341 Nutrient Deficiency or Disease

Definition/Cut-off Value

Any currently treated or untreated nutrient deficiency or disease. These include, but are not limited to, Protein Energy Malnutrition, Scurvy, Rickets, Beriberi, Hypocalcemia, Osteomalacia, Vitamin K Deficiency, Pellagra, Xerophthalmia, and Iron Deficiency.

Presence of condition diagnosed, documented, or reported by a physician or someone working under a physician's orders, or as self-reported by applicant/participant/caregiver. See Clarification for more information about self-reporting a diagnosis.

Participant Category and Priority Level

Category	Priority
Pregnant Women	I
Breastfeeding Women	I
Non-Breastfeeding Women	III, IV, V, or VI
Infants	I
Children	III

Justification

Nutrient deficiencies or diseases can be the result of poor nutritional intake, chronic health conditions, acute health conditions, medications, altered nutrient metabolism, or a combination of these factors, and can impact the levels of both macronutrients and micronutrients in the body. They can lead to alterations in energy metabolism, immune function, cognitive function, bone formation, and/or muscle function, as well as growth and development if the deficiency is present during fetal development and early childhood.

The Centers for Disease Control and Prevention (CDC) estimates that less than 10% of the United States population has nutrient deficiencies; however, nutrient deficiencies vary by age, gender, and/or race and ethnicity (1). For certain segments of the population, nutrient deficiencies may be as high as one third of the population (1).

Intake patterns of individuals can lead to nutrient inadequacy or nutrient deficiencies among the general population. Intakes of nutrients that are routinely below the Dietary Reference Intakes (DRI) can lead to a decrease in how much of the nutrient is stored in the body and how much is available for biological functions. DRIs are based on age and sex and include Recommended Dietary Allowance (RDA), Adequate Intake (AI), Estimated Average Requirement (EAR) and Tolerable Upper Intake Level (UL). DRIs are established by the National Academies of Science, Engineering and Medicine and include the following definitions:

- RDA - Indicates the average daily intake of particular nutrients to meet the requirements of 97-98% of healthy people.
- AI - Established to assume adequate intake when there is insufficient evidence to develop an RDA.

- EAR - The average daily intake of a nutrient that is thought to meet the needs of 50% of healthy individuals. EARs are used to assess the adequacy of nutrient intakes among populations rather than the individual.
- UL - The highest nutrient intake that is considered to be safe and does not lead to adverse health effects in the general population (2).

Macronutrient deficiencies include deficiencies in protein, fat, and/or calories, and can lead to stunting, pronounced wasting (marasmus) or a disproportionately large abdomen (a sign of kwashiorkor). Marasmus is a disease of severe wasting due to a prolonged inadequate intake of protein, carbohydrate, and fat. Kwashiorkor is a disease that results from a prolonged inadequate intake of protein. Essential fatty acid deficiencies, which would include omega-3 fatty acid deficiency, are thought to be rare among the general population (3, 4). Signs of an essential fatty acid deficiency may include a dry scaly rash, decreased growth in infants and children, lowered immune response, and impaired wound healing (3).

Micronutrient deficiencies would include deficiencies in vitamins and minerals in the body. According to National Health and Nutrition Examination Survey (NHANES) data, the most common nutrient deficiencies from 2003-2006 in the general United States population were vitamin B6, iron, vitamin D, vitamin C, and vitamin B12 (1). Because NHANES does not assess the status of all vitamins and minerals, there may be other micronutrient deficiencies that are present in the population without an estimated prevalence.

According to NHANES data from 2005-2012, a significant proportion of women who participate in WIC have inadequate nutrient intakes of vitamin E (96-100%). Additionally, greater than 50% of pregnant women participants reported inadequate intakes of iron and between 10-50% reported inadequate intakes of magnesium, folate, zinc, vitamin A, vitamin C, and vitamin B6 (5). Micronutrient deficiencies during pregnancy are not only a concern for the mother, but are of great concern to the developing fetus that is at risk of certain birth defects related to inadequate levels of certain nutrients including B vitamins, vitamin K, magnesium, copper, and zinc (6). Iodine deficiency during pregnancy can lead to irreversible adverse effects on fetal growth and development. Iodine deficiency is the leading cause of intellectual disability worldwide. According to NHANES data from 2005-2008, 56.9% of the pregnant women surveyed had urinary iodine concentrations below the established threshold of 150mcg/L. This finding suggests that greater than half of pregnant women have insufficient intakes of iodine (7). Because intake patterns of pregnant women can exclude or limit specific food groups, it is not uncommon to have multiple nutrient deficiencies during pregnancy (8). For example, iron deficiency usually does not occur alone, but it often occurs in conjunction with other vitamin and mineral deficiencies (9).

