



NCC Pediatrics Continuity Clinic Curriculum: Nutrition III: School-Age & Adolescent



Goal:

To understand the nutrition recommendations and key issues for school-age children and adolescents, and to be able to translate them into practical, anticipatory guidance for parents.

* Note: Obesity will be covered separately in the Nutrition IV Module.

Pre-Meeting Preparation:

- Read “School-Age & Adolescent Nutrition” (*Excerpts from HealthyChildren.org*)
- Skim “Vegetarian Diets in Children and Adolescents” (*PIR, 2009*)
- Skim “Eating Disorders” (*PIR, 2016*)
- **Be prepared to provide a case-example or FAQ related to School-Age & Adolescent Nutrition from your clinic experience.** Discuss how you approached the case/ question.

Conference Agenda:

- *Review* Nutrition III Quiz
- Complete Nutrition III Cases
- **Round table discussion of *resident School-Age & Adolescent cases***

Post-Conference: Board Review Q&A

Extra Credit:

Please review the following enclosures, related to the practical guidelines, above:

- [The 2022 Child Nutrition Reauthorization — An Opportunity to Advance Children’s Health](#) (*NEJM, April 2022*)
- [Nutritional Deficiencies in Vegetarian, Gluten-Free, and Ketogenic Diets](#) (*PIR, 2022*)
- [The Role of Diet, Nutrition, and Exercise in Preventing Disease](#) (*PIR, 2022*)
- [AAP Clinical Report on Eating Disorders](#) (*Pediatrics, 2010*)
- [Planning Well-Balanced Vegetarian Diets in Infants, Children, and Adolescents: The VegPlate Junior](#) (*Journal of the Academy of Nutrition and Dietetics, July 2019*)
- [Managing Feeding Disorders and Feeding Problems](#) (*PIR, 2013*)
- [Vitamin Deficiency & Overdose Chart](#) (*helpful for Board Review questions*)
- [Nurturing Children's Healthy Eating: Position statement](#) (*Appetite, 2019*)
- [USDA Dietary Guidelines for Americans 2020-2025](#) (*starting at page 69*)
- [Screen and Intervene: A Toolkit for Pediatricians to Address Food Insecurity](#)
- *Links to [SNAP](#) and [WIC](#)*

School-Age Nutrition

Material adapted from: <http://www.healthychildren.org/English/ages-stages/>

Calories & Servings

As the middle years progress, children's total energy needs will increase and thus their food intake will rise, especially as they approach puberty. Between ages 7 and 10, both boys and girls consume about **1,600 to 2,400 calories per day**. Most girls experience a significant increase in their growth rate between ages 10 and 12 and will take in about 200 calories more each day, while boys go through their **growth spurt** about 2 years later and increase their food intake by nearly 500 calories a day.

Some parents worry that throughout the school age years, there seems to be no rhyme or reason to their children's appetite. **Appetites can vary**, even from day to day, depending on factors like activity levels. A child who spends the afternoon doing homework, for example, may have fewer caloric needs than one who plays outdoors after school.

At the same time, children in this age group eat for a lot of reasons besides hunger. They could be upset or tired and relying on food for comfort. When your youngster says that he's hungry and it's not a regular meal or snack time, try to determine whether food might be serving some other purpose. Then help him find an activity that will keep him occupied doing something productive.

Ultimately, children in early to middle adolescence should be gaining **4 to 7 lbs per year**. As long as your child is growing normally, keep your focus on serving a variety of healthy foods.

Variety & Nutrients

Your child should consume a variety of foods from the five major food groups that make up the "**Food Plate**" developed by the U.S. Department of Agriculture in July 2011, to replace the "Food Pyramid".



Vegetables: 3-5 servings/day. Serving = 1 cup of raw leafy vegs, 3/4 cup of veg juice, or 1/2 cup of other vegs, chopped raw or cooked.

Fruits: 2-4 servings/day. Serving = 1/2 cup sliced fruit or a medium-size whole fruit.

Bread, cereal, or pasta: 6-11 servings/day. Serving = 1 slice of bread, 1/2 cup of rice/pasta, or 1 oz of cereal.

Protein foods: 2-3 servings of 2-3 oz of cooked lean meat, poultry, or fish per day. Serving also = 1/2 cup of cooked dry beans, 1 egg, or 2 TBSPs of peanut butter for each oz lean meat.

Dairy products: 2-3 servings/day of 1 cup of low-fat milk or yogurt, or 1.5 oz of natural cheese.

Foods to Reduce:

- **Fat:** High fat intake, particularly saturated fats (solid at room temp), can increase cholesterol and lead to coronary artery disease. *After age 2*, children should be served foods lower in saturated fats (e.g. poultry, fish, lean meat—not fried; low-fat dairy; low-saturated-fat oils; soft margarine—not butter; limited eggs). In general, **fats should make up <30% of calories in a child's diet**, with >2/3 of those fat calories coming from *unsaturated* fats (liquid at room temp—e.g. corn, safflower, sunflower, soybean, and olive oil).

- **Sugar:** Many children consume sugar in great quantities, usually at the expense of healthier foods (e.g. sodas and juice, instead of milk or water). Keep consumption at moderate levels.
- **Salt:** The habit of using extra salt is acquired. Thus, as much as possible, serve a child food low in salt, to decrease the risk of high blood pressure. Use herbs, spices, or lemon juice to flavor foods and avoid processed foods such as cheese, instant puddings, canned vegetables and soups, hot dogs, salad dressing, pickles, and potato chips.

Vitamins

Supplements are rarely needed in middle childhood, since a balanced diet contains sufficient quantities for the essential vitamins and minerals. However, children with poor appetite, erratic eating habits, or highly selective diets (e.g. vegetarian or vegan) may need vitamin supplements.

Over-the-counter supplements (e.g. [Flintstones chewables or gummies](#)) are generally safe; however, if taken in excessive amounts or combined, some—particularly fat-soluble vitamins (A, D, E, K)—can be toxic. Of note, “**mega-vitamin therapy**” or “orthomolecular medicine”—in which vitamins are given in extremely large doses for conditions ranging from the common cold to hyperactivity—has no proven scientific validity and may pose risks.

Following are some of the vitamins and minerals necessary for normally growing children, and some of the foods that contain them. (Review this [“Vitamin Deficiency & Overdose Chart”](#) chart for a more complete list of vitamins and the conditions associated with deficiency or excessive intake).

- **Vitamin A** promotes normal growth, healthy skin, and tissue repair, and aids in night and color vision. Rich sources include yellow vegetables, dairy products, and liver.
- **B vitamins** promote red blood cell formation and assist in a variety of metabolic activities. Found in meat, poultry, fish, soybeans, milk, eggs, whole grains, and enriched breads and cereals.
- **Vitamin C** hastens the healing of wounds and increases resistance to infection. Found in citrus fruits, strawberries, tomatoes, potatoes, Brussels sprouts, spinach, and broccoli.
- **Vitamin D** promotes tooth and bone formation and regulates calcium absorption. Sources include fortified dairy products, fish oils, fortified margarine, and egg yolks. Sunlight also contributes to dietary sources of vitamin D, stimulating the conversion in the skin.

Adolescent Nutrition

Material adapted from: <http://www.healthychildren.org/English/ages-stages/>

Calories & Servings

The body demands more calories during early adolescence than at any other time of life. On average, **boys require about 2800 calories per day; and girls, 2200 calories per day.** Typically, the ravenous hunger of adolescence starts to wane once a child has stopped growing, though not always. Kids who participate in physical activity will still need increased amounts of energy into late adolescence.

Serving sizes for teenagers should still be about the same as they are for adults. Please review the chart on the following page to see the number of servings and sizes recommended for the average teen. The USDA “Food Plate” can still be used as a visual guide.

Food Group	Number of Servings Per Day	
	Females	Males
Calories	Aged 11-24 Total Calories: 2,200	Aged 11-14 Total Calories: 2,500
		Aged 15-18 Total Calories: 3,000
		Aged 19-24 Total Calories: 2,900
Bread, Cereal, Rice and Pasta Group 6-11 servings	9 servings	11 servings
Milk, Yogurt and Cheese Group 4-5 servings	4 or 5 servings	Aged 11-18: 4 or 5 servings Aged 19-24: 2-3 servings
Vegetable Group 3-5 servings	4 servings	5 servings
Fruit Group 2-4 servings	3 servings	4 servings
Meat, Poultry, Fish, Dry Beans, Eggs and Nuts 2-3 servings	6 ounces total	7 ounces total
Total Fat	73 grams	Aged 11-14: 83 grams Aged 15-18: 100 grams
Total Added Sugar	12 teaspoons	18 teaspoons

Variety & Nutrients

There are a number of obstacles to balanced adolescent nutrition:

- **Skipping meals:** According to a recent poll, about ½ of boys and girls aged 9-15 years said that they didn't eat breakfast on school mornings. Breakfast-to-go options include a bagel and peanut butter, a hard-boiled egg, nuts & raisins, a yogurt, or an apple.
- **Snacking:** 1/3 of the caloric intake of adolescents comes from snacks—particularly unhealthy ones. It's therefore important to keep the refrigerator and pantry stocked with healthy options like low-fat cheeses, applesauce, air-popped popcorn, and baked potato chips.
- **Eating away from home:** At school, adolescents will often settle for a stop at the vending machine for lunch. After school, they may decide that fitting in with their peers at a fast-food restaurant or pizza shop is more important than making healthy food selections. Brainstorm healthy alternatives and/or other activities to do with their peers.
- **The lure of fad diets:** As teenage girls “hopscotch” from one fad diet to another, good nutrition may fall by the wayside. Reinforce that these diets are too restrictive and unhealthy and bad for weight loss in the long run.

The guidance in the above section for “Foods to Reduce” still applies to adolescents. Also remember, each gram of protein and carbohydrates supplies 4 calories, whereas **fat contributes 9 calories/gram**.

Vitamins

Adolescents—particularly girls, who eat roughly 25% fewer calories per day than boys—tend to fall short of their daily quotas of vitamins and minerals. Calcium, iron and zinc are most vulnerable.

Calcium:

Adolescence provides a window of opportunity for avoiding osteoporosis later in life. During the teenage years, the growing bones absorb more calcium from the blood than at any other time of life. By early adulthood, our bones stop accepting deposits, and not long after, the gradual loss of calcium begins.

In a clinical study sponsored by the National Institute of Child Health and Human Development, one group of teenage girls received daily supplements containing extra 500 mg calcium; the other group's calcium came strictly from food. The girls who were given supplements saw their bone density improve by 14%. Each 5% increase in bone mass reduces the risk of suffering a bone fracture by 40%.

The American Academy of Pediatrics recommends the following daily intake of calcium:

Age	Calcium Need (mg per day)	Servings of Milk to Meet Need
4–8 years	800	3 servings
9–18 years	1,300	4 servings
19–50 years	1,000	3–4 servings

Milk and milk products provide $\frac{3}{4}$ of the calcium in the American diet. Other foods contain calcium, like broccoli and collard greens. However, these vegetables also contain substances that impair the body's ability to absorb calcium, so that a teen would need to eat approximately 9 cups of broccoli a day to meet the recommended intake. Also consider calcium-fortified juice (no more than 8-12 oz/day!) and cereals.

Unfortunately, $\frac{2}{3}$ of adolescent girls in the US fail to meet the daily requirement for calcium. The NIH supports the use of supplements for young people who don't get sufficient calcium through their diet. For optimal absorption, no more than 500mg should be taken at one time.

Also remember that other factors can decrease calcium and impair bone health: excessive soda intake; vegan diets; caffeine, alcohol, and tobacco; certain medications (e.g. diuretics) and GI diseases (e.g. IBD).

Iron:

According to a national survey conducted by the USDA, three in four teenage girls' diets are deficient in this essential mineral, as compared to just one in five of their male counterparts. Adolescent girls are also prone to iron-deficiency due to menstrual losses.

Foods rich in iron include meats (beef, pork, lamb, liver); poultry (especially dark meat); fish; dark-green leafy vegetables (kale, collards, broccoli); legumes (lima beans, peas, dry beans); dried fruit (prunes, apricots, raisins); potatoes with skin; seeds (sunflower, pumpkin, squash); and whole-wheat breads.

Other points to keep in mind are, as follows: (1) the iron in meat, poultry, and fish is more readily absorbed than the iron in vegetables, beans, and grains; (2) vitamin C & citric acid in fruits promotes absorption of iron; (3) the tannins in tea can interfere with metabolism of non-heme (i.e. non-meat) iron.

Please review "Screening for Iron Deficiency" (*see Health Maintenance II*) for more information about the pathophysiology, evaluation, and treatment of iron-deficiency anemia.

Vegetarian Diets in Children and Adolescents

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Drs Renda and Fischer have disclosed no financial relationships relevant to this article. This commentary does not contain a discussion of an unapproved/investigative use of a commercial product/device.

Introduction

Vegetarianism is becoming more common among adults, with 1 in 40 adults currently choosing a vegetarian diet. Consequently, more children are raised as vegetarians. Vegetarianism is adopted for various reasons, including moral, religious, and health. Numerous studies have shown significant health benefits for individuals following this type of diet. Pediatricians should be well informed about vegetarianism and its role in our pediatric population.

Case 1

A first-time mother and her 2-month-old boy present to the clinic for a health supervision visit. The mother is breastfeeding, and her baby is growing appropriately. At the end of the visit, the mother mentions that she is a vegetarian and that she would like to raise her son in the same way. She would like to know what she should be doing as a breastfeeding mother and how she can make sure that her son has the appropriate nutrition in the future.

The physician should begin by taking a dietary history from the mother to determine what type of vegetarianism she practices. He or she should explain to the mother that her infant's nutrition is based on her own dietary intake for as long as she continues to breastfeed. The pediatrician should counsel the mother on the importance of diet variety. If the mother is vegan, the pediatrician must take time to ensure that she is getting enough vitamin B₁₂ and calcium in her diet. When she is ready to wean her infant, she should continue to focus on dietary variety. The mother should be cautioned that adult vegetarian diets that are high in bulk and low in calories are not always appropriate for the growing and developing child. Finally, the pediatrician should ensure that the mother has the appropriate resources to guide her in finding the best foods for her child's nutritional needs.

