obesity should receive nutrition support therapy and other appropriate nutrition interventions as indicated, the same as patients without obesity

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References

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Learning Assessment Questions

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Learning Assessment Question 1

The malnutrition screening tool recommended by the Academy of Nutrition and Dietetics is:

A. SNAQ

B. MUST

C. MST

D. NRS-2002

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Learning Assessment Question 1

The malnutrition screening tool recommended by the Academy of Nutrition and Dietetics is:

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Learning Assessment Question 2

Individuals who may have had adequate energy consumption but suboptimal micronutrient intakes can be described as having:

A. Poor diet quality

B. Risk of deficiencies

C. Malnutrition

D. Hidden hunger

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Learning Assessment Question 2

Individuals who may have had adequate energy consumption but suboptimal micronutrient intakes can be described as having:

A. Poor diet quality

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D. Hidden hunger

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Learning Assessment Question 3

Women with obesity are at risk for inadequate intake of:

A. Vitamin A

B. Vitamin D

C. Vitamin E

D. Vitamin K

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Learning Assessment Question 3

Women with obesity are at risk for inadequate intake of:

A. Vitamin A

B. Vitamin D

C. Vitamin E

D. Vitamin K

aspen American Society for Parenteral and Enteral Nutrition

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