

Episode 144 – Nutrition and Oral Health: Part One November 7, 2025

Introduction

Nutrition is the science that studies the relationship between food and health. It involves the processes of consuming, absorbing, and utilizing nutrients the body requires for growth, development, energy, and the maintenance of life. Nutrients are the chemical substances in food that the body uses for these processes. Diet refers to the specific foods consumed. [1] [2]

Nutrition is essential for health and development. Improved nutrition is associated with better outcomes in infant, child, and maternal health, stronger immune systems,[1] safer pregnancies and childbirth,[2] reduced risk of noncommunicable diseases (e.g., diabetes, cardiovascular diseases,[3] dental caries[4]), and increased longevity.[5] [3] [4]

Healthy children perform better academically. Individuals with adequate nutrition are more productive and can create opportunities to help break the cycles of poverty and hunger.

Malnutrition

Malnutrition poses significant threats to human health. Currently, the world faces a double burden of malnutrition, which includes both undernutrition and overnutrition, particularly in low- and middle-income countries. Malnutrition manifests in various forms, including underweight (low weight-for-age), wasting (low weight-for-height), stunting (low height-for-age), vitamin and mineral deficiencies, overweight, obesity,[6] and the resulting diet-related noncommunicable diseases.[7] [3] [5]

Overnutrition

Overnutrition is a type of malnutrition that occurs when an individual consumes more nutrients than needed. Chronic overnutrition can lead to the accumulation of body fat from the excess nutrients, resulting in overweight or obesity. People with overweight or

[1] Listen to Episodes 44 and 45 for discussion on the immune system.
[2] Refer to Episodes 108, 109, and 110 for additional information on pregnancy and oral health.
[3] Refer to Episodes 37, 79, 80, and 81 for additional information on cardiovascular diseases.
[4] Refer to Episodes 86 and 87 for additional information on dental caries.
[5] Listen to Episodes 123 and 124 for additional information on aging and longevity.
[6] Refer to Episodes 120, 121, and 122 for conversations on obesity and oral health.
[7] Refer to Episode 60 for additional information on nutritional disorders.

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obesity are at greater risk of cardiovascular disease, hypertension,[8] diabetes,[9] certain cancers, and high cholesterol. [6] [7]

Obesity is associated with oral health problems, such as periodontitis, peri-implantitis,[10] dental caries, and tooth loss. Inflammation is thought to play a key role in this relationship.[11] [8]

Obesity may also increase the risk of head and neck squamous cell carcinoma (HNSCC).[12] Evidence from several large prospective cohort studies involving millions of participants from several continents suggests obesity is a significant risk factor for HNSCC initiation and escape from the immune system. [9]

Heath et al. (2023) characterized the mechanism underpinning obesity-potentiated immune escape of HNSCC. The researchers found excessive saturated fat accumulation affects the ability of certain HNSCCs to evade attacks from the immune system, thus promoting immune escape and increasing tumour burden. [9]

Undernutrition

Undernutrition is another form of malnutrition, characterized by a lack of nutrients and insufficient energy supply (i.e., calories). Undernutrition can result from:

- Inadequate ingestion of nutrients.
- Malabsorption. Causes of malabsorption include insufficient digestive agents (e.g., cystic fibrosis[13]) and disorders that may injure the intestinal lining (e.g., celiac disease,[14] Crohn's disease[15]).
- Impaired metabolism.
- Loss of nutrients due to diarrhea.
- Increased nutritional requirements.
- Disorders and medical procedures. For example, diabetes and bariatric surgery can impair nutrient absorption.[16] AIDS, cancer, and depression can make people lose their appetite and consume less food. Individuals with anorexia nervosa restrict their food intake despite continued weight loss.[17]
- Vegetarian and vegan diets. Individuals following an ovo-lacto diet[18] may be at risk of iron deficiency, while those on a vegan diet may be at risk of vitamin B12 deficiency.
- Fad diets. Some fad diets result in vitamin, mineral, and protein deficiencies (e.g., a fruit-only diet is deficient in protein, sodium, and many micronutrients).