Initiating a Dialogue

When confronted with this scenario, it is most important to take a dietary history. Although this mother defines herself as a vegetarian, she did not specify what type of vegetarianism she practices (Table 1). In the simplest sense, a vegetarian eliminates animal-flesh foods and products from the diet (including fish). However, the definition can be delineated further. A lacto-ovo vegetarian consumes milk and egg products. A lactovegetarian consumes milk in addition to plant products. A vegan eliminates all animal and fish products. Recommendations for this mother depend on what form of vegetarianism she follows.

Comparing Human Milk Composition

For the first 6 to 12 months after birth, most babies are lactovegetarians. Their primary source of nutrition is milk, either from human milk or formula. Studies have shown that for the first 6 months, the human milk of a lacto-ovo vegetarian does not differ significantly from that of an omnivore. (1) Specifically, the composition of human milk between lacto-ovo vegetarians and omnivores is similar in minerals, trace elements, lactose, and total fat. Another study revealed that human milk from vegetarians has fewer environmental and indirect additives than that of nonvegetarians. (2)

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Table 1. Types of Vegetarianism

Semivegetarian
Includes poultry and fish
Lacto-ovovegetarian
Includes milk and egg products
Lactovegetarian
Includes milk products
Vegan
Eliminates all animal and fish products

Important Nutritional Considerations

Lacto-ovovegetarians and lactovegetarians (who consume milk or eggs or both in their diet) tend to be less deficient in certain elements than vegans, who eliminate all fish and animal products. Surprisingly, the human milk of poorly nourished women often has relatively adequate volume and composition. One hypothesis is that human milk composition is maintained to the detriment of the mother’s overall nutritional status. Regardless of the volume and composition, human milk of poorly nourished women may have fewer calories, water-soluble vitamins, calcium, and protein. (3) All vegetarians should pay special attention to the amount of vitamin B₁₂, folate, and omega-3 fatty acids that they consume. Vitamin B₁₂ and folate are important factors in protein and DNA synthesis as well as in growth and development of the brain and nervous system. Omega-3 fatty acids play a significant role in brain and retinal development. During times of growth and reproduction, requirements for these elements increase.

Vitamin B₁₂

Reliable sources for vitamin B₁₂ for the vegetarian include cereal, nondairy beverages, meat analogs, and supplements. It is important to read the labels to ascertain that the item has been fortified with vitamin B₁₂. If a vegan mother does not consume enough B₁₂-fortified foods or supplements, her infant receives 0.4 mcg/day of vitamin B₁₂ during the first 6 postnatal months and 0.5 mcg/day after 6 months of age. (4) Another reason that a breastfed infant might need to receive supplementation with vitamin B₁₂ is if the mother had an ileal resection. Removing this section of the bowel prevents the body from absorbing vitamin B₁₂.

Folate

Folate is found in enriched breads, pastas, cereals, green leafy vegetables, and orange juice. Interestingly, most vegetarians consume more than the recommended amount of folate. Although the addition of folate to fortified foods has helped to reduce the risk of neural tube defects in infants, folate can mask some of the hematologic changes that signal a vitamin B₁₂ deficiency. A vitamin B₁₂ deficiency that has been masked by folate may not be apparent until deleterious neurologic consequences already have occurred. (5)

Omega-3 Fatty Acids

Omega-3 fatty acids are important in all lactating women because they assist in brain and retinal development of nursing infants. However, they also serve a special role for vegetarians because they act as building blocks for the longer chain fatty acids docosahexaenoic (DHA) and eicosapentaenoic acid (EPA), which are found in fish. DHA and EPA are critical for brain and organ development in the fetus and newborn. A daily intake of 3 to 5 g of omega-3 fatty acids is adequate, based on a 2,000-kcal/day diet. However, lactating women (especially vegetarians) should consider supplementation with reliable sources of fatty acids. Omega-3 fatty acids can be found in walnuts, flax seed, hemp, dark greens, and tofu. Quality fish oil supplements and DHA-rich eggs also are available for consumption. (6)

Weaning Future Vegetarians

When weaning infants from human milk, it is important to ensure that they receive adequate nutrition. Dietary problems that stem from certain inadequacies are seen more often in children than in adults. Children have greater energy requirements relative to their body weight, and they are not always in control of what they eat. Many of the significant deficiencies seen in children occur because of inappropriate understanding and dietary choices by adults.

Vegetarian diets that are appropriate for adults are not always right for children. Adults tend to want to consume foods that are lower in caloric and fat content, yet high in bulk. The bulk ensures that the stomach feels full despite the adult consuming a lesser amount of calories and fat. A child who is 1 to 3 years of age has a stomach capacity of only 200 to 300 mL at each meal. Thus, problems ensue when high-bulk foods are eaten by children. Children may feel satiated quickly, even though they have not eaten an adequate amount of their nutritional requirements. (7)

When well-informed parents raise vegetarian children,

studies show that the children’s means for height for age, weight for age, and weight for height are close to the 50th percentile of the National Center for Health Statistics reference values. (8) Another study of vegetarian British children, ages 1 to 18 years, found heights, weights, and head and chest circumferences to be within normal range compared with those of nonvegetarian British children. (9)

Dietary Variety is the Secret to Success

When a vegetarian follows a well-rounded diet, the health benefits are numerous. In an analysis of five prospective studies examining mortality in vegetarians and nonvegetarians, vegetarians had a 24% decrease in ischemic heart disease. (10) Vegetarian children tend to be leaner and have lower relative body weights and skinfold thicknesses while retaining normal growth and maturation. (11) As food sources become increasingly fortified, it is easier and more convenient to provide vegetarian children with appropriate food elements. Parents should ensure that their children are receiving adequate amounts of vitamin B₁₂, folate, iron, and zinc (Table 2). Food also should be high in energy density without significant bulk.

Toddlers and preschool-age children tend to develop strong eating preferences, and it may be difficult to present a variety of foods to them each day. Patience, along with repeated exposure to unfamiliar foods, may help. When opting for prepackaged foods made with tofu or tempeh (fermented soy), it is important to read the nutritional information. Many of these processed foods tend to be high in fat, sodium, and calories, similar to nonvegetarian packaged foods.

Parents should make “whole plant food” the primary staple in their child’s diet. This element includes whole grain breads, pastas, cereals, tofu, soy, legumes, vegetables, and fruits. Legumes are a class of vegetables that includes a variety of beans, peas, and lentils. Nutrients in vegetables are preserved best when they are cooked with the least amount of heat, water, and time. Therefore, ideal cooking includes steaming vegetables in a small amount of water, stir-frying, and boiling in a bag. As mentioned, vitamin B₁₂ and folate are found in a variety of fortified cereals and breads. Iron can be found in dried fruits, legumes, nuts, and fortified foods. Zinc also is found in legumes, nuts, and whole grains.

Although protein can be a concern, plant foods provide more than 10% of their calories in the form of protein. Plant foods combined with meat substitutes such as soy and tempeh tend to provide adequate protein for the vegetarian child. The protein intake of vegan children has been shown to be similar to that of nonvegetarian children, and the intake also is higher than the recommended standard. (12)

Case 2

A new patient and his parents present to the clinic for a health supervision visit. The boy is 7 years old and has had appropriate growth and development. The parents are lacto-ovo vegetarians, and they have raised their son in the same way. As their son becomes older and more independent, they have concerns about his eating patterns and nutrition. They want to ensure that he makes appropriate food choices at school and at friends’ houses. They ask you for advice in ensuring that he continues to have appropriate nutrition now and in the future.

It is important to identify the parents’ reasons for being vegetarian as well as their reasons for raising their son as a vegetarian. It also is essential that the physician ask both the parents and child how each feels about being vegetarian. Although the boy is only 7 years old, he most likely is exposed to many different types of food while at school and friends’ homes. How have these experiences influenced his feelings about his daily diet? The physician should follow this discussion with a dietary history. If

Table 2. Nutrients and Food Sources

Protein
Tofu, tempeh, legumes, grains, eggs, dairy
Omega-3 Fatty Acids
Flax seed, dark greens, tofu, fish oil, nuts
Iron
Legumes, nuts, dried fruit, spinach, fortified grains
Calcium
Kale, broccoli, fortified orange juice, fortified soy, figs, dairy
Zinc
Whole grains, legumes, nuts, wheat germ, whole grain pasta
Folate
Legumes, dark green leafy vegetables, fortified cereals/breads
Vitamin B ₁₂
Fortified eggs, fortified dairy, cereals, breads, some fortified soy

additional education is needed to teach the family about appropriate nutrition, more time should be arranged to delve into this issue. The physician should ensure that this family has the appropriate resources available to them. Finally, the physician needs to begin to touch on the topics of independence and autonomy. Depending on how this boy feels about being a vegetarian, the physician may want to counsel the parents on ways that they can be accepting of their son regardless of whether he chooses to be vegetarian in the future.

Raising a School-age Vegetarian

From a nutritional standpoint, raising a school-age vegetarian is not very different from raising a younger vegetarian. These children require the same nutritional considerations as their younger counterparts, with particular attention paid to elements such as vitamin B₁₂, folate, omega-3 fatty acids, and protein. Dietary variety is the best way to ensure normal growth and development for vegetarian children.

Aside from the nutritional issues, however, many other aspects of vegetarianism during elementary school ages should be considered. Whereas the toddler or preschool-age child is still eating most of his or her meals at home, the school-age child often eats a large portion of his or her daily diet away from the home (school, extracurricular activities, friends' homes). Not only is it more difficult for parents to be in control of what their children are eating, but it also may be difficult for the child to make appropriate choices based on the foods that are available.

The school-age child places a great deal of interest and importance on fitting in among his or her social group. Acceptance in one's social group often depends on the ability to relate to other children and share in common experiences. If a vegetarian child is unable to share in common experiences, such as meals, this state may be distressing for the child and peers alike.

Finally, school-age children are just beginning to realize that children and families are not all similar to their own. Depending on school and social experiences, some vegetarian children may be exposed to many different foods that they have never encountered. Curiosity may cause vegetarian children to desire new foods, including meat products. If vegetarian children feel that they are unjustly restricted, or if the restriction causes them distress, they may begin to resent their vegetarian diets.

To identify and resolve issues related to school-age vegetarians, parents should determine how strongly they feel about reinforcing a vegetarian diet inside and outside of the home. As children enter school and become more

independent, some parents allow their children the freedom of dietary experimentation. Others may feel that a vegetarian diet takes precedence, regardless of the circumstances. Once a viewpoint has been determined, parents should include their children in a discussion that tackles the issues pertinent to school-age vegetarians.

Planning Ahead

Because of the many motivations and rationales for choosing vegetarianism, parents' discussions will differ among their children. Regardless of the differences, parents can be more prepared to work through specific issues if they have some universal tools at their disposal.

Following a vegetarian diet can be challenging to even the most experienced vegetarian. Despite advancing public awareness, vegetarian options are not always available; planning ahead is often necessary. This proves to be of greater consequence when a child is involved. The vegetarian school-age child always should leave the house with an appropriate meal or at least with a snack that he or she can eat if there are no vegetarian options. If peer inclusion is an issue, parents should think about packing vegetarian foods that mimic popular meat products (ie, veggie burger, soy nuggets). Children feel more included in peer groups if their meal appears similar.

Packing food for other situations may be more complex. If a vegetarian child is asked to dinner at a friend's house, the child and his parents may seem impolite if the child brings his or her own food. In this case, communication is the key. Once nonvegetarian parents understand the situation, they may be very accommodating in terms of offering food that is appropriate for the vegetarian child. On the other hand, some parents may welcome help from a vegetarian parent in terms of suggesting or packing appropriate foods. Parents of nonvegetarian children may be very agreeable to preparing foods for their vegetarian guest, but they may not know what to cook. Vegetarian parents can offer some basic education if they think other parents would be open to suggestions.

Although planning ahead can address many scenarios, parents and children should role-play to practice scripts that deal with unexpected situations. Role-playing is particularly useful because it may help parents understand what type of circumstance causes their children the most worry or apprehension. Acting out a few scenarios can do wonders in terms of quelling a school-age vegetarian's concerns regarding diet.

Finally, it is important for parents to discuss vegetarianism and nonvegetarianism in a way that does not place undue positive or negative values on either group. A common defense mechanism for parents of a vegetar-

ian child who is questioning his or her diet may be to speak of nonvegetarians negatively. This type of coping skill is detrimental because it accentuates the differences that already are of concern to the vegetarian child. It also may have a paradoxical effect in that the vegetarian child may have heightened negative feelings about his or her diet if the child feels that his or her parents have spoken negatively about a cherished friend or peer. Parents should attempt to discuss issues of diet with objectivity. In doing so, they will make their argument more effectively without alienating others.

Case 3

A 16-year-old girl returns to the pediatric clinic for her first health supervision visit in 5 years. When questions arise concerning her diet, she appears very defensive. She states that she became a vegetarian on February 16, approximately 2 months ago. She reluctantly shares that her diet consists largely of pasta, bagels, and “side dishes” from the family meal. She cites “animal cruelty” as her motivation to become a vegetarian.

The physician should begin by taking a dietary history as well as attempting to determine what prompted this teen to change her diet, remembering that adolescence is a unique period of development that may have played a role in this teen’s motivations. To provide the most comprehensive education regarding vegetarianism, the teen’s family should be included in the discussion whenever possible. The physician should ensure that the teen and her family have access to accurate resources that can provide them with important information. Finally, the physician should take the time to ensure that this teen’s decision to be vegetarian was not based on an underlying emotional problem, including an eating disorder.

Adolescent Vegetarians: A Unique Challenge

During adolescence, youth assert their independence, develop their self-identity, and build relationships with both sexes. Adolescent vegetarians should not be thought of as younger versions of adult vegetarians. The common adult explanations for a vegetarian diet include health, religious, familial, and cultural reasons. However, these motives do not always influence adolescents in the same way. Often, the decisions that adolescents make are related directly to their developmental needs and developmental stage. (13)

The most challenging of adolescent vegetarians is one who has been raised as an omnivore and who decides to change dietary habits independent of his or her family’s eating style. Of a sample adolescent population in Minnesota of just fewer than 20,000 individuals, 0.6% of

adolescents identified themselves as vegetarians. (14) The starting point for an appropriate dialogue with a teenage patient is similar to that of a breastfeeding mother: taking a dietary history. It is most important to ascertain what it means to this young woman to be a vegetarian. Similarly, how does she define and apply this form of diet in her own life?