Intakes of nutrients were also found to be low among postpartum and breastfeeding women participating in WIC. Among women who were breastfeeding and participating in WIC, more than 50% had inadequate intakes of vitamin A, and 10-50% had inadequate intakes of magnesium, zinc, vitamin C, vitamin B6, folate, copper, and calcium (5). Greater than 50% of postpartum women who were not breastfeeding were found to have inadequate intakes of magnesium, vitamin A, and calcium, while 10-50% had inadequate intakes of vitamin C, folate, copper, zinc, thiamin, vitamin B6, vitamin B12, iron, and riboflavin (5).

According to NHANES data from 2011-2012, formula fed infants had an average usual intake of choline that was below the AI for that nutrient; however, intakes of other vitamins and minerals were estimated to be adequate (5). Intakes of vitamin D, iron, and zinc among breastfed infants can be of concern if appropriate and timely complementary foods and/or vitamin and mineral supplements are not provided to the infant. According to NHANES data from 2009-2012, at least 10% of infants receiving human milk between 6 and 12 months of age had inadequate intakes of iron and zinc (5). Concentrations of vitamin D in human milk have

been found to be low. Therefore, it has been recommended by the American Academy of Pediatrics (AAP) to provide all infants who are taking less than 32 ounces of formula a day a vitamin D supplement of 400 IU daily (10, 11). Additionally, infants who are born to mothers who are vitamin D deficient are more likely to be deficient themselves. (For more information see risk 411 *Inappropriate Nutrition Practices for Infants*.)

For children participating in the WIC program, the prevalence of inadequate intakes of nutrients was found to be less than 5% for each nutrient, except vitamin E, which was found to be inadequate in the diets of 34.9% of children between 2 and 5 years of age (5). Additionally, it has been estimated that one in four children does not meet the RDA for iron, and one in ten does not meet the RDA for calcium (12).

In addition to health risks associated with low nutrient status, some micronutrients pose a health risk at levels higher than the established UL. For this reason, individuals with nutrient deficiency diseases, or who are concerned that they may have a nutrient deficiency disease, should be followed by their medical provider (especially if supplements are required for treatment).

Populations who may be at greater risk of nutrient deficiencies or diseases include:

- Individuals who have intakes below the established RDA, AI, or EAR for the nutrient.
- Individuals who experience food insecurity.
- Individuals who are experiencing homelessness.
- Women who have a short interpregnancy interval.
- Individuals who have recently left their previous country of residence.
- People with a gastrointestinal disease that can limit absorption of nutrients (i.e. celiac disease or Crohn's disease) or individuals with a history of gastrointestinal surgery (including gastric bypass). For example, individuals who have had a portion of their stomach removed or their distal ileum removed during a weight-loss or other surgery are at a greater risk of developing a vitamin B12 deficiency (13).
- Individuals with other medical conditions that influence nutrient status (i.e. cystic fibrosis, renal disease, genetic disorders).
- Individuals on medications that are known to interact with the absorption or excretion of certain vitamins and minerals.
- People with substance use disorders (including alcohol) may be more likely to have deficiencies due to poor intake and/or the effects of the substance. People who have high intakes of alcohol are at greater risk of developing a magnesium deficiency (14, 15).
- People who smoke are more likely to have a vitamin C deficiency due to the increase in oxidative stress.

Nutrient deficiencies or diseases can be subclinical or clinical. Subclinical deficiencies involve changes to the concentrations of the micronutrient in the blood or tissues. Clinical deficiencies involve noticeable changes to the appearance of skin, nails, hair, oral cavity, and bone formation as well as major disturbances in the function of cells and tissues in the body. At either stage of a nutrient deficiency, blood work is often taken to confirm a deficiency. Blood work to detect nutrient deficiencies can be misleading, as some nutrients, such as magnesium, may have an overall deficiency in the body but be at a normal level in the blood (15). Other methods can be used to assess for nutrient deficiency disease, such as a physical

nutrition assessment. Because it can be difficult to be tested for, and diagnosed with, a nutrient deficiency or a nutrient deficiency disease can go undetected and untreated.