[8] Refer to Episodes 135, 136, and 137 for additional information on blood pressure and oral health.
[9] Refer to Episodes 91, 93, and 94 for discussion on diabetes and oral health.
[10] Listen to Episode 84, 141, and 142 for additional information on peri-implant diseases.
[11] Refer to Episodes 120, 121, and 122 to learn more about obesity and oral health.
[12] Refer to Episodes 7, 9, 76, 77, and 78 for additional information on oral cancer.
[13] Refer to Episode 83 for discussion on cystic fibrosis.
[14] Refer to Episode 132 for additional information on celiac disease and oral health.
[15] Refer to Episode 60 for discussion on oral manifestations of gastrointestinal disorders.
[16] Refer to Episode 121 for information on bariatric surgery.
[17] Listen to Episodes 95 and 96 for discussion on eating disorders.
[18] A lacto-ovo vegetarian diet is a primarily plant-based diet that excludes meat, fish, and poultry but includes dairy and eggs.

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- Medications and nutritional supplements. Some medications, such as appetite suppressants, digoxin, and glucagon-like peptide-1 (GLP-1) receptor agonists can decrease appetite. Some medications can impair nutrient absorption or metabolism (e.g., antiseizure medications can impair vitamin absorption).
- Smoking dulls taste and smell, making food less appealing.[19]
- Alcohol and substance use. Individuals with alcohol or substance dependence may overlook their nutritional needs, and their ability to absorb and metabolize nutrients can also be affected.[20]
- Lack of access to food due to physical impairment, lack of transportation, poverty, war, civil unrest, drought, flooding, overpopulation, unsafe housing conditions, and famine. [5] [10] [11] [12]

Undernutrition is of particular concern during times of rapid growth and/or increased need for nutrients during:

- Infancy
- Early childhood
- Adolescence
- Pregnancy
- Breastfeeding[21]
- Older age[22]

Inadequately fed infants and children are at risk of protein-energy undernutrition (previously called protein-energy malnutrition). Protein-energy undernutrition is a severe deficiency of protein and calories that occurs when individuals do not consume sufficient protein and nutrients over a prolonged period. Infants and children are also at risk for deficiencies in iron, folate (i.e., vitamin B9 or folic acid), vitamins A and C, copper, and zinc.

During adolescence, nutritional requirements increase because the growth rate accelerates. Anorexia nervosa may affect adolescents, in particular females. Anorexia nervosa is characterized by self-starvation and weight loss resulting in low weight for height and age. Individuals with anorexia are at risk of dying from medical complications associated with starvation. Starvation is the most extreme form of protein-energy undernutrition. [10] [13] [14]

During pregnancy and breastfeeding, nutrient requirements increase to support fetal growth and the metabolic demands of pregnancy and breastfeeding.

Older adults are at high risk of undernutrition, as their nutritional needs increase, while their energy requirements decrease. This imbalance highlights the importance of older adults consuming nutrient-dense foods. [5]

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[19] Refer to Episode 101 for additional information on tobacco use and cessation.
[20] Refer to Episodes 104 and 105 for additional information on substance use and oral health.
[21] Listen to Episodes 74, 111, and 127 for discussion on breastfeeding, human milk composition and periodontal health.
[22] Refer to Episode 55 for discussion on seniors and oral health.

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Undernutrition in older adults increases the risk of fractures, post-surgical problems, pressure sores, and infections. [10]

Risk factors that contribute to undernutrition in older adults include:

- Decrease in ability to taste and smell food, reducing the enjoyment of eating.
- Oral health problems, such as ill-fitting dentures, xerostomia, tooth loss, and periodontitis, can limit the ability to chew, swallow, and digest food.
- Tooth loss can affect food choices, leading to decreases in dietary fibre and protein intake, as well as lowering the nutritional value of fresh produce through overcooking or peeling the outer skin.
- Xerostomia may influence the ability to taste salt, potentially resulting in increased salt consumption and elevated blood pressure.
- Dentures that cover the palate can affect taste and physical perception of food by blocking taste receptors and mechanoreceptors on the palate, which can impact nutritional status.
- Stroke, tremors, or other neurologic disorders can make chewing, swallowing, and preparing food difficult.
- Depression can cause a loss of appetite.
- Living situations (e.g., those who live alone may be less motivated to prepare and eat meals).
- Lack of transportation to a grocery store.
- Arthritis or other physical impairments can make shopping for and preparing food more difficult.
- Cancer can reduce appetite and increase the body's need for calories.
- Dementia can make people forget to eat or become unable to prepare food.[23]
- Poverty can limit access to nutritious foods. [10] [15] [16] [17] [18] [19]

Older adults living in care facilities are particularly vulnerable to protein-energy undernutrition due to:

- Confusion.
- Difficulty expressing hunger or food preferences.
- Not being able to choose food they like.
- Physically unable to feed themselves.
- Advanced dementia may result in resistance to attempts by others to feed them.
- Slow chewing or swallowing, making it difficult for caregivers to feed them adequately. [5] [10]

Risk factors for undernutrition [10]

Risk factor	Examples
Conditions increasing need for calories	Demanding exercise (e.g., rehabilitation or training for athletic competition) Injury (e.g., burns) High fever Infections that are widespread or severe

[23] Refer to Episode 29 for additional information on dementia and oral health.