The Typical Adolescent Vegetarian

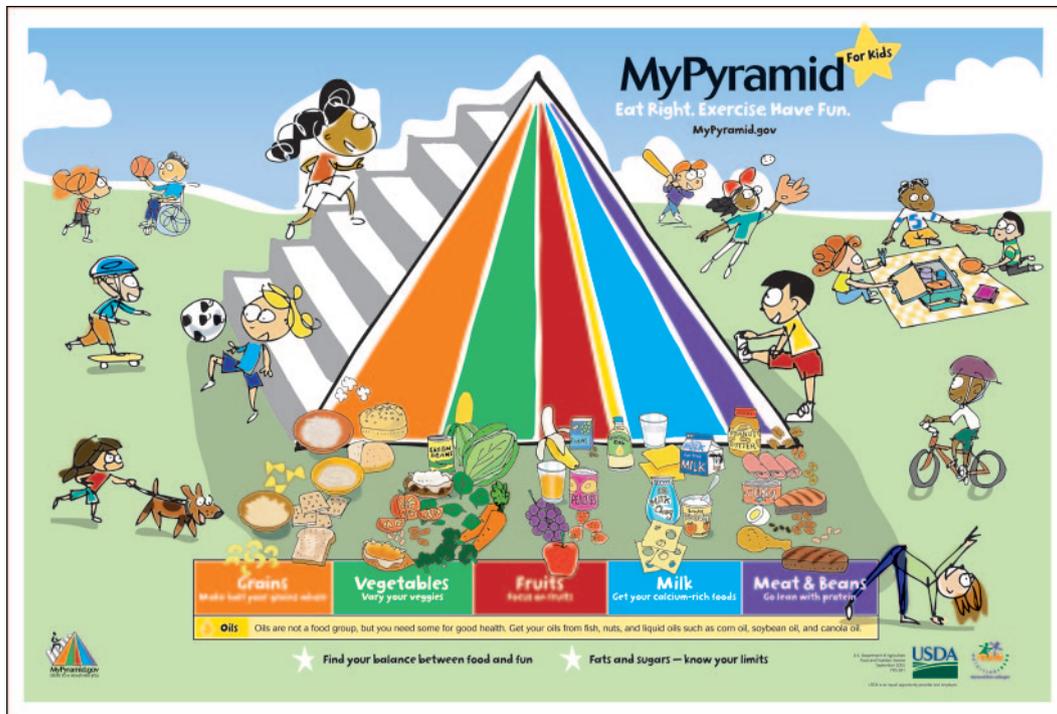
Most adolescent vegetarians tend to be female. In one study that investigated adolescent vegetarians in Minnesota, 81% of self-identified vegetarians were female, and only 19% were male. (14) Most often, adolescent vegetarians share negative feelings toward eating meat, feel strongly about animal cruelty, and place more importance on their appearance and environment. (13) Another common characteristic of adolescent vegetarians is that they engage in many positive behaviors. Adolescent vegetarians tend to consume more fruits and vegetables while consuming fewer sweet and salty snack foods. These youth also tend to weigh less than their nonvegetarian peers.

An important aspect of adolescence is that many decisions are made impulsively and without much consideration for the future. Consequently, positive aspects of vegetarianism also can lend themselves to negative or harmful behaviors. All vegetarians are at risk for nutritional inadequacies if they do not consume appropriate amounts of foods rich in protein, iron, calcium, and zinc. Adolescents are at even greater risk if their decisions to become vegetarian were sudden and without proper attention to necessary details and information.

The adolescent patient in this case revealed a distinct date in history when she changed her eating habits. Her sudden dietary changes, as well as her current food choices, imply that her decision was not well researched. If she were to continue to eat the foods that she describes (pastas, bagels, and “side dishes”), she would be at risk for specific nutritional deficiencies. However, adolescents frequently have difficulty imagining the future, and it can be challenging to impress on them future consequences. Regardless, efforts should be made to prepare them for the future because adolescents will be in charge of all their dietary choices once they leave the home for college or employment.

The Vegetarian Food Guide Pyramid, a New Model

To capitalize on positive benefits and minimize negative consequences, it is important that adolescent vegetarians receive appropriate counseling and guidance regarding



"My Pyramid" is now obsolete, replaced by "My Plate."

Figure 1. The Food Guide Pyramid.

their dietary choices. One of the challenges in providing appropriate information is the limited number of easily accessible models that demonstrate what foods are important and how they should be applied to the diet. Most adolescents are familiar with the Food Guide Pyramid, a model that shows how nutritional guidelines and requirements fit into one's daily food choices (Fig. 1). The difficulty in using the Food Pyramid as a guide when talking to vegetarian adolescents is that it targets a population of omnivores. Thus, the nutritional standards are based on a nonvegetarian diet. (15)

There are adaptations of the food guide to account for vegetarianism. One example is the United States Department of Agriculture's Food Guide Pyramid. In this guide, flesh foods are eliminated from the protein food group. Unfortunately, this guide does not take into account that some vegetarians exclude all animal and fish products. Therefore, dairy products and eggs also should be eliminated. Additionally, the proportions of the pyramid no longer are appropriate because certain staple foods have been removed without accounting for relative proportions or nutrient composition.

When presented with accurate information, vegetarians can fulfill all of their nutritional requirements in all stages of life. Many individuals would like to become vegetarians because they are aware of the health benefits.

However, these individuals are at a loss as to how to make the transition when there are no appropriate and easily accessible guides.

Recently, a Vegetarian Food Guide Pyramid was introduced to the United States Congress by organizers of the Third International Congress on Vegetarian Nutrition (Fig. 2). (15) The bottom tiers of the pyramid consist of the five major plant-based food groups: whole grains, legumes, vegetables, fruits, nuts, and seeds. At the top of the pyramid are the foods that may or may not be included in a vegetarian diet: vegetable oil, dairy, eggs, and sweets. The hope is that this provisional guide will motivate additional research and development of future guides. (15)

Involving the Family

Another opportunity to counsel adolescent vegetarians comes about because of an adolescent's impulsivity. Sudden changes in diet for newly converted adolescent vegetarians often are not accompanied by a change in their families' eating habits. Many families tend to be accepting of their child's new eating habits, but provisions are not always made to help the child receive the nutrition that he or she needs. The new vegetarian adolescent described in the case reports eating "side dishes" at the family meal. The most common reason for eating only

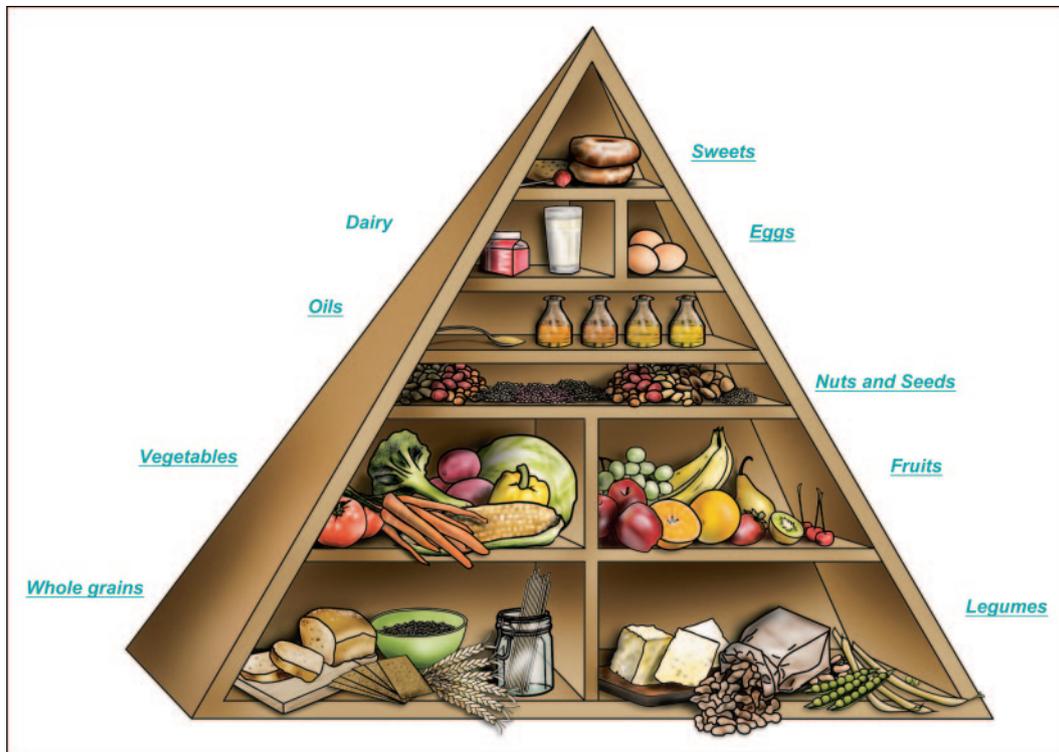


Figure 2. Vegetarian Food Guide Pyramid, depicting the specific food groups that may be included in a vegetarian diet along with the appropriate food proportions for each food group. The Dairy, Eggs, and Sweets categories are optional. Modified from Haddad et al. (15)

“side dishes” is that the main dish usually is an animal or fish product. Many families assume that their vegetarian child is going through a phase and soon will return to a meat-based diet.

Although most adolescents no longer depend solely on their families for food, it still is important to educate

parents and siblings about vegetarianism and available resources (Table 3). Families should not be expected to change their eating habits, but it is important that appropriate foods be available for the vegetarian child. Well-informed parents can guide vegetarian adolescents who are having difficulty adapting to their new dietary restrictions. Vegetarian adolescents commonly eat foods out of convenience, such as pasta and bagels. It is important to stress that these foods may be meatless, but they do not provide adequate nutrition. It also is important to stress that adolescent vegetarians need to be aware of nutritional information for preprepared vegetarian meals. Vegetarians often have the misconception that certain foods must be healthy because they contain products such as tofu or tempeh. As with any food, assessing nutritional information concerning fat, sodium, calories, and sugar is important.

Potential Disorders in the Adolescent Vegetarian

An important point that often can be the most difficult to elicit is whether an adolescent’s choice to be a vegetarian is a form of restriction. Is it possible that vegetarianism

Table 3. Available Resources

United States Department of Agriculture MyPyramid.gov
Local Farmers' Markets http://www.ams.usda.gov/farmersmarkets/
Vegetarian Resource Group www.vrg.org
Vegetarian Children and Adolescents Vegetarianteen.com
Vegetarian Restaurants Around the World Vegdining.com

could be disguising an underlying eating disorder? A recent study of adolescents in Minnesota showed that adolescent vegetarianism may be a red flag signaling underlying issues of unhealthy attitudes and weight control. Interestingly, the youth in this study cited wanting to lose or not gain weight as their primary reason for being vegetarians. (13)

This study also found several “sex/vegetarian-status interactions.” Male vegetarians were much more likely than nonvegetarian males to be overly concerned about weight and body image. Adolescent vegetarian males warrant additional screening and counseling to ensure that their dietary choices are not concealing a larger issue.

Another interesting distinction was found between semivegetarians (those who eat fish and chicken) and restricted vegetarians (those who eliminate meat and fish). Restricted vegetarians were more likely to have healthful attitudes toward weight issues, and they also were more likely to engage in physical activities. They appeared more secure and had followed a vegetarian diet for at least 2 years. Semivegetarians commonly had inconsistent eating patterns and harmful weight control measures. (13)

Although adolescent vegetarianism can be a marker for an underlying disorder, it is important to remember that adult vegetarianism is associated with many health benefits. It is important for physicians to teach adolescent vegetarians how to eat in a healthy manner so they can benefit from the positive health effects that have been documented so strongly in their adult counterparts.

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Summary

Vegetarian diets can provide appropriate and adequate nutrition for all stages of life. The key to success is accurate information and understanding of the subject matter. Because vegetarianism is a complex issue influenced by many different factors, it can be difficult to stay well informed. Numerous studies have shown several important health benefits for adult vegetarians. The job of pediatricians is to ensure that their pediatric patients reap the same health benefits as adults.

- Based on strong research evidence, breastfeeding vegetarians should ensure that they are consuming adequate amounts of vitamin B₁₂, folate, and omega 3 fatty acids. (4)(5)(6)
- Based on strong research evidence, vegetarian children raised on a varied diet have normal growth and development measures. (7)(8)(9)(10)(11)(12)(16)
- Based on strong research evidence, adolescent vegetarians choose vegetarianism for very different reasons than their adult counterparts, and their decision often is impulsive and without much forethought. (13)(14)
- Based on strong research evidence, a food guide pyramid that is specific to vegetarians and takes into account the many subtleties of vegetarianism is important when counseling vegetarian patients. (15)
- Based on strong research evidence, vegetarianism in adolescents can be a means of concealing an underlying eating disorder. (13)

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Eating Disorders

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Educational Gap

For patients with moderate malnutrition, higher-calorie diets during refeeding may provide benefits, such as less initial weight loss, faster weight gain, and shorter hospitalization, without increasing the risk of refeeding syndrome. (1)(2)(3)

Objectives After completing the article, the reader should be able to:

1. Understand the differences between *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5) and prior diagnostic criteria for eating disorders.
2. Recognize clinical presentations characteristic of anorexia nervosa, bulimia nervosa, and binge-eating disorder.
3. Plan appropriate management for anorexia nervosa, bulimia nervosa, and binge-eating disorder.
4. Distinguish avoidant/restrictive food intake disorder from other eating disorders.

INTRODUCTION

Eating disorders are complex illnesses with profound psychosocial and physical consequences, including high rates of mortality. Despite growing recognition of their prevalence and severity, eating disorders remain underdiagnosed and undertreated. This review provides up-to-date information on eating disorder diagnosis, including tips for early recognition and evaluation, along with an overview of potential complications and evidence-based treatments. Pediatricians, in particular, play an important role in providing patients and their families with the care, resources, and guidance they need to reach and maintain recovery.