The table below provides information regarding specific nutrients that are more commonly of concern among the WIC population; however, additional nutrient deficiency diseases may occur in the population. Detailed fact sheets about each nutrient can be found at the National Institutes of Health Office of Dietary Supplements website: https://ods.od.nih.gov/factsheets/list-all/.

Nutrient	Function	Signs and Symptoms of Deficiency
Vitamin A	Involved in immune function, vision, cell growth and cell communication.	Night blindness and xerophthalmia (16).
Vitamin B6	Involved in greater than 100 enzyme reactions in the body and involved in protein metabolism.	Microcytic anemia, scaling of the lips and cracks in the corners of the mouth, swollen tongue, depression, and confusion (17).
Vitamin B12	Involved in red blood cell formation, neurological function, and DNA synthesis.	Megaloblastic anemia, fatigue, weakness, constipation, loss of appetite, and weight loss (13).
Vitamin C	Involved in the formation of collagen, certain neurotransmitters, and protein synthesis.	Development of scurvy which would include: fatigue, inflammation of the gums, and weakened connective tissue (14).
Vitamin D	Promotes calcium absorption and proper bone formation, involved in cell growth, immune function, and reduces inflammation.	Development of rickets in children or osteomalacia in adults, and fatigue (18).
Calcium	Involved in muscle function, nerve transmission, and proper bone formation.	Development of osteoporosis (19).
Folate	Involved in the synthesis of RNA and DNA and is required for cell division and the prevention of Neural Tube Defects.	Megaloblastic anemia (20).
Iodine	A component of thyroid hormones that regulate protein synthesis, metabolism, and enzyme activity.	Stunted growth and neurodevelopmental deficits (7).
Iron	A component of hemoglobin and therefore important in the transfer of oxygen from the lungs to organs, and involved in the synthesis of hormones as well as normal growth and development.	Microcytic, hypochromic anemia; impaired cognitive function, poor body temperature regulation, depressed immune function, and spoon like shape of nails (9).
Magnesium	Involved in more than 300 enzyme	Loss of appetite, fatigue, weakness, nausea,

Nutrient		
Magnesium (continued)	reactions, protein synthesis, muscle function, nerve function, blood sugar control, and blood pressure control.	vomiting, numbness, tingling, muscle cramps, seizures, personality changes, and abnormal heart rhythms (15).
Zinc	Involved in cell metabolism, enzyme activity, immune function, protein synthesis, wound healing, DNA synthesis, and cell division.	Stunted growth, depressed immune function, hair loss, eye and skin lesions, delayed wound healing, and taste alterations (21).

Implications for WIC Nutrition Services

The WIC food package is designed to include foods that contain specific nutrients to improve the health status of program participants, address inadequate intakes, and, ultimately, prevent nutrient deficiencies. Nutrition education combined with the WIC food package can help decrease the likelihood that an individual would develop a nutrient deficiency or disease. For individuals who currently have a nutrient deficiency or disease, WIC staff can:

- Encourage improved intake of whole grains, legumes, dairy, lean protein, fruits, and vegetables.
- Emphasize appropriate portion size and variety to avoid nutrient to nutrient interaction. (For example, excessive calcium intake inhibits the absorption of iron.)
- Provide education on foods that contain the specific nutrient(s) of concern.
- Provide education on preparing foods that are part of the WIC food package.
- Refer individuals who report food insecurity to appropriate resources in the community like the Supplemental Nutrition Assistance Program (SNAP) and/or food pantries.
- Reinforce the medical and dietary treatment plans provided by the medical provider, and refer participants to medical providers for medical follow-up care.
- Refer individuals who smoke to tobacco cessation programs.

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Clarification

Self-reporting of a diagnosis by a medical professional should not be confused with self-diagnosis, where a person simply claims to have or have had a medical condition without any reference to professional diagnosis. A self-reported medical diagnosis ("My doctor says that I have/my son or daughter has…") should prompt the CPA to validate the presence of the condition by asking more pointed questions related to that diagnosis.