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Risk factor	Examples
	Growth and development in infants, children, and adolescents Hyperthyroidism Pregnancy and breastfeeding Surgery
Lack of access to food	Inability to obtain food (e.g., lack of transportation, physical impairment) Poverty Drought, flooding War, civil unrest, overpopulation, unsafe housing conditions, famine
Conditions interfering with nutrient intake, metabolism, or absorption	AIDS Alcohol use disorder Anorexia nervosa Cancer Depression Diarrhea Substance use disorders Kidney failure Impaired mental function (e.g., dementia) Inflammatory bowel disorders (e.g., Crohn's disease, ulcerative colitis) Liver disorders Malabsorption disorders Bariatric surgery Vomiting
Conditions restricting the amount or type of food eaten	Fad diets Some vegan and vegetarian diets Voluntary restriction of calories (e.g., strict dieting, fasting)
Medications that interfere with nutrient consumption, metabolism, or absorption	Some medications used to treat anxiety, hypertension, heart failure, hypothyroidism, asthma, or cancer

Oral health

Nutrition and diet significantly influence oral health. Oral health refers to the condition of the mouth, teeth, and orofacial structures that allows people to perform vital functions, such as eating, breathing, and speaking. It also encompasses psychosocial aspects, including self-confidence, overall well-being, and the ability to socialize and work without pain, discomfort, or embarrassment. Oral health is crucial for maintaining general health and helps individuals participate in society and reach their full potential. [20] [21]

Nutrition and diet can affect the development and progression of oral diseases and conditions, such as dental caries, periodontal disease,[24] enamel erosion,[25] and other oral health conditions. [20]

[24] Refer to Episodes 5, 6, and 138 for discussion on periodontal disease.
[25] Refer to Episode 82 for additional information on tooth wear.

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A bidirectional relationship exists between oral health and diet and nutrition. Diet and nutrition affect the health of oral tissues; and the health of the mouth affects the ability to eat and consume nutrients. [20]

Overview of nutrition

Individuals need to consume a healthy diet consisting of a variety of nutrients to receive adequate, appropriate nutrition. A healthy diet enables people to maintain a desirable body weight and composition (i.e., percentage of fat and muscle in the body), perform daily physical and mental activities, and minimize the risk of disease and disability. [2]

Nutrients are generally divided into macronutrients and micronutrients:

- Macronutrients are required daily in relatively large amounts. These include carbohydrates proteins, fats, some minerals, and water.

- Micronutrients are required daily in small amounts (i.e., micrograms to milligrams). These include vitamins and certain minerals that enable the body to use macronutrients. These minerals are called trace minerals because only very small amounts are needed. [2]

Foods consumed in the daily diet contain as many as 100,000 substances. However, only 300 are considered nutrients, and only 45 are essential nutrients. Essential nutrients cannot be synthesized by the body and must be consumed in the diet.

Essential nutrients include:

- Vitamins
- Minerals
- Some amino acids
- Some fatty acids

Nutrients the body can make from other compounds are called nonessential. However, under certain conditions, such as illness or stress, the body may not make enough of these nonessential nutrients, thus making them essential. These conditionally essential nutrients must then be supplied by the diet. [1] [2]

Excess intake of macronutrients can lead to obesity and related disorders. Excess intake of micronutrients can lead to toxicity. Insufficient nutrients can cause undernutrition, which can result in nutritional deficiency disorders, such as:

- Kwashiorkor caused by a severe of protein deficiency resulting in fluid retention and a swollen, distended abdomen. Kwashiorkor most commonly affects children, particularly in developing countries with high levels of poverty and food insecurity.
- Pellagra caused by a severe deficiency of niacin, marked by dementia, diarrhea, and dermatitis (known as the “three Ds”). If left untreated, pellagra can be fatal.

The balance of different types of nutrients, such as unsaturated versus saturated fat consumed, can influence the development of health disorders. [1] [2] [22]

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Macronutrients
Macronutrients make up the bulk of the diet, provide energy and many essential nutrients. They include carbohydrates, proteins (which contain essential amino acids), fats (which include essential fatty acids), macrominerals, and water.