EATING DISORDERS IN THE CONTEXT OF DSM-5

Eating disorder presentation and severity varies widely among individuals. In developing the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5), (4) one of the primary goals of the Eating Disorder Work Group was to better describe the spectrum of patient behaviors. Previous editions of DSM only specified 2 eating disorders, anorexia nervosa and bulimia nervosa,

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with more than 50% of patients grouped into the category of Eating Disorders Not Otherwise Specified (EDNOS). The DSM-5 Feeding and Eating Disorders chapter includes 6 entities: anorexia nervosa, bulimia nervosa, binge-eating disorder, avoidant/restrictive food intake disorder (ARFID), rumination disorder, and pica. In addition, DSM-5 replaces EDNOS with the categories: 1) Other Specified Feeding or Eating Disorder, which specifies subcategories for patients who do not meet full criteria for other eating disorders; and 2) Unspecified Feeding or Eating Disorders, which encompasses any other concerning presentation suggestive of an eating disorder. This review focuses on anorexia nervosa, bulimia nervosa, and binge-eating disorder, along with a brief overview of ARFID. Please refer to the recent *Pediatrics in Review* article entitled “Managing Feeding Problems and Feeding Disorders” for additional information on ARFID, pica, and rumination disorder.

The case studies illustrate prototypical cases in our clinical practice. We have included these cases as educational examples. However, pediatric patients often do not present typically, and their diagnoses may evolve from 1 DSM category to another over time. Thus, their treatment may be more nuanced than what can be represented in this review. This set of challenges highlights the need for a trained therapy team partnering with the pediatrician to provide optimal care.

ANOREXIA NERVOSA AND ATYPICAL ANOREXIA NERVOSA

Case

A 14-year-old girl is admitted for severe bradycardia, with a resting heart rate of 39 beats per minute and QTc of 476 msec (normal QTc \leq 450 msec). Her weight has decreased from 61.2 kg to 50 kg in the last 6 months after adopting a vegan diet and increasing her running regimen. She has recently experienced worsening constipation and irregular menses. Her growth trajectory has been at the 25th percentile for height and 60th percentile for weight since 5 years of age, but in the past 6 months her height has stayed at the same percentile but weight has decreased to the 28th percentile. At her annual health supervision visit last year, her pediatrician had counseled her on the need for weight loss and a healthy lifestyle.

On physical examination, her body mass index (BMI) is 19.4 (33% of expected). Other findings on physical examination are normal, as are results of laboratory tests, with the exception of a serum magnesium measurement of 1.5 mEq/L (0.75 mmol/L) (normal, 1.7-2.6 mEq/L [0.85-1.3 mmol/L]).

On her first hospital day, the girl initially refuses her meal, expressing concerns over weight gain. She is offered

the options of 2 high-caloric nutritional supplements orally or by nasogastric tube. After one look at the NG tube, she chooses the oral supplements and finishes them within the specified 30-minute time period as per the hospital’s care path. She consumes all subsequent meals in their entirety. For the rest of her hospital stay, she experiences steady weight gain of approximately 0.2 kg per day, with QTc correcting to 434 msec on hospital day 5 and heart rate maintained above 50 beats per minute when awake and above 40 beats per minute when asleep by hospital day 5. She remains mildly orthostatic by pulse (64 beats per minute supine, 90 beats per minute standing). She is discharged that day to an outpatient family-based treatment (FBT) program.

DSM-5 Characteristics

Anorexia nervosa is characterized by severe caloric restriction due to a fear of weight gain and a disordered body image, resulting in low body weight. DSM-5 retains these core characteristics but expands the diagnostic criteria to accommodate a wider range of individuals (Table 1). Unlike DSM-IV criteria, DSM-5 does not include a requirement for amenorrhea, increasing the applicability of the diagnosis in males, premenarchal females, and postmenopausal females. Other changes include alterations in wording, particularly the replacement of a specific weight criterion (<85% expected body weight) with a broader statement that allows clinicians to assess weight based on individual growth trajectory as well as numerical guidelines. In addition, the phrase “refusal to maintain weight” was removed and an alternative behavioral criterion (“persistent behavior that interferes with weight gain”) was added to avoid making assumptions about the patient’s intentions.

Anorexia nervosa most commonly occurs in adolescent and young adult females, although the disorder is also seen in males and other age groups. The prevalence of DSM-5 anorexia nervosa is approximately 1% among female adolescents, with no current estimates for males. Previous estimates using DSM-IV criteria suggested the male-to-female ratio as between 1:3 and 1:12, although additional studies are needed to determine how DSM-5 affects this ratio.

CLINICAL APPROACH TO SUSPECTED EATING DISORDERS

Regardless of a patient’s physical appearance or weight, annual visits as well as any visit with a parental concern for weight loss or gain should include questions about diet and body image. When a clinician suspects an eating disorder, this discussion should be more in-depth (Table 2), including questions regarding specific disordered thoughts and behaviors as well as other aspects of the history, such as menstrual,

TABLE 1. **DSM-5 Diagnostic Criteria for Anorexia Nervosa (4)**

A. Restriction of energy intake relative to requirements, leading to a significantly low body weight in the context of age, sex, developmental trajectory, and physical health. <i>Significantly low weight</i> is defined as a weight that is less than minimally normal or, for children and adolescents, less than that minimally expected (e.g., falling off a previously followed growth curve).
B. Intense fear of gaining weight or of becoming fat or persistent behavior that interferes with weight gain, even though at a significantly low weight.
C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or persistent lack of recognition of the seriousness of the current low body weight.
Types:
Restricting type: During the last 3 months, the individual has not engaged in recurrent episodes of binge eating or purging behavior (i.e., self-induced vomiting or misuse of laxatives, diuretics, or enemas). This subtype describes presentations in which weight loss is accomplished primarily through dieting, fasting, and/or excessive exercise.
Binge-eating/purging type: During the last 3 months, the individual has engaged in recurrent episodes of binge eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).

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psychiatric, and family history, that may provide further insight into patient risk factors. Of note, patients with eating disorders, particularly anorexia nervosa, may have anosognosia (a lack of self-awareness about their disordered behaviors) as well as alexithymia (a lack of ability to describe their emotions). Input from parents and other family members is, therefore, essential to clarify changes in patient behavior and emotional state. Several screening questionnaires are also widely used, including the SCOFF questionnaire, the Eating Disorders Examination-Questionnaire (EDE-Q), and the Female Athlete Screening Tool (FAST).

Some behaviors addressed in the interview may not have occurred to a child or adolescent, such as self-induced vomiting. When asking questions about these behaviors, motivational interviewing skills may help to avoid the development of new behaviors. For example, when asking about vomiting, the clinician can follow the question with an educational pearl such as, "Individuals who vomit intentionally may not realize that this behavior can actually result in long-term weight gain because your body thinks it has to 'store up nuts for the winter' to survive future episodes of vomiting."

Clinical evaluations of adolescents should always include measurements of both weight and height, including assessments in the context of the growth curve to identify changes in growth trajectory. In some cases, an adolescent may withhold information during the history, and changes in weight or growth may provide the primary clue to a developing or established problem. Other physical findings suggestive of an eating disorder are summarized in Table 3, although many patients have no overt physical findings. Binge-eating disorder, in particular, rarely presents with physical findings other than possible weight gain.

Most laboratory tests yield normal results in patients with eating disorders, but they may provide insight into the severity of illness, current medical complications, or other possible ideologies. Conversely, normal laboratory values may falsely reassure families or clinicians; imminent decompensation (eg, cardiac ventricular tachydysrhythmias resulting in sudden cardiac death) can occur despite recent normal laboratory results. Initial laboratory evaluation should include a complete metabolic panel that includes serum electrolytes, magnesium, and phosphorus; liver function tests; blood urine nitrogen; creatinine; complete blood cell count; urinalysis; and thyrotropin assessment. For patients with amenorrhea, additional tests should include serum luteinizing hormone (LH), follicle-stimulating hormone (FSH), and prolactin and, if amenorrheic for more than 6 months, evaluation of bone mineral density. In patients with obesity, a fasting lipid panel, insulin measurement, and fasting glucose may help to detect chronic comorbidities.

Electrocardiography should be obtained when a patient presents with bradycardia (heart rate <50 beats per minute), abnormal rhythm, palpitations, and chest pain or when the clinician detects a high risk of electrolyte imbalance. When evaluating bradycardia, families or clinicians may confuse an "athlete's heart" with an undernourished heart. On electrocardiography, an athlete's heart produces a healthy voltage due to the large amount of muscle that depolarizes and repolarizes with each beat. An undernourished heart, on the other hand, produces a low voltage due to heart muscle loss during starvation. This visual display may provide concrete evidence of the medical challenges created by the disordered eating for patients and families.

TABLE 2. **Example Questions to Ask Adolescents with a Possible Eating Disorder**

Weight History	<ul style="list-style-type: none"> • What was your highest weight? How tall were you? How old were you? • What was your lowest weight? How tall were you? How old were you? • What do you think your weight should be? What feels too high? What feels too low?
Body Image	<ul style="list-style-type: none"> • How much of your day is spent thinking about food or your body? • Are there body areas that cause you stress? Which areas? Do you do any body checking (ie., weighing, body pinching or checking, mirror checking)?
Diet History	<ul style="list-style-type: none"> • 24-hour diet history • Do you count calories/fat/carbohydrates? How much do you allow? What foods do you avoid? • Do you ever feel guilty about eating?
Exercise History	<ul style="list-style-type: none"> • Do you exercise? What activities? How often? How intense is your workout? • How stressed do you feel when you are unable to exercise?
Binge Eating and Purging	<ul style="list-style-type: none"> • Do you ever binge? On what foods? How much? How often? Any triggers? • Do you vomit? How often? How soon after eating? • Do you use laxatives/diuretics/diet pills/caffeine? What types? How many? How often?
Reproductive Health	<p>Females:</p> <ul style="list-style-type: none"> • When was your first period? Are they regular? • When was your last period? How much did you weigh? <p>Males:</p> <ul style="list-style-type: none"> • How is your libido? • Do you get morning erections? Has that changed?
Psychiatric History	<ul style="list-style-type: none"> • How is your mood? Any anxiety, panic attacks, obsessive-compulsive disorder, depression, self-injury? • Have you ever wished you didn't exist? When was that and how often? Any thoughts of suicide? What methods have you imagined? Past attempts? • Any prior therapy?
Substance Use	<ul style="list-style-type: none"> • Have you ever used tobacco, alcohol, or drugs? Which ones? How much? How often? Any blackouts or passouts? • Have you ever used steroids or stimulants? Caffeine consumption? Other substances?
Family History	<ul style="list-style-type: none"> • Does anyone in your family have a history of an eating disorder, obesity, or dieting? • Does anyone with a history of depression, anxiety, bipolar disorder, obsessive-compulsive disorder, substance abuse, or other psychiatric illness?
Review of Systems	<ul style="list-style-type: none"> • Dizziness, syncope, weakness, fatigue? • Pallor, easy bruising/bleeding, cold intolerance? • Hair loss, lanugo, dry skin? • Constipation, diarrhea, early fullness, bloating, abdominal pain, heartburn? • Palpitations, chest pain? • Muscle cramps, joint pains? • Excessive thirst and voiding?
HEADS Questions	<ul style="list-style-type: none"> • Home: Who lives at home? What happens when there is an argument in the home? • Education: What grade are you in school? How are your grades? • Activities: What activities do you participate in? • Drugs: See Substance Use • Sexual activity: Are you attracted to guys, girls, or both? Have you ever had sex? If yes, with guys, girls, or both? Oral, vaginal, anal? Condoms used sometimes, all the time, not at all? Second method of contraception used (for heterosexual sex)? History of sexually transmitted illnesses? Any unwanted sexual contact ever? Physical or emotional abuse? • Suicide/Depression: See Psychiatric History • Social media: How much/where do you spend time online?

Other studies, such as radiographic imaging or gastrointestinal endoscopy, may be performed if the clinician is uncertain about the diagnosis, and considerable evidence supports their utility. For example, if the clinician strongly suspects gallbladder disease, imaging in a patient with an eating disorder is likely only to show an abundance of stool but no pathology. Table 4 lists other conditions that can lead

to weight loss, vomiting, or binge eating that should be considered when assessing an individual with these concerns.

Medical Complications

In the starvation state, the body adapts by slowing metabolism and decreasing energy requirements wherever possible. As undernutrition persists, the body is unable to

TABLE 3. Potential Physical Examination Findings in Eating Disorders

SYSTEM	PHYSICAL FINDINGS
Vital signs	Bradycardia, hypotension, orthostatic hypotension, hypothermia
Weight and growth	Body mass index, body weight percentile, growth trajectory changes
Head	Parotid gland swelling; enamel erosion, especially of lingual and occlusal surfaces; dental caries
Chest	Arrhythmia
Abdomen	Palpable stool, bloating, abdominal pain
Extremities	Edema, muscle atrophy, weakness
Skin	Dry skin, hair loss, lanugo, acrocyanosis

maintain its regular functions, and complications develop in nearly every system, with increasing risk of death. Eating disorders have the highest mortality of any mental illness. Many of the medical complications of eating disorders improve and ultimately reverse with nutritional rehabilitation. Some complications, however, such as low bone mineral density, growth retardation, and structural brain changes, may not fully normalize after prolonged disease.

Cardiovascular changes, including severe bradycardia, hypotension, and orthostatic hypotension, occur frequently in patients with restrictive eating disorders, including anorexia nervosa and atypical anorexia nervosa. Bradycardia, QTc prolongation, and electrolyte abnormalities are the most common reasons for hospitalization. Patients, particularly those who vomit, often present with fluid and electrolyte abnormalities that may cause or contribute to cardiac complications. Gastrointestinal complaints occur commonly when the body tries to compensate for insufficient nutritional intake by slowing gastric motility, leading to increased constipation, bloating, and abdominal discomfort. Complications in the endocrine system may include euthyroid sick syndrome (low total and unbound triiodothyronine values with normal thyroxine and thyrotropin values), an adaptive response to starvation. Girls may have amenorrhea with decreased FSH, LH, and estradiol concentrations, and boys may have low testosterone concentrations. Prepubertal patients may experience delayed puberty and growth retardation, and older patients with suppressed hypothalamic-pituitary-gonadal axes may fail to deposit bone, leading to osteopenia and increased risk of stress fractures. Patients with restrictive eating disorders may develop pancytopenia, with white blood cell loss first, anemia second, and platelet suppression last. Closer examination of the bone marrow can reveal an increase in

fat deposition in the hypocellular matrix despite loss of fat elsewhere in the body during prolonged starvation. In the brain, weight loss is associated with decreased brain tissue (both white and gray matter), reduced brain activity, and mood changes. Psychomotor retardation, or slowing of speech, thought, and movement, may occur with prolonged starvation. Patients may have deficits in concentration, ability to focus, and memory. Although some patients may continue to perform exceptionally well in school, others may show declining academic performance with ongoing undernutrition.

Of note, patients with atypical anorexia nervosa can have a similar risk of sudden cardiac death due to prolonged QTc syndrome, bradycardia, and other arrhythmias as those who have a more classic picture of anorexia nervosa. Precipitous weight loss in an obese patient may be underrecognized or even celebrated by friends, family, and a medical team, not realizing the medical consequences caused by abnormal eating attitudes and behaviors. Medical risks are underrecognized in patients such as the girl in the case, especially in light of her normal BMI and seemingly reasonable weight for

TABLE 4. Differential Diagnosis for Weight Loss, Vomiting, and Binge Eating

Weight loss
• Celiac disease
• Inflammatory bowel disease
• Malabsorption
• Hyperthyroidism
• Addison disease
• Acquired immunodeficiency syndrome
• Occult malignancies
Vomiting
• Migraine
• Pseudotumor cerebri
• Hydrocephalus
• Central nervous system malignancy
• Gastrointestinal disease
• Cyclic vomiting
Binge eating
• Obesity
• Major depressive disorder
• Borderline personality disorder
• Prader Willi syndrome
• Kleine-Levin syndrome

height. Loss of heart muscle and life-threatening arrhythmias do not require the occurrence of an exceptionally low weight.

Refeeding and Refeeding Syndrome

The foremost treatment for restrictive eating disorders is nutritional rehabilitation or “refeeding.” Refeeding can often take place in the outpatient setting, but when a patient is medically or psychologically unstable, initial refeeding should occur in the hospital setting to prevent additional complications. Table 5 provides guidelines for hospital admission for patients with eating disorders. One of the most feared complications of refeeding is “refeeding syndrome,” a life-threatening condition characterized by widespread organ dysfunction related to failure to make adequate adenosine triphosphate (ATP). Prior to refeeding, prolonged undernutrition decreases blood glucose concentrations, resulting in catabolism of fat and protein stores and depletion of intracellular electrolytes, including phosphorus. During refeeding, rising glucose concentrations stimulate insulin secretion, which causes phosphorus to move into cells to create more ATP for metabolism. Because phosphorus concentrations are already low from prolonged undernutrition, this process can lead to insufficient amounts within 12 to 72 hours of initiating refeeding. Without adequate ATP, every system in the body is prone to failure.

Traditional approaches to refeeding assume that a “start low, advance slow” approach to caloric replenishment can prevent refeeding syndrome. Increasing evidence, however, suggests that higher-calorie diets may have benefits without increasing the risk of refeeding syndrome. In 2010, Whitelaw et al (1) demonstrated the safety of initiating refeeding with diets of 1,900 kcal or higher. Two recent studies by Garber et al (2) and Golden et al (3) also demonstrated that higher-calorie interventions (approximately 1,400 to 2,400 kcal) decreased length of hospitalization compared to lower-calorie interventions (approximately 800 to 1,300 kcal) without increasing the incidence of hypophosphatemia in adolescents with moderate malnutrition. Clinical care paths have been used to standardize care in nutritionally depleted patients with eating disorders, with feeding initiated at 1,900 to 2,400 kcal daily. (6) Despite recent advances, an optimal approach to refeeding has yet to be established, and refeeding syndrome continues to be a risk. General guidelines recommend aiming for weight gain of 1.0 to 1.5 kg per week in inpatients (0.2 to 0.5 kg per week in outpatients) and regularly monitoring for and correcting electrolyte shifts.

Therapeutic Approach

Options for care in medically stable patients range from long-term residential care to day treatment programs to

TABLE 5. **Criteria for Hospital Admission for Patients with Eating Disorders (5)**

- Heart rate <50 beats per minute while awake
- Heart rate <45 beats per minute while asleep
- Systolic pressure <90 mm Hg
- Temperature <35.6°C (96°F)
- Prolonged QTc or other arrhythmia
- Orthostatic changes in blood pressure (>10 mm Hg)
- Orthostatic changes in pulse (>20 beats per minute)
- Syncope
- Electrolyte abnormalities
- Esophageal tears or hematemesis
- Intractable vomiting
- Suicide risk
- Weight <75% of expected body weight or body fat <10%
- Ongoing weight loss despite intensive management
- Acute weight loss and food refusal
- Failure to respond to outpatient treatment

individual, group, or family therapies. Although site of care depends on multiple factors, including the patient’s physical condition, psychiatric stability, and social circumstances, treatment outcomes are generally superior in the outpatient setting. Treatment typically requires a multidisciplinary team, including physicians, registered dietitian nutritionists, and therapists, trained in the management of eating disorders. The pediatrician, as a member of the treatment team, is responsible for monitoring patients for medical complications that may require additional interventions and for signs of physical recovery or relapse, such as interval weight gain or loss. In addition, as a potential leader of the treatment team, the pediatrician is often responsible for educating patients and their families on available therapies, connecting patients with other team members, and encouraging regular communication within the team to ensure unified care. Failure to recognize disease or relapse can lead to a prolonged course of illness. Similarly, failure to gain weight in the first month of illness for patients with restrictive eating disorders corresponds with a lower likelihood of recovery at 1 year. The pediatrician can play a key role in ensuring that patients and families find the level of care appropriate to meet their needs.

Common psychotherapies used to treat patients with anorexia nervosa include cognitive behavioral therapy (CBT), which focuses on changing negative patterns of

thinking and behavior; dialectic behavioral therapy (DBT), which combines principles of CBT with insight plus techniques for emotional regulation; and FBT, which incorporates the family into treatment. Growing evidence suggests that FBT, also known as the Maudsley approach, is the most effective treatment for adolescents with anorexia nervosa. (7) This type of therapy involves 3 phases of treatment: giving the family complete control over the patient's food choices to facilitate weight restoration (Phase I), returning control gradually back to the patient (Phase II), and addressing other issues of adolescent development (Phase III). Weight gain in the first month is predictive of success with the Maudsley approach. Useful websites for parents include www.maudsleyparents.org, Families Empowered and Supporting Treatment of Eating Disorders (www.feast-ed.org), and the National Eating Disorders Association (www.nationaleatingdisorders.org) as well as the excellent article by Kaztman et al. (8)

Data on the therapeutic benefits of pharmacotherapy for patients with anorexia nervosa are limited, particularly for adolescents. The World Federation of Societies of Biological Psychiatry conducted a systematic review of studies on the pharmacologic treatment of eating disorders between 1977 and 2010. (9) Based on 20 randomized, controlled trials primarily in adult patients with anorexia nervosa, the authors concluded that Grade B evidence (ie, limited positive evidence from controlled studies) exists for the use of olanzapine for weight gain, with less evidence for other second-generation antipsychotics. No clear evidence supports the use of antidepressants to promote weight gain in patients with anorexia nervosa, although they may help with depressive symptoms, anxiety, or obsessive-compulsive tendencies. In general, when considering pharmacologic therapy, clinicians should weigh the adverse effects against the potential benefits of the medication on both eating disorder pathology and comorbid psychiatric symptoms.

Prognosis

The prognosis for anorexia nervosa varies, based on the type of therapy. Approximately 33% of patients achieve recovery by 5 years with traditional treatments. With FBT, however, the rate of full recovery increases to 50% by 1 year. (10) Lock et al (10) defined recovery as normal weight ($\geq 95\%$ of expected for sex, age, and height) and mean global Eating Disorder Examination score within 1 standard deviation of published means. Good outcomes are associated with shorter durations of illness and positive parent-child relationships, whereas poor outcomes are associated with greater weight loss, purging behaviors, and psychiatric comorbidity. Anorexia nervosa has the highest rate of mortality of any mental illness.

Patients with anorexia nervosa are 5 times more likely to die prematurely and 18 times more likely to die via suicide. (11) Adolescents generally have better outcomes than adults, emphasizing the importance of early recognition and treatment to promote recovery and prevent complications, including death.

BULIMIA NERVOSA

Case

A 16-year-old girl is brought to her pediatrician by her parents after they discovered her forcing herself to vomit in the bathroom. She has a history of alcohol use and self-harm (cutting). Physical examination findings include a BMI of 22 (111% of expected), mild parotitis, and mild erosion of her tooth enamel. Laboratory tests document hypokalemia with a potassium value of 3.3 mEq/L (3.3 mmol/L). Following potassium supplementation and a brief hospitalization, the patient is enrolled in a day treatment program that utilizes both CBT and DBT. She is prescribed fluoxetine along with psychotherapy but continues to struggle with daily binge eating and self-induced vomiting. Her behaviors decrease in frequency but she drops out of treatment before complete abstinence. After a 3-year hiatus, she returns after being forced to leave college due to her identified purging behaviors.

DSM-5 Characteristics

Patients with bulimia nervosa engage in recurrent episodes of binge eating and compensatory behaviors, such as self-induced vomiting or laxative abuse, to prevent weight gain. Unlike patients with anorexia nervosa, who may also engage in binge eating and purging episodes, patients with bulimia nervosa may have normal or above-normal body weights. The primary change in the diagnostic criteria for bulimia nervosa in DSM-5 is a reduction in the frequency of binge-purge episodes from an average of twice a week to an average of once a week for 3 months (Table 6). The prevalence of bulimia nervosa, approximately 3% in female adolescents using DSM-5 criteria, peaks in late adolescence and young adulthood. Bulimia nervosa is far less common in males, with an estimated 1:3 to 1:18 male-to-female ratio using DSM-IV criteria.

Medical Complications

Most medical complications associated with bulimia nervosa are due to purging behaviors. Electrolyte abnormalities are the most common reasons for hospitalization in patients with bulimia nervosa who vomit or abuse laxatives, diuretics, or other weight loss substances. Patients who vomit may present with metabolic alkalosis, hypochloremia, and/or hypokalemia, potentially resulting in life-threatening cardiac

TABLE 6. DSM-5 Diagnostic Criteria for Bulimia Nervosa (4)

- A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:
1. Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than what most individuals would eat in a similar period of time under similar circumstances.
 2. A sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating).
- B. Recurrent inappropriate compensatory behaviors in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, or other medications; fasting; or excessive exercise.
- C. The binge eating and inappropriate compensatory behavior both occur, on average, at least once a week for 3 months.
- D. Self-evaluation is unduly influenced by body shape and weight.
- E. The disturbance does not occur exclusively during episodes of anorexia nervosa.

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arrhythmias. Laxative abuse may similarly lead to hypokalemia as well as metabolic acidosis. Persistent vomiting can also lead to Mallory-Weiss esophageal tears that present with either hematemesis or melena. Similar to patients with anorexia nervosa, those with bulimia nervosa may have vital sign abnormalities, especially orthostasis related to volume depletion. Reasons for hospitalization are summarized in Table 5. As with anorexia nervosa, inpatient medical stabilization focuses on initiating nutritional rehabilitation, replenishing electrolytes, preventing further medical or psychiatric complications, and providing resources for subsequent care.

Therapeutic Approach

Outpatient treatment is recommended for bulimia nervosa, except when a patient experiences complications that require hospitalization or severe symptoms that do not respond to outpatient treatment. To break a pattern of binge-purge behaviors, a day treatment program is often required first, followed by intensive outpatient therapy, individual therapy, or FBT. CBT is generally considered the most effective intervention for bulimia nervosa, although FBT and DBT in bulimia nervosa appear promising and warrant further study. In a recent randomized clinical trial comparing CBT and FBT, for example, patients who participated in FBT achieved higher rates of abstinence from binge eating and purging at the end of treatment, although no difference was identified 12 months after treatment. (12)

Pharmacotherapy has more evidence-based support in bulimia nervosa than in anorexia nervosa, although studies primarily have been conducted in adults. According to a systematic review of 36 randomized, controlled trials, (9) Grade A evidence (ie, full evidence from controlled trials) supports the use of tricyclic antidepressants, fluoxetine, or topiramate to reduce binge eating and purging in patients with bulimia

nervosa. These therapies may provide additional benefit when combined with CBT, DBT, or FBT and may help manage comorbid psychiatric symptoms in addition to eating pathology.

Prognosis

The rate of recovery from bulimia nervosa is similar to that for anorexia nervosa, with approximately 33% to 66% of patients achieving full recovery by 5 years, depending on severity of illness and type of treatment. Mortality is less common in bulimia nervosa than in anorexia nervosa, although patients are twice as likely to die prematurely compared to the general population, (13) with high rates of suicide. Poor outcomes are associated with older age at presentation, higher binge eating and purging frequency, and psychiatric comorbidity.

BINGE-EATING DISORDER

Case

A 19-year-old male visits his college health center for a routine physical. His weight is 114 kg, with a BMI of 35 (154% of expected). He states that he periodically feels out of control when he eats and often eats beyond fullness. Recently, these episodes have been occurring a few times a week, leading him to feel guilty and avoid eating around his friends. He has a history of obesity as a child and his mother frequently engages in dieting. Other than obesity, physical examination findings are unremarkable and laboratory testing suggests insulin resistance. The patient is referred for DBT and a weight loss program. His binge eating reduces substantially after 1 year of therapy and his weight declines by 4.5 kg, although he continues to be overweight.

DSM-5 Characteristics

In binge-eating disorder, patients engage in recurrent episodes of binge eating, similar to bulimia nervosa, but do not

engage in compensatory behaviors. Binge-eating disorder was previously listed in the appendix of DSM-IV, with patients grouped under EDNOS. With DSM-5, binge-eating disorder was established as a separate diagnosis and the frequency of binge eating episodes was reduced to an average of once a week for 3 months (Table 7). Similar to bulimia nervosa and anorexia nervosa, binge-eating disorder often begins during late adolescence or early adulthood, although many patients do not present for treatment until later in life. The prevalence of binge-eating disorder ranges from 1% to 4% among female adolescents. The gender ratio for binge-eating disorder is less skewed than for bulimia nervosa or anorexia nervosa, with an estimated male-to-female ratio of 1:2 to 1:6.