Carbohydrates, proteins, and fats all serve as energy sources, with fat providing nine calories per gram, while both carbohydrates and protein provide four calories per gram. These macronutrients also differ in how quickly they supply energy, with carbohydrates being the quickest and fats being the slowest. [1] [23]

Carbohydrates
Carbohydrates play a crucial role in providing an energy source, helping to control blood glucose and insulin metabolism, and participating in the metabolism of cholesterol and triglycerides. [24]

Carbohydrate digestion begins in the mouth, where salivary amylase starts the breakdown. The digestive tract breaks down carbohydrates into glucose, which is used for energy upon consumption. Extra glucose in the bloodstream is stored either in the liver and muscle tissue as glycogen or as fat until needed for further energy. [23] [24]

Carbohydrate molecules are composed of carbon, hydrogen, and oxygen atoms. Carbohydrates can be divided into four major groups based on the number of sugar molecules in the compound. These groups include:

- Monosaccharides are the most basic, fundamental unit of a carbohydrate consisting of one unit of sugar and are often referred to as simple sugars. Examples include glucose, galactose, and fructose.
- Disaccharides are compound sugars containing two monosaccharides. Examples include sucrose (i.e., table sugar) and lactose.
- Oligosaccharides typically contain three to ten monosaccharides. Examples include maltodextrins and raffinose.
- Polysaccharides contain long chains of monosaccharides. Examples include amylose and cellulose.

Carbohydrates can be classified as simple or complex, depending on the size of the molecule. [1] [23]

Simple carbohydrates are small molecules of one or two sugars, typically monosaccharides or disaccharides, combined together. Simple carbohydrates are easily used for energy, causing a rapid increase in blood glucose levels and insulin secretion from the pancreas. Examples of simple carbohydrates include glucose, fructose, and sucrose, lactose, maltose, galactose, and ribose. Foods containing simple carbohydrates include candy, carbonated beverages, corn syrup, fruit juice, and honey. [24]

Complex carbohydrates are made up of three or more sugars (e.g., oligosaccharides or polysaccharides) bonded together, which are broken down into monosaccharides during digestion. Complex carbohydrates tend to provide energy more slowly than simple

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carbohydrates but still more quickly than protein or fat. They also increase blood glucose levels more slowly and to lower levels than simple carbohydrates but for a longer time. Complex carbohydrates include glycogen, starches, and fibre. [1] [23] [25]

Glycogen is a form of starch found in animal tissue, formed in the liver and muscles and is stored as an energy source. [23]

Starches are *c*omplex carbohydrates containing a large number of glucose molecules. Plants produce these polysaccharides. Examples include potatoes, chickpeas, pasta, and wheat. [24]

Fibre is a nondigestible complex carbohydrate. Because the body is not able to digest fibre, fibre does not provide calories or energy. Fibre has a variety of health benefits, including bulking stool for easier excretion preventing constipation and intestinal issues, encouraging healthy bacterial growth in the colon, offering prebiotic properties, and promoting satiety (the feeling of fullness and relief of hunger). Fibre occurs in various forms, such as cellulose, hemicellulose, pectin, and gums. Dietary fibre can be insoluble or soluble. [24]

Insoluble fibre promotes gastrointestinal motility, prevents constipation, increases fecal bulk, and helps manage diverticular disease. It also may provide satiety. Insoluble fibre is believed to accelerate the elimination of cancer-causing substances produced by bacteria in the large intestine. Epidemiological evidence suggests low fibre intake is associated with a higher risk of colon cancer. Adequate fibre intake may have beneficial effects for individuals with functional bowel disorders, Crohn's disease, obesity, or hemorrhoids. Insoluble fibre is found in brans, seeds, vegetables, brown rice, and potato skins. [24]

Soluble fibre, found in foods such as fruits, vegetables, oats, barley, and legumes, helps reduce postprandial (post-meal) increases in blood glucose and insulin, and can lower blood cholesterol levels. [24]

The typical Western diet is low in fibre, averaging around 12 to 17 grams per day, due to high consumption of highly refined wheat flour and low intake of fruits and vegetables. Increasing fibre intake to about 30 grams per day by consuming more vegetables, fruits, and high-fibre cereals and grains is generally recommended. For example, females need approximately 25 grams of fibre per day and males need 38 grams of fibre per day. Most Canadians only get about half that much. However, very high fibre intake may interfere with the absorption of certain minerals. [1] [24] [26] [27]