Medical Complications

Medical complications in patients with binge-eating disorder are similar to those in patients with obesity, although patients with binge-eating disorder may have increased medical morbidity compared to patients with the same BMI. Common conditions include hypertension, dyslipidemia, type 2 diabetes, coronary artery disease, osteoarthritis, and obstructive sleep apnea. Unlike patients who have anorexia nervosa or bulimia nervosa, patients with binge-eating disorder rarely require hospitalization for acute medical stabilization. Individuals may, however, require hospitalization for acute complications of chronic comorbidities, such as gallstones and the need for cholecystectomy.

Therapeutic Approach

Psychotherapeutic approaches for patients with binge-eating disorders include CBT and DBT. Each of these interventions, including self-help approaches, can effectively reduce binge eating but may not substantially reduce BMI. Accordingly, psychotherapy, particularly in obese patients, should be coupled with weight loss treatment to target both the psychiatric and behavioral components as well as the physical and medical consequences of the disorder. Pharmacotherapy may also provide benefits in binge-eating disorder. A systematic review of 26 randomized, controlled trials concluded that Grade A evidence supports the use of imipramine, topiramate, or selective serotonin reuptake inhibitors, particularly sertraline or citalopram, to reduce binge eating. (9) For patients older than 18 years, lisdexamfetamine (30 mg daily, orally) was recently approved by the US Food and Drug Administration for treatment of binge-eating disorder. Patients should be assessed for cardiac disease before use and monitored for inadequate intake and any other adverse effects during use.

Prognosis

Data on long-term outcomes in binge-eating disorder are scarce. Wide ranges of recovery, from around 30% to 80% of patients, have been reported for follow-up durations between 1 and 6 years. (13) Limited data suggest that mortality, including suicide, may not be significantly higher than in the general population.

TABLE 7. **DSM-5 Diagnostic Criteria for Binge-Eating Disorder (4)**

A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:

1. Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than what most individuals would eat in a similar period of time under similar circumstances.
2. A sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating).

B. The binge-eating episodes are associated with three (or more) of the following:

1. Eating much more rapidly than normal.
2. Eating until feeling uncomfortably full.
3. Eating large amounts of food when not feeling physically hungry.
4. Eating alone because of feeling embarrassed by how much one is eating.
5. Feeling disgusted with oneself, depressed, or very guilty afterward.

C. Marked distress regarding binge eating is present.

D. The binge eating occurs, on average, at least once a week for 3 months.

E. The binge eating is not associated with the recurrent use of inappropriate compensatory behavior as in bulimia nervosa and does not occur exclusively during the course of bulimia nervosa or anorexia nervosa.

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OTHER SPECIFIED FEEDING OR EATING DISORDER

Other specified feeding or eating disorder (OSFED) is a category added to DSM-5 that applies to patients whose presentations do not meet the full criteria for other eating or feeding disorders. This category, unlike EDNOS in DSM-IV, allows a clinician to subclassify a patient based on the reason that his or her presentation does not fit into other diagnoses. Such subclassification may help to identify similarities and differences between specific groups of patients, potentially leading to more effective interventions and further improvements in eating disorder classification. Table 8 provides examples of presentations that would be included in this category. If, on the other hand, a clinician does not choose to specify a diagnosis or if the presentation is insufficient to make a diagnosis, the clinician can use the category “Unspecified Feeding or Eating Disorder” (UFED). Changes made to DSM-5 effectively reduce the number of individuals in the “other category” (OSFED/UFED in DSM-5 and EDNOS in DSM-IV) by up to 50.

AVOIDANT/RESTRICTIVE FOOD INTAKE DISORDER

Case

While performing a school physical examination, a clinician notes that an 11-year-old boy's weight and height, which previously followed the 25th percentile, have now dropped to the 3rd percentile and 15th percentile, respectively. He has always been a picky eater but recently refuses to eat any items that are not white. He has a set of food rules, including not having foods touch each other on the plate. He wants to gain weight and would like to grow taller. Further history confirms that he had

some challenges with the introduction of textured foods as a toddler and ate pureed foods well into his second year. Physical examination findings are normal other than a BMI of 13.4 (79% of expected). The parents are coached in FBT, starting with foods he deems safe, with a schedule of 3 meals and 3 snacks per day. A selective serotonin reuptake inhibitor is started as well as CBT with exposure-response prevention therapy. Over the next few months, various foods are reintroduced and he begins to increase in height. At 1 year after the initial diagnosis, his weight and height curves have normalized, although he continues to have some compulsive behaviors that are unrelated to food.

Contrast to Other Eating Disorders

In DSM-5, ARFID replaces the DSM-IV diagnosis of feeding disorder of infancy or early childhood and removes the requirement of presentation before age 6 years. (4) This disorder is characterized by avoidance of food intake and may present similarly to anorexia nervosa, with significant weight loss or impaired growth. Unlike other eating disorders, however, food avoidance is not influenced by body image but rather by an aspect of the food (eg, its texture), a potential consequence of eating (eg, choking), or lack of interest (Table 9).

ARFID typically develops in childhood but may occur at any time or persist without full recognition into adulthood. Compared with other eating disorders, ARFID tends to occur at a higher frequency in males, with equal prevalence in males and females during early childhood. ARFID has also been found in patients with comorbid anxiety disorders as well as developmental disorders, such as autism spectrum disorders. The differential diagnosis for ARFID includes gastrointestinal diseases such as celiac disease,

TABLE 8. Examples of Diagnoses in the DSM-5 Other Specified Feeding or Eating Disorder Category (4)

Atypical Anorexia Nervosa: All of the criteria for anorexia nervosa are met, except that despite significant weight loss, the individual's weight is within or above the normal range.
Bulimia Nervosa (of low frequency and/or limited duration): All of the criteria for bulimia nervosa are met, except that the binge eating and inappropriate compensatory behaviors occur, on average, less than once a week and/or for less than 3 months.
Binge-Eating Disorder (of low frequency and/or limited duration): All of the criteria for binge-eating disorder are met, except that binge eating occurs, on average, less than once a week and/or for less than 3 months.
Purging Disorder: Recurrent purging behavior to influence weight or shape (e.g., self-induced vomiting; misuse of laxatives, diuretics, or other medications) in the absence of binge eating.
Night Eating Syndrome: Recurrent episodes of night eating, as manifested by eating after awakening from sleep or by excessive food consumption after the evening meal. There is awareness and recall of the eating. The night eating is not better explained by external influences such as changes in the individual's sleep-wake cycle or local social norms. The night eating causes significant distress and/or impairment in functioning. The disordered pattern of eating is not better explained by binge-eating disorder or another mental disorder, including substance use, and is not attributable to another medical disorder or to an effect of medication.

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TABLE 9. DSM-5 Diagnostic Criteria for Avoidant/Restrictive Food Intake Disorder (4)

- A. An eating or feeding disturbance (e.g., apparent lack of interest in eating or food; avoidance based on the sensory characteristics of food; concern about aversive consequences of eating) as manifested by persistent failure to meet appropriate nutritional and/or energy needs associated with one (or more) of the following:
1. Significant weight loss (or failure to achieve expected weight gain or faltering growth in children).
 2. Significant nutritional deficiency.
 3. Dependence on enteral feeding or oral nutritional supplements.
 4. Marked interference with psychosocial functioning.
- B. The disturbance is not better explained by lack of available food or by an associated culturally sanctioned practice.
- C. The eating disturbance does not occur exclusively during the course of anorexia nervosa or bulimia nervosa, and there is no evidence of a disturbance in the way in which one's body weight or shape is experienced.
- D. The eating disturbance is not attributable to a concurrent medical condition or not better explained by another mental disorder. When the eating disturbance occurs in the context of another condition or disorder, the severity of the eating disturbance exceeds that routinely associated with the condition or disorder and warrants additional clinical attention.

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ocult malignancies, and neurological or congenital conditions associated with structural or functional abnormalities that affect feeding. Treatment varies, depending on the reasons for food avoidance and its impact on physical and social functioning. Further complicating the diagnosis of ARFID is the similarity in presentation to early-onset anorexia nervosa in patients who have not yet developed the vocabulary to discuss body image disturbance. Thus, the astute pediatrician must recognize that weight restoration remains paramount in the treatment of ARFID. If the child or adolescent fails to gain weight with appropriate treatment, the pediatrician should have a high index of suspicion for early-onset anorexia nervosa. For more information on the management of ARFID and other feeding disorders, please refer to the recent *Pediatrics in Review* article entitled "Managing Feeding Problems and Feeding Disorders."

Underlying obsessive-compulsive disorder (OCD) can be found in patients with ARFID, as with patients with anorexia nervosa and other eating disorders. For patients with OCD, the rituals do not just involve food but cross into other realms of life, such as having crayons separated specifically by color in a certain order, counting rituals, or taking 20 hours on a homework assignment that should only take 30 minutes to get it "just right." ARFID and other eating disorders may present with OCD behaviors, but as the brain is refed, such behaviors resolve. In the patient with underlying OCD, the eating and food behaviors may fade, but other rituals take their place over time. Similarly, anxiety disorder, depression, or other comorbid psychiatric diagnosis can be found in patients with

eating disorders. The pediatrician, in partnership with the multidisciplinary team, can help identify whether there is an underlying "iceberg" of psychiatric diagnosis, with the eating disorder serving as the tip rather than the iceberg itself.

RISK FACTORS AND UNDERLYING INFLUENCES

The etiology of eating disorders is unclear and likely multifactorial, including physiologic and sociocultural factors. Growing evidence supports a genetic contribution to eating disorder pathogenesis, particularly in anorexia nervosa and bulimia nervosa. Eating disorders can run in families, with about a 10-fold increased risk of an eating disorder in an individual with an affected first-degree relative. Twin studies demonstrate higher concordance rates among monozygotic compared to dizygotic twins. Alterations in brain chemistry may also play a role, particularly changes to the brain reward system and neurotransmitters, such as serotonin and dopamine, which can dysregulate appetite, mood, and impulse control. Whether these alterations predispose individuals to disease development or occur as a consequence of disease remains unknown.

Eating disorders have recently been recognized as "equal opportunity illnesses" found in all socioeconomic strata and in widely divergent cultures, including in developing countries. As with all mental health disorders, stressful life events, such as relationship conflicts, difficulties in school, or sexual assault, can play a role in triggering the onset of disordered eating in youth who are genetically or neurobiologically vulnerable. Eating disorders commonly occur in

patients with other psychiatric conditions, particularly anxiety, depression, bipolar disorder, or substance abuse.

EARLY RECOGNITION IS KEY

The pediatrician, in partnership with the family, represents the front line for eating disorder detection. Warning signs, however, may be difficult to detect. Weight is not the only marker of clinically significant disease. As many as 66% of individuals with eating disorders are at normal weight and 33% are obese at the onset of disease. Both anorexia nervosa and bulimia nervosa frequently begin with dietary changes, such as adopting a vegetarian, low-fat, low-carbohydrate, or other “healthy” diet, along with changes in mealtime rituals, such as taking longer to complete meals, cutting food into small pieces, or shifting food around on the plate. Individuals who purge often make frequent trips to the bathroom, particularly during or after meals, and may adjust their schedules to accommodate both binge eating and purging. Many adolescents, including those with binge-eating disorder, begin to avoid social eating. Increases in physical activity may precede changes in diet and often become progressively obsessive throughout the course of illness. In general, suspicions from individuals close to the adolescent, such as a family member, friend, or coach, can correctly identify disordered eating and should be fully evaluated.

Several groups are at particular risk of delayed diagnosis. Younger children may present atypically, with failure to grow rather than precipitous weight loss and less focus on body image. Both anorexia nervosa and bulimia nervosa, however, have been seen in very young children. Weight loss in boys may also go undetected for a longer period of time due to the cultural perception of eating disorders as a female phenomenon. In addition, adolescents with chronic illnesses require close monitoring for abnormal eating attitudes and behaviors, particularly patients with type 1 diabetes (“diabulimia” in the layperson’s literature), corticosteroid-dependent illnesses, or those taking any other medications that affect appetite and eating habits.

In overweight adolescents, weight loss may initially draw praise rather than raise concerns, especially given the cultural focus on obesity prevention. How weight loss occurs, however, matters, and the pediatrician should assess methods of weight loss, including meal plans, exercise patterns, and body image. A child who declines from the 90th to the 50th percentile for BMI, for example, may have an illness as severe as a child who declines from the 30th to the 5th percentile, despite being in the normal range for age. Furthermore, natural differences in frame size and body composition affect individual growth patterns and, for some adolescents, following a

higher growth curve may be healthy. This understanding is important not only for identifying unhealthy weight loss, but also for determining individual treatment goals. Some clinicians may encourage all patients to aim for a BMI in the 50th percentile during recovery, but this goal may not correct eating disorder physiology or mindset in some patients. Research is currently underway to help determine optimal weight gain goals for both medical stability and emotional well-being, particularly in patients who were overweight before the onset of the eating disorder.

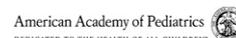
Summary

- On the basis of some research evidence along with expert opinion, *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* diagnostic changes increase the number of patients who meet criteria for specific eating disorders.
- On the basis of primarily consensus, pediatricians should evaluate patients for signs and symptoms of eating disorders to promote recovery and prevent complications.
- On the basis of some research evidence, higher calories during initial refeeding may provide benefits without increasing the risk of refeeding syndrome in moderately malnourished adolescents with anorexia nervosa. (1)(2)(3)
- On the basis of strong research evidence, family-based treatment is helpful in the treatment of anorexia nervosa in adolescents. (7)
- On the basis of some research evidence, cognitive behavioral therapy and family-based treatment are helpful in the treatment of bulimia nervosa in adolescents. (5)
- On the basis of some research evidence, psychotherapy or pharmacotherapy coupled with a weight loss intervention is helpful in the treatment of binge-eating disorder. (9)

To view PowerPoint slides that accompany this article, visit <http://pedsinreview.aappublications.org> and click on the Supplemental tab for this article.

Eating Disorders

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CME Quiz, References, and Suggested Readings for this article are at <http://pedsinreview.aappublications.org/content/37/8/323>.

Parent Resources from the AAP at HealthyChildren.org

Eating Disorders

- <https://www.healthychildren.org/English/health-issues/conditions/emotional-problems/Pages/Treating-Eating-Disorders.aspx>
- Spanish: <https://www.healthychildren.org/spanish/health-issues/conditions/emotional-problems/paginas/treating-eating-disorders.aspx>
- <https://www.healthychildren.org/English/health-issues/conditions/emotional-problems/Pages/Is-Your-Teen-at-Risk-for-Develop>
- Spanish: <https://www.healthychildren.org/spanish/health-issues/conditions/emotional-problems/paginas/is-your-teen-at-risk-for-developing-an-eating-disorder.aspx>
- <https://www.healthychildren.org/English/health-issues/conditions/emotional-problems/Pages/Eating-Disorders-in-Men-Boys.aspx> (English only)
- <https://www.healthychildren.org/English/health-issues/conditions/abdominal/Pages/Bowel-Function-in-Eating-Disorders.aspx> (English only)

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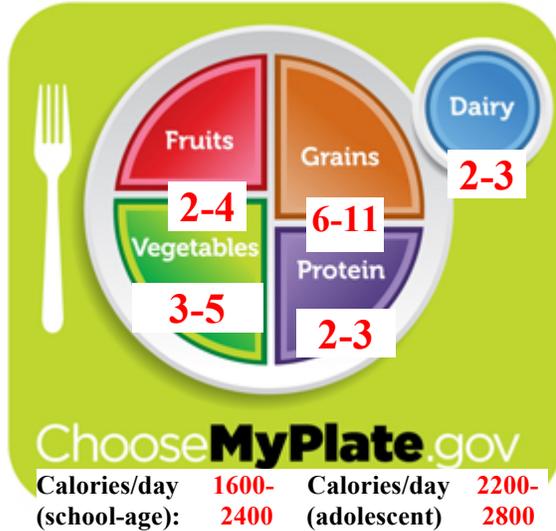
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Nutrition III Quiz

1. Please fill-in the serving ranges for the “**Food Plate**” of an early-to-middle adolescent:



**** Remember—these are recommended ranges and not absolute rules.**

2. What are the most common nutritional deficiencies in **adolescent females**, and how might they present? **Calcium**— osteopenia. **Iron**— anemia. **Zinc**— hair/skin/nail changes.

3. What nutritional components are particularly critical for **vegetarians**? How do their deficiencies present?

- **Vitamin B12**: aid in growth and development of brain and nervous system; in older children and adolescents, may present as megaloblastic anemia.
- **Folate**: aid in growth and development of brain and nervous system; in older children and adolescents, may present as megaloblastic anemia.
- **Omega-3-fatty acid**: assist in brain and retinal development; in older children and adolescents, may present as fatigue, poor memory, dry skin, mood swings or depression, and poor circulation.

Other important vitamins/minerals that may be lacking are protein (malnutrition → kwashiorkor & marasmus); iron (anemia); calcium (osteopenia); and zinc (hair/skin/nail changes).

4. Please match the following indications for admission with the appropriate **eating disorder**.

Indicate AN, BN, or both:

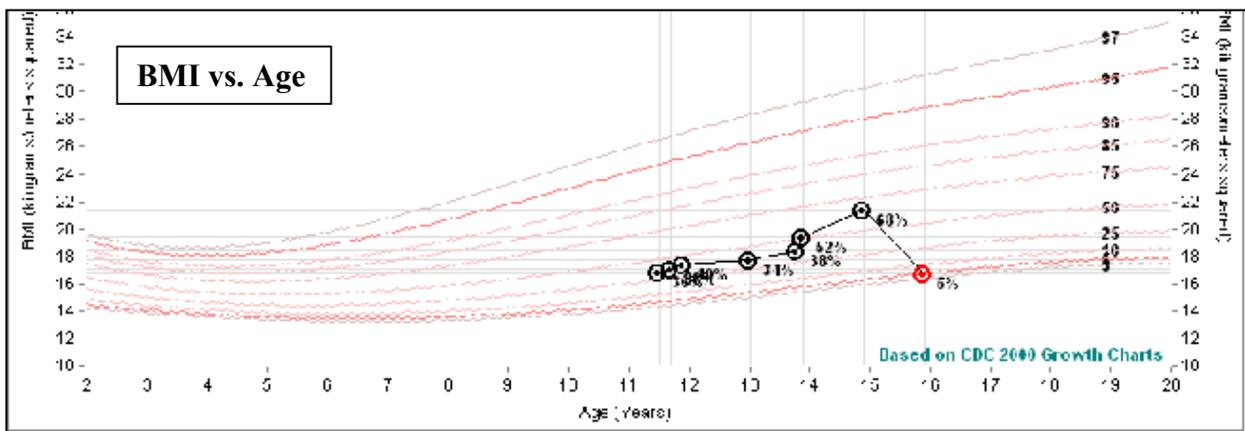
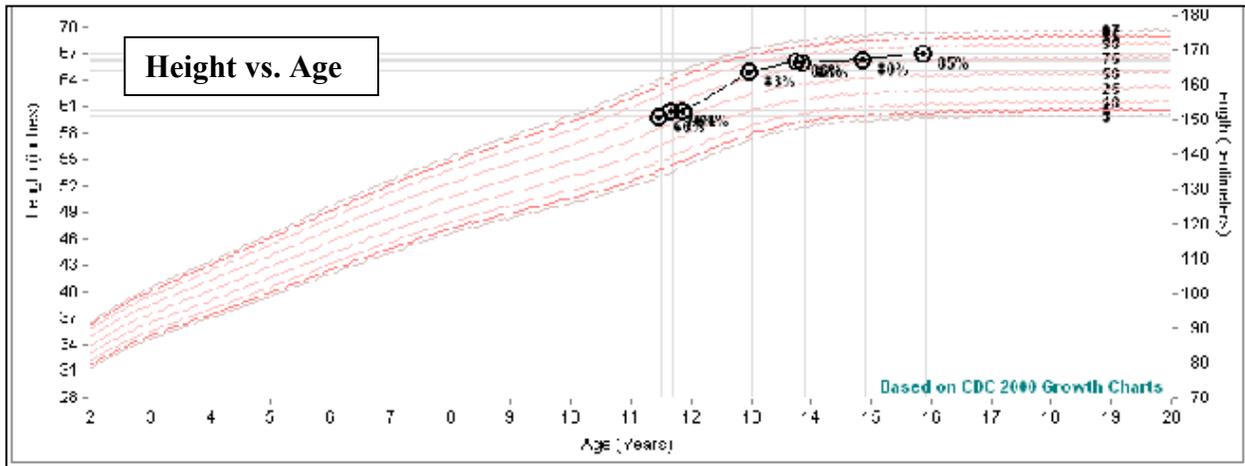
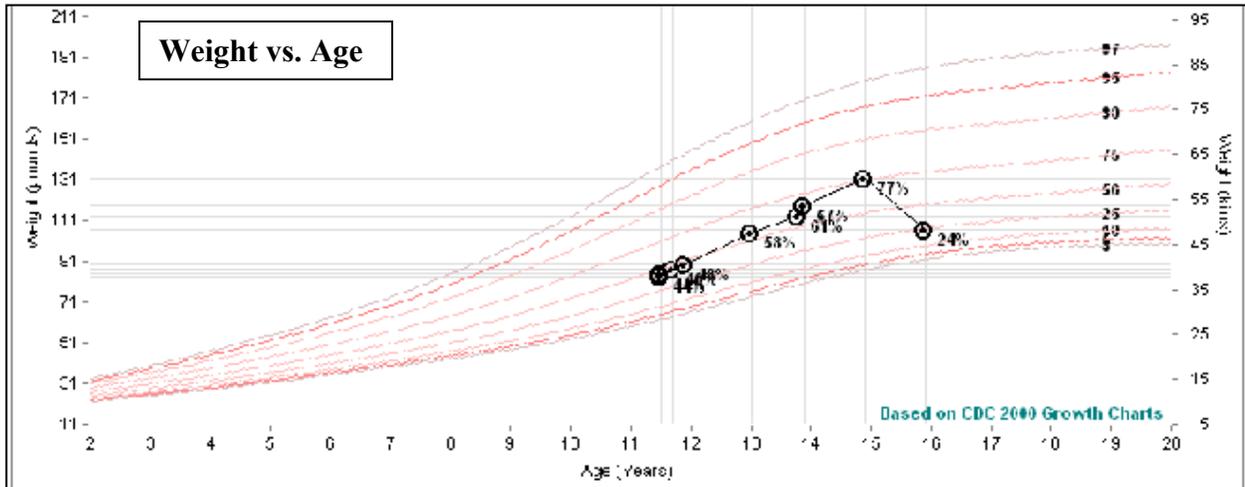
- | | |
|---|-----------------|
| A. Heart rate <50 (awake), <45 (asleep) | <u>AN</u> |
| B. arrhythmia | <u>Both</u> |
| C. hypothermia | <u>Both</u> |
| D. K < 3.2 | <u>BN</u> |
| E. refusal to eat | <u>Anorexia</u> |
| F. significant orthostatic changes | <u>Anorexia</u> |
| G. esophageal tears, intractable vomiting | <u>BN</u> |
| H. failure to respond to outpatient tx | <u>Both</u> |

5. For females, the lifetime prevalence of AN is **1%** (**male:female=1:3-1:12**). The female lifetime prevalence for BN is **3%** (**male:female=1:3-1:18**). The baseline mortality rate for BN is **3%** but lifetime suicidality and suicide attempts are much higher. The female prevalence of Binge Eating Disorder is **1-4%** (**male:female = 1:2-1:6.**) **66%** of individuals with eating disorders are normal weight and **33%** are obese at the onset of disease. 33-66% of patients with **AN and BN** will achieve full recovery in 5 years.

Nutrition III Cases

Case 1: Eating Disorders

Abby, a 16-year old previously healthy female, presents for a school physical. You glance at the following growth charts, imported by your corpsman, as she enters your room.



Based on the growth chart, what is your biggest concern? What else is in your differential?

- **Eating disorder:** anorexia nervosa vs. bulimia nervosa vs. other eating disorders
- **DDx:** hyperthyroidism, IBD, malignancy/brain tumor, immunodeficiency, malabsorption (e.g. celiac disease), chronic infection, Addison's disease, diabetes mellitus/insipidus.

What history do you want to obtain to clarify your diagnosis?

History

Past medical history

Time course of weight loss, including minimum and maximum weight during adolescence.

Perceived goal weight/healthy weight

Body image concerns

Dietary habits including 24-hr recall, history of restricting, binge eating, and/or purging

Exercise history

Previous therapy

Secretive behaviors

Symptoms of systemic illnesses, such as inflammatory bowel disease, diabetes mellitus, celiac, lupus

Relevant review of systems: presyncope, syncope, headaches, fatigue, exercise intolerance, sleep disturbance, dry skin, increased shedding of hair/hair loss, cold intolerance, easy bruising, delayed wound healing, mood changes

Family history

Eating disorders, obesity, depression, anxiety, alcoholism or drug abuse, bipolar affective disorder, schizophrenia

Pubertal/menstrual history

Menarche, last menstrual period, changes in regularity, duration

Timing of thelarche and pubarche if premenarchal

Growth rate deceleration

For males: history of decreased erections or nocturnal emissions

Social history

Recent stressors, family, school, friends

Tobacco, alcohol, illicit drug use

History of physical or sexual abuse

Use of pro-eating disorder Web sites

Mood changes

Time with friends

Engagement in fun activities

Recent stressors, family, school, friends

Abby tells you that, although her body weight today in clinic is <85% of her ideal body weight, she continues to desire to lose weight. Review of her diet history shows adequate caloric intake, but she endorses swimming 2x per day for 2hrs each session. Before the prom last spring, she

took OTC laxatives in order to “look good in [her] dress”. She got her period at age 13 and she continues to have regular menses. Her ROS is negative.

What will you look for on your physical exam?

Physical Examination Findings

Anorexia nervosa and other restrictive disorders

Sinus bradycardia

Cardiac arrhythmias including QT prolongation

Orthostatic changes in pulse >20 or blood pressure >10

Hypotension

Hypothermia

Dry, pale skin

Orange discoloration of skin

Lanugo

Bruising/abrasions over spine

Acrocyanosis

Thinning scalp hair

Facial wasting

Cachexia

Atrophic breasts

Scaphoid abdomen

Dependent edema

Flat or anxious affect

BN and other purging disorders

Sinus bradycardia or cardiac arrhythmias including QT prolongation

Orthostatic changes in pulse >20 or blood pressure >10

Callouses or abrasions over knuckles due to self-induced vomiting

Parotid enlargement

Dental enamel erosions, caries, oral ulcerations

Mood lability

Scleral hemorrhage

Palatal petechiae

Loss of gag reflex

Her vitals upon presentation are HR 56, RR 20, BP 106/77, and 98.6F. She appears thin, but not cachectic, and her physical exam is otherwise unremarkable.

Can you definitively diagnose her given the findings on your history and physical?

Yes (by DSM-V criteria.) Key criteria in chart below, with footnotes:

Anorexia Nervosa		Bulimia Nervosa	
Wt loss to >15% below IBW	Yes	Recurrent bingeing: 1x/wk x 3mo ²	No
Amenorrhea x 3 cycles ¹	No	Recurrent compensatory behaviors	Yes?
Disturbed body image; fear of gaining wt	Yes?	Self-evaluation α body shape, weight	Yes?

¹ Eliminated in DSM-V

² Previously 2x/wk in DSM-IV

* Previously, patient may have fit in category of **Eating Disorder-not-otherwise-specified (EDNOS)**; however DSM-V intends to minimize use of this “catch-all” diagnosis.

Will you order any laboratory or radiologic studies? If so, which ones?

Yes. A limited lab evaluation is warranted to r/o possible complications or alternate diagnoses. Do **CBC, CMP, U/A, TFTs**. If amenorrhea, would consider LH, FSH, E2, PRL, hCG, as well as DEXA scan. If cardiac sxs, abnormal electrolytes, or severe bulimia, would consider ECG.

What is your management plan? What are her options specifically at WR-B?

- She does not meet criteria for inpatient treatment. If this is necessary, consider [Sheppard Pratt](#) or CNMC. Occasionally, a patient may be admitted to 3W on a short-term basis if the diagnosis is uncertain or if there are emergent medical complications to be addressed immediately.
- A **multidisciplinary outpatient team approach** is necessary. This includes YOU, as the medical provider; a therapist (consider Dr. Elmore or consult [Peds Behavioral Health](#)); and potentially a nutritionist (consult [Peds Nutrition](#)). [Adolescent Medicine](#) is also available to help.
- Your job is to first r/o any medical complications, and second to follow the patient’s weights diligently, as well as any long-term issues such as menses and bone health.

Case 2: Vegan/Vegetarian Eating

PO3 Smith presents with his pregnant wife and son, age 4, and daughter, Kimberly, age 13, for their school physicals. In taking a dietary history, you learn that the 13 year-old has decided to become “vegan”, after watching a vintage rerun of [“The Vegan Challenge” episode on Oprah](#). She also DVR’d the episode for her mother and convinced her to start cooking vegan for the entire family. Mrs. Smith proudly reports that, for the last year, the entire family has been eating vegan, and she has noticed that she and her children have been healthier and more energetic. PO3 Smith, who has been missing his steak dinners, asks you to explain to his wife and strong-willed Kimberly why a vegan diet is unhealthy.

What is eliminated in a vegan diet versus a vegetarian diet?

Vegan diets eliminate ALL animal and fish products, to include eggs and dairy. Lacto-vegetarians include milk products. Lacto-ovovegetarians include milk and egg products. Semi-vegetarians include poultry and fish.

Can you make an argument to support Mrs. Smith? What are the benefits of a vegan or vegetarian diet? Studies have shown that when “well-informed” parents raise vegetarian children, their growth parameters compare with that of non-vegetarian children. In addition, they tend to be leaner, with lower relative body weights and skin-fold thicknesses. Studies show that children and adolescents who follow a vegetarian diet have a lower intake of cholesterol, saturated fat, and total fat and a higher intake of fruit, vegetables, and fiber than their non-vegetarian counterparts. Vegetarian adults have a decreased risk for several chronic diseases such as diabetes, coronary artery disease, hypertension, obesity, and some types of cancer.

PO3 Smith seems even more distressed by this explanation. To diffuse the situation, you ask the others to step out the room, so that you can do your HEADSS exam for Kimberly.

Regarding her choice to become vegan, what sorts of questions and counseling do you want to address to Kimberly?

- Understand Kimberly’s reason for a vegetarian diet, recognizing that the rationale may be ideological rather than health-related, including: ethical opposition to killing animals; disgusted by animal processing; and influence of friends.
- Evaluate weight concerns, body image, frequency of dieting for weight loss, and exercise patterns (a vegetarian diet may be an attempt to camouflage an eating disorder)
- Assess knowledge base and provide targeted education, including how to read food labels and healthy vegetarian options at school or out with friends.
- Recommend supplementation as necessary with calcium and vitamin B12

Kimberly reassures you that her reasons for becoming vegan were due to Oprah—and not an underlying eating disorder. You complete the remainder of her HEADSS and physical exam, and you nervously invite the rest of the family back into the room. After examining the 4-year-old, PO3 Smith asks you to provide his wife with guidance for the younger children, “since she insists on this vegan nonsense”.

What guidance would you give for the toddler Smith? What guidance would you give for Mrs. Smith, as she anticipates the arrival of Baby #3?

Toddler/preschool

- Assess vegan/vegetarian food availability at day care
- Ensure healthy and frequent snacks with a variety of energy-dense, low-bulk foods
- Evaluate calcium, B12, folate, iron, and zinc sources
- Review choking hazard with nuts and vegetables

Infants

- Supplement with B12 for breastfed infants, if mother is not supplementing her diet or is not consuming food with adequate B12
- Recommend vitamin D supplementation if the infant is exclusively breastfed
- Review introduction of solids with protein-rich foods: pureed tofu, pureed legumes, soy yogurt
- Full-fat fortified soy milk may be used at age 1 year or older

Nutrition III Board Review

1. You are evaluating a 2-year-old daughter of strict vegan parents. Her birth weight at term was 3.5 kg. Since weaning at 12 months of age, the child's diet has included a homemade, macrobiotic-based formula. In your office today, the girl's weight is 11.2 kg.

Of the following, the child's diet MOST likely is deficient in

- A. essential amino acids
- B. linoleic acid
- C. vitamin A
- D. vitamin B12**
- E. vitamin C

Strict vegan diets include foods that come solely from plant sources. Such diets generally contain adequate amounts of vitamins A and C as well as essential fatty acids (including linoleic acid). However, a strict vegan diet instituted after weaning contains very little vitamin B12, a nutrient primarily found in meats, eggs, and dairy products, unless supplements are provided.

Breastfed infants of vegan mothers may develop vitamin B12 deficiency, but only if maternal stores are low. Although the vitamin composition of human milk is directly related to dietary intake of vitamins A, C, D, and the B group, studies comparing the vitamin content of human milk from vegan compared with nonvegan mothers have not demonstrated any significant micronutrient differences. Commercial soy-based formulas are alternatives for vegan mothers who do not breastfeed. In most cases, therefore, the greatest potential nutritional risks for both breastfed and soy formula-fed infants of vegan parents occur after weaning. This is particularly the case when a homemade weaning formula is given. Conversely, commercially available soy milks are supplemented with vitamins.

Studies in both the United States and the United Kingdom have shown that vegan children exhibit small but significant differences in growth variables (height and weight percentiles) compared with children eating mixed diets. This observation most likely is the consequence of group differences in total energy consumption, although other studies have demonstrated that the calcium and zinc content of the vegan diet also may be low, indicating the requirement for supplementation.

Conversely, the essential amino acid and total protein intake of vegan children has been shown to be adequate to support normal growth. Despite the lower mean height and weight of vegan children compared with children eating mixed diets, a large British study found no evidence of growth failure (weight or height less than the 5th percentile) in vegan children, and no between-group differences were noted in terms of muscle strength and overall health.

A routine health assessment of any child should include a careful dietary history. Information about specific cultural or family customs permits identification of patients at nutritional risk and aids the clinician in determining whether caregivers require education regarding appropriate nutrition for growing children. For example, in industrialized countries, vitamin D deficiency rickets is an emerging nutritional problem. Such deficiency is particularly prevalent for dark-skinned infants living in temperate or northern climates, those whose cultural/religious customs may include extensive covering of body surfaces, and in infants and children who receive little direct sunlight exposure (ie, less than 30 minutes to the face and hands three times per week).

2. A 7-month-old child presents for a follow-up office visit after undergoing a Kasai procedure for biliary atresia at 6 weeks of age. The mother states that the boy is irritable when his right arm is moved. On physical examination, the infant is jaundiced. You detect tenderness in the anterior radial head. Radiography of the affected region demonstrates metaphyseal fraying and a fracture.

Of the following, the MOST appropriate laboratory studies to obtain next are

- A. calcium and phosphorus measurement and bone densitometry (DEXA scan)
- B. calcium and phosphorus measurement and urinary calcium-to-creatinine ratio
- C. calcium, phosphorus, and 25-hydroxyvitamin D measurement**
- D. calcium, phosphorus, and magnesium measurement
- E. magnesium, phosphorus, and parathyroid hormone measurement

Chronic cholestasis due to biliary atresia results in decreased bile flow into the intestine. The absence of intraluminal bile acids, in turn, causes decreased digestion of lipids, leading to fat malabsorption. In addition, absorption of fat-soluble vitamins (A, D, E, and K) is impaired, which may lead to clinical sequelae of fat-soluble vitamin deficiency. Finally, steatorrhea may impair calcium absorption because intraluminal free fatty acids may bind calcium.

The clinical presentation of the patient in the vignette strongly suggests the presence of rickets from vitamin D deficiency. Therefore, the most helpful initial laboratory testing is determination of calcium, phosphorus, and 25-hydroxyvitamin D concentrations. The 25-hydroxyvitamin D assay is the best measure of hepatic stores of vitamin D and is a better marker of vitamin D status than either serum vitamin D or 1,25-dihydroxyvitamin D. Although bone density testing, measurement of serum magnesium and parathyroid hormone, and determination of the urinary calcium-to-creatinine ratio may provide useful additional information, they will not help establish the diagnosis of vitamin D-deficient rickets.

Rickets is a potentially preventable complication of biliary atresia, but requires monitoring of calcium, phosphorus, and 25-hydroxyvitamin D concentrations two to four times a year. Infants who have biliary atresia routinely receive supplementation with approximately 8,000 IU of ergocalciferol (vitamin D₂) daily. This dose of vitamin D is approximately 20 times the recommended dietary allowance for a healthy toddler. If rickets develops or the vitamin D concentration cannot be maintained within the normal range, the patient should receive either calcitriol (1,25-dihydroxyvitamin D₃) or intramuscular vitamin D.

3. A 12-year-old boy has had cholestasis since infancy from Alagille syndrome. He has been lost to medical follow-up for the last several years. He now presents to your office with pain in his right upper thigh after a fall. His thigh is intensely tender, and ultrasonography demonstrates a large hematoma in his quadriceps. The parents state that he has tended to bruise easily in the past few months.

Of the following, the condition MOST likely to account for this patient's symptoms is

- A. factor VIII deficiency
- B. idiopathic thrombocytopenic purpura
- C. vitamin C deficiency
- D. vitamin K deficiency**
- E. von Willebrand disease

Alagille syndrome is characterized by cardiac disease (especially peripheral pulmonary stenosis), vertebral anomalies, ocular anomalies (posterior embryotoxon), facial dysmorphism (triangular facies, macrocephaly, large ears), and paucity of the intrahepatic bile ducts. The hepatic manifestations of this syndrome account for much of the medical morbidity. Specifically, impaired bile flow results in chronic cholestasis, which leads to severe pruritus, jaundice, malabsorption of nutrients, and malabsorption of fat-soluble vitamins. Although most affected children have their jaundice improve as they grow older, a subset progresses to cirrhosis and requires liver transplantation.

Patients who have hepatic disease must have their nutritional status monitored carefully. Chronic anorexia, recurrent illnesses, and fat malabsorption may result in caloric deficiency and growth failure. Caloric supplementation by nasogastric tube or gastrostomy may be necessary to ensure adequate caloric intake. In addition, patients who have cholestasis are at risk for fat-soluble vitamin deficiency.

Vitamin D deficiency typically causes osteopenia and rickets, vitamin E deficiency causes peripheral neuropathy and ataxia, and vitamin A deficiency may cause night blindness or corneal lesions. The bruising described for the patient in the vignette most likely is due to vitamin K deficiency. Vitamin K is a cofactor essential in posttranscriptional carboxylation of the clotting factors II, VII, IX, and X. Thus, vitamin K deficiency leads to prolonged prothrombin and partial thromboplastin time, which predisposes to bruising. Although factor VIII deficiency, vitamin C deficiency, von Willebrand disease, and idiopathic thrombocytopenia purpura also may cause bruising, the patient who has Alagille syndrome is not at increased risk for developing these conditions.

In addition to supplementing patients who have chronic liver disease with fat-soluble vitamins, the clinician caring for these patients also must supply adequate calories. Patients who have advanced chronic liver disease may have both anorexia and increased caloric requirements. In addition, patients who have portal hypertension and ascites may

need to have total fluid intake restricted, which, in turn, means that they may require a more concentrated and less palatable formula. For these reasons, nasogastric or gastrostomy feedings sometimes are necessary to achieve optimal growth, especially when preparing a patient for liver transplantation.

4. A 16-year-old boy in your practice has cystic fibrosis. As a complication of his illness, he has developed cirrhosis and cholestasis. He now complains of shaky hands. Neurologic examination demonstrates hyporeflexia and tremor with hands outstretched.

Of the following, the patient's symptoms are MOST consistent with deficiency of

- A. vitamin A
- B. vitamin B1 (thiamine)
- C. vitamin C
- D. vitamin D
- E. vitamin E**

Because the young man described in the vignette has chronic cholestasis, he is at risk for developing deficiency of any of the fat-soluble vitamins, including vitamins A, D, E, and K. His neurologic symptoms of tremor and hyporeflexia most strongly suggest vitamin E deficiency. Vitamin E (tocopherol) is an important factor in stabilizing the lipid membrane of the red blood cell and the lipids in the myelin sheath of neurons. Therefore, the most common presenting features of hypovitaminosis E are hemolysis (primarily reported in preterm infants) and peripheral neuropathy (identified in infants and children who have chronic cholestasis, pancreatic insufficiency, or malabsorption).

Supplementation of formulas and parenteral nutrition with vitamin E has reduced substantially the incidence of hemolysis in the vitamin E-deficient preterm infant. However, patients who have cystic fibrosis or cholestatic liver disease require both monitoring of vitamin E concentrations and supplementation with vitamin E. Because vitamin E is a fat-soluble vitamin, those who have cholestasis may have difficulty absorbing alpha-tocopherol, the form of vitamin E available in most dietary supplements. For this reason, d-alpha-tocopheryl polyethylene glycol 1,000 succinate, a water-soluble form of vitamin E, should be given to patients who have significant cholestatic liver disease. The recommended dose for a patient who has cholestatic liver disease is 15-25 IU/kg/day.

Deficiency of vitamin A, B1, C, or D would not be expected to cause such a clinical presentation. Vitamin A deficiency causes impaired vision ("night blindness") and corneal ulcers; vitamin B1 deficiency can cause myopathy and heart failure ("beriberi"); vitamin C deficiency causes irritability, bone lesions, and bruising (scurvy); and vitamin D deficiency causes osteopenia or rickets.

5. A medical student rotating in your clinic tells you about a 5-month-old infant he has evaluated. He reports that the infant is fed goat milk exclusively and asks you if this is adequate nutrition at this age.

Of the following, the MOST likely deficiency in this infant is of

- A. folate**
- B. iron
- C. niacin
- D. vitamin A
- E. vitamin D

Goat milk is used exclusively for infant nutrition in some countries and has been used occasionally in the United States for infants who have cow milk allergies, but its routine use in the United States is not recommended. Although its fat may be digested more easily than fat found in cow milk preparations, it is deficient in several important nutrients, such as iron, vitamin D, and especially folate. Folate is a cofactor required in nucleoprotein synthesis, and deficiency ultimately results in ineffective erythropoiesis and megaloblastic anemia. Macrocytosis and hypersegmented neutrophils are typical findings on complete blood count, and if the anemia is severe, pancytopenia also can occur. Mothers who feed their infants goat milk exclusively should be counseled to switch to cow milk formula to avoid these complications. Niacin and vitamin A are sufficiently present in goat milk to avoid deficiency of these nutrients.