Soluble and insoluble fibre [26]

Type	Examples of sources	Function
Soluble	Apples (mainly in flesh of apples) Barley Beans Citrus fruits Lentils	Helps moderate changes in blood glucose and insulin levels that occur after eating a meal Helps reduce cholesterol levels May reduce the risk of atherosclerosis, including coronary artery disease

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Type	Examples of sources	Function
	Oat bran Oatmeal Pectin (from fruit) Psyllium Rice bran Strawberries	
Insoluble	Apples (mainly in apple skin) Brown rice Pears Prunes Many vegetables (e.g., cabbage, root vegetables, zucchini) Whole grains Whole-grain breads and pastas	Provides bulk to feces, helping food move through the digestive tract, preventing constipation Helps eliminate cancer-causing substances produced by bacteria in the large intestine Helps prevent diverticular disease Helps people feel less hungry by adding bulk to the diet, encouraging slower chewing, and prolonging the time food stays in the stomach, making it beneficial for weight loss.

Proteins

Proteins are complex organic molecules composed of carbon, hydrogen, oxygen, and nitrogen. During digestion, dietary proteins are broken down into peptides and amino acids. Proteins are critical for the maintenance, replacement, function, and growth of tissues. Certain proteins also serve as enzymes, constitute specific hormones, and play a vital role in maintaining fluid balance. [1]

There are 20 amino acids. The body synthesizes some of them from components within the body. Nine amino acids are essential amino acids as they cannot be synthesized and must be consumed in the diet. Everyone requires eight essential amino acids: isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Infants also need histidine. [1] [23]

The body needs protein to maintain and replace tissues and to function and grow. Protein is not usually used for energy. However, if the body does not receive enough calories from food sources or from body fat stores, protein is broken down to be used for energy. If more protein is consumed than is needed, the body breaks the protein down and stores its components as fat. [1] [23]

As individuals age, they often experience muscle loss. If older adults do not consume enough protein, they may lose even more muscle. For those with eating difficulties, such as swallowing or chewing issues (e.g., from tooth loss or ill-fitting dentures), it is important to include protein-rich foods that are easier to chew than meat, including fish, dairy and soy products, eggs, peanut butter, and beans. [1] [2]

Fats

Fats are broken down into fatty acids and glycerol. Fats are required for tissue growth, energy, hormone production, and other substances needed by the body (e.g., prostaglandins). [1] [23]

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Fats are the slowest source of energy but also the most energy-efficient type of food. Because fats provide an efficient energy source, the body stores any excess energy as fat. This excess fat is typically deposited in the abdomen (visceral fat) and beneath the skin (subcutaneous fat) to use when additional energy is required. However, excess fat can also accumulate in blood vessels and organs, potentially blocking blood flow and damaging organs, which can lead to serious health disorders. [23]

Fatty acids

The body can synthesize certain fatty acids. Other fatty acids, called essential fatty acids, cannot be synthesized by the body and must be consumed in the diet. Essential fatty acids include:

- Linoleic acid, an omega-6 fatty acid
- Linolenic acid, an omega-3 fatty acid

Other omega-6 acids (e.g., arachidonic acid) and other omega-3 fatty acids (e.g., eicosapentaenoic acid, docosahexaenoic acid) are required by the body but can be synthesized from essential fatty acids.

Eicosapentaenoic acid and docosahexaenoic acid, which are fatty acids vital for brain development, can be synthesized from linolenic acid. However, they also are present in certain marine (salt water) fish oils, which are a more efficient source. [1] [23]

Essential fatty acids are needed to form various eicosanoids (biologically active lipids), including prostaglandins, thromboxanes, prostacyclins, and leukotrienes.

Vegetable oils provide linoleic acid and linolenic acid. Oils made from safflower, sunflower, corn, soy, primrose, pumpkin, and wheat germ provide large amounts of linoleic acid. Marine fish oils and oils made from flaxseeds, pumpkin, soy, and canola provide large amounts of linolenic acid. Marine fish oils also provide some other omega-3 fatty acids in large amounts.

A diet rich in omega-3 fatty acids may reduce the risk of atherosclerosis, including coronary artery disease. Most people tend to consume enough omega-6 fatty acids, which occur in the oils used in many processed foods, but not enough omega-3 fatty acids. [1] [23]

Types of dietary fat

There are different types of fat:

- Monounsaturated
- Polyunsaturated
- Saturated

Saturated fats are more likely to increase cholesterol levels and increase the risk of atherosclerosis. Foods derived from animals commonly contain saturated fats, which tend to be solid at room temperature. Fats derived from plants commonly contain monounsaturated or polyunsaturated fatty acids, which tend to be liquid at room

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temperature. Palm and coconut oil are exceptions and contain more saturated fats than other plant oils. [1] [23]

Partial hydrogenation of unsaturated fatty acids during food manufacturing, produces trans fatty acids (trans fats), which are solid or semisolid at room temperature. Consuming trans fatty acids may elevate LDL (low-density lipoprotein) cholesterol, lower HDL (high-density lipoprotein) cholesterol, and increase the risk of atherosclerosis and coronary artery disease. [1] [23]

Sources of fat [23]

Type of fat	Examples of sources
Monosaturated	Avocado, olive, and peanut oils Peanut butter
Polyunsaturated	Canola, corn, soybean, sunflower, and many other liquid vegetable oils
Saturated	Meats, particularly beef Full-fat dairy products such as whole milk, butter, and cheese Coconut and palm oils Artificially hydrogenated vegetable oils
Omega-3 fatty acids	Flaxseed Lake trout, certain deep-sea fish (e.g., mackerel, salmon, herring, tuna) Green leafy vegetables Walnuts
Omega-6 fatty acids	Vegetable oils (e.g., sunflower, safflower, corn, cottonseed, soybean oils) Fish oils Egg yolks
Trans fats	Commercially baked foods (e.g., cookies, crackers, doughnuts) Some French fries and other fried foods Margarine Shortening Potato chips

Acceptable macronutrient distribution ranges [28]

Age	Total carbohydrate percent of energy	Total protein percent of energy	Total fat percent of energy
1 – 3 years	45–65%	5–20%	30–40%
4 – 18 years	45–65%	10–30%	25–35%
19 years and older	45–65%	10–35%	20–35%

Acceptable macronutrient distribution is a range of intake for a particular energy source (protein, fat, or carbohydrate), expressed as a percentage of total energy (kcal), that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients. [29]

Macrominerals

Calcium, chloride, magnesium, phosphate, potassium, and sodium are required in relatively large amounts per day (approximately 1 to 2 grams per day) and are considered macrominerals. Macrominerals important for tooth and bone formation include calcium, magnesium, and phosphorus. [1] [30]

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Macrominerals [1]

Mineral	Main sources	Functions
Calcium	Milk and milk products, meat, fish, eggs, cereals, beans, fruits, vegetables	Bone and tooth formation, blood coagulation, nerve transmission, muscle contraction, myocardial conduction
Chloride	Many foods, mainly animal products but some vegetables; similar to sodium	Blood and intracellular acid-base balance, osmotic pressure, kidney function
Potassium	Many foods, including whole and skim milk, bananas, prunes, raisins, and meats	Muscle contraction, nerve transmission, intracellular acid-base balance, water balance
Magnesium	Milk and milk products, meat, fish, eggs, cereals, beans, fruits, vegetables	Bone and tooth formation, nerve transmission, muscle contraction, enzyme activation
Sodium	Many foods, including beef, pork, sardines, cheese, green olives, and sauerkraut	Blood and intracellular acid-base balance, osmotic pressure, muscle contraction, nerve transmission, maintenance of cell membrane gradients
Phosphorus	Milk, cheese, meat, poultry, fish, cereals, nuts, legumes	Bone and tooth formation, blood and intracellular acid-base balance, energy production

Water

Water is classified as a macronutrient because the body requires approximately 1 millilitre of water for each calorie of energy expended, or approximately 2.7 litres for adult females and 3.7 litres for adult males per day. However, individual water intake needs can vary significantly based on factors such as age, sex, fever, physical activity levels, and changes in climate and humidity. What is most important is to drink enough fluids to avoid dehydration.

Signs of dehydration may include:

- Thirst
- Dry lips and dry mouth
- Flushed skin
- Headache
- Dizziness and fainting
- Dark yellow, strong-smelling urine
- Hypotension and increased heart rate

Individuals can be dehydrated without showing any signs, so it is important to drink fluids regularly, even before feeling thirsty. People can meet their water needs by consuming water as well as variety of other beverages.

As people age, they are more likely to become dehydrated because their ability to sense thirst decreases. Dehydration can lead to dizziness, fainting, and hypotension, putting older adults at risk for falls. Dehydration may also make constipation worse. Older adults need to make a conscious effort to drink enough fluids rather than wait until they feel thirsty. However, older adults do not typically need to drink more water than younger people. [1] [2] [31] [32]

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Drinking water is important for overall health, quenching thirst and staying hydrated without the added sugar, calories, sodium, and saturated fats.

Tips to stay hydrated include:
- Making water the drink of choice and drink water throughout the day.
- Choosing water to drink when thirsty. Avoid soft drinks, sugary drinks, and fruit juices, which can contribute to dental caries and enamel erosion.
- Drinking water hot or cold.
- Taking sips of water while eating meals and snacks.
- Asking for water when eating out.
- Keeping a jug full of ice water in the fridge at home or at work.
- Adding flavour to water by adding herbs or fruit (e.g., fresh mint or basil, berries, chopped apples, cucumber slices).
- Carrying water in a reusable bottle at work, school, or when out.
- Drinking water during and after physical activity or playing sports.
- Remembering to drink more in hot weather and when very active. [31] [33] [34]

Other beverages to help stay hydrated can include:
- White milk (unsweetened lower fat milk).
- Unsweetened fortified plant-based beverages such as soy or almond beverage.
- Unsweetened coffee and teas.
- Drinks with little to no added sodium, sugars, or saturated fat. [34]

Fluid intake to help stay hydrated [32]

Life stage	Number of cups to aim for each day (1 cup = 250 mL)
0-6 months	3*
7-12 months	2.5**
1-3 years	3.5
4-8 years	5
9-13 years (female)	6.5
9-13 years (male)	7
14-18 years (female)	7
14-18 years (male)	10.5
19 years and older (female)	9
19 years and older (male)	12
Pregnant	9
Breastfeeding	12.5

* From breastmilk or formula
** From breastmilk, formula, water, or fluid milk

Micronutrients
Vitamins and minerals are essential nutrients as they cannot be made by the body from other substances in the diet. Thus, vitamins and minerals must be consumed. Vitamins and minerals required in minute amounts are considered micronutrients.

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Vitamins

Vitamins are classified as either water or fat soluble:

- Water soluble vitamins are vitamin C (ascorbic acid) and the eight members of the vitamin B complex, including B1 (thiamin), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin), B9 (folate [folic acid]), B12 (cobalamin).
- Fat soluble vitamins are vitamins A (retinol), D (cholecalciferol and ergocalciferol), E (alpha-tocopherol), and K (phylloquinone and menaquinone). [35]

Only vitamins A, D, E, K, and B12 are stored to any significant extent in the body; the other vitamins must be consumed regularly to maintain tissue health. [1] [30]

Vitamin deficiencies can result from:

- Poverty
- Food fads, restrictive diets
- Drug and food interactions
- Alcohol use disorder
- Prolonged and inadequately supplemented parenteral nutrition[26]
- Malabsorption
- Bariatric surgery
- Hemodialysis [35]

Mild vitamin deficiency is common among older adults who are frail, living in care facilities, and have protein-energy undernutrition.[27] [35]

Deficiencies of water-soluble vitamins (except vitamin B12) may develop after weeks to months of undernutrition. Deficiencies of fat-soluble vitamins and vitamin B12 take over one year to develop, as the body stores them in relatively large amounts. [35]

Vitamin toxicity (hypervitaminosis) usually results from taking megadoses of vitamin A, D, C, B6, or niacin, usually as supplements, without medical supervision. [1] [10] [30] [35]

Vitamin sources, functions, and effects [30] [35] [36]

Vitamin	Main sources	Functions	Deficiency effects	Toxicity effects
A (retinol) [37] [38]	As vitamin A: fish liver oils, liver, egg yolks, butter, vitamin A-fortified dairy products As carotenoids (converted to vitamin A in the	Required to form light-sensitive nerve cells (photoreceptors) in the retina, to help maintain night vision Helps maintain health of skin, cornea, and lining of lungs, intestine, and urinary tract	Night blindness Blindness can eventually develop Eyes, skin, and other tissues become dry and damaged Infections develop more often	Headache Hair loss Dry, peeling skin Hepatosplenomegaly Weakened bones Intracranial hypertension (increased pressure within the skull)

[26] Parental nutrition is nutrition given intravenously.

[27] Protein-energy undernutrition refers to an energy deficit primarily caused by a severe lack of protein. However, it often includes deficiencies in other macronutrients and many micronutrients. [76]

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Vitamin	Main sources	Functions	Deficiency effects	Toxicity effects
	body), such as beta-carotene: dark green, yellow, and orange vegetables and yellow and orange fruits	Helps protect against infections Lysosome stability Glycoprotein synthesis	Increased morbidity and mortality in young children	Hypercalcemia (increased blood calcium levels)
B1 (thiamin) [39] [40]	Dried yeast, whole grains, meat (especially pork and liver), enriched cereal products, nuts, legumes, potatoes	Carbohydrate, fat, amino acid, glucose, and alcohol metabolism Central and peripheral nerve cell function Heart function	Beriberi (peripheral neuropathy, heart failure) Wernicke-Korsakoff syndrome (confusion, severe memory loss)	Toxicity is rare
B2 (riboflavin) [41] [42] [43]	Milk, cheese, liver, meat, eggs, enriched cereal products	Carbohydrate and protein metabolism Integrity of mucous membranes, including oral mucous membranes	Corneal vascularization Seborrheic dermatitis	Essentially nontoxic
B3 (niacin) [44] [45]	Dried yeast, liver, red meat, poultry, fish, legumes, whole-grain or enriched cereals and breads	Oxidation-reduction reactions Carbohydrate and fat metabolism Normal cell functioning	Pellagra: dermatitis (localized dark rash on hands, feet, calves, neck, face), diarrhea, and central nervous symptoms with cognitive decline and dementia	Flushing, itching Liver damage (rare)
B5 (pantothenic acid) [46] [47]	Liver, beef, egg yolks, yeast, potatoes, broccoli, whole grains	Carbohydrate and fat metabolism	Isolated pantothenic deficiency is rare	Toxicity is rare Upset stomach Diarrhea
B6 (pyridoxine, pyridoxal, pyridoxamine) [48] [49]	Dried yeast, organ meats (e.g., liver), whole-grain cereals, fish, legumes	Fat, carbohydrate, and amino acid metabolism Normal nerve function Formation of red blood cells and healthy skin	Seizures Anemia Neuropathy Seborrheic dermatitis	Peripheral neuropathy
B7 (biotin) [46] [50]	Liver, kidneys, meats, eggs, milk, fish, dried yeast, sweet potatoes, seeds, nuts	Fat and carbohydrate metabolism	Isolated biotin deficiency is rare	Toxicity is rare Insomnia Excessive thirst and urination
B9 (folate, folic acid) [51]	Raw green leafy vegetables, asparagus, broccoli, fruits	Red blood cell formation DNA and RNA synthesis Fetal nervous system development	Anemia Neural tube birth defects Diarrhea	Essentially nontoxic

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Vitamin	Main sources	Functions	Deficiency effects	Toxicity effects
	(especially citrus), liver, other organ meats, dried yeast, enriched breads, pastas, and cereals (Note: Extensive cooking destroys 50–95% of folate in food)		Depression Confusion	
B12 (cobalamin) [52]	Meats (especially beef, pork, organ meats), poultry, eggs, fortified cereals, milk and milk products, clams, oysters, mackerel, salmon, tuna	Red blood cell formation, nerve function, DNA synthesis, myelin synthesis and repair	Anemia Neurologic symptoms (e.g., confusion, loss of reflexes, difficulty walking, paresthesia, dementia)	Large amounts of vitamin B12 seem to be nontoxic; consuming excess amounts is not recommended
C (ascorbic acid) [53] [54]	Citrus fruits, tomatoes, potatoes, broccoli, strawberries, sweet peppers	Formation, growth, and repair of bone, skin, and connective tissue Collagen synthesis Wound healing Recovery from burns Normal blood vessel function Antioxidant, protects cells from damage by free radicals Supports immune function Facilitates iron absorption	Scurvy (bone defects, see oral manifestations below) Fatigue Depression Impaired wound healing Internal bleeding Petechiae rash	Toxicity is rare but may be caused by high doses of vitamin C supplements Nausea Diarrhea Interferes with antioxidant activity balance in the body Can promote iron overload in individuals with thalassemia or hemochromatosis
D (cholecalciferol and ergocalciferol) [55]	Direct ultraviolet B irradiation of the skin (main source) Fortified dairy products (main dietary source), fish liver oils, fatty fish, liver, egg yolks	Promotes calcium and phosphate absorption Bone formation, growth mineralization, and repair Insulin and thyroid function Improves immune function, reduces risk of autoimmune disorders	Hypocalcemia Rickets in children (e.g., soft skull, abnormal bone growth, infants slow to sit and crawl, muscle spasms [tetany]) Osteomalacia in adults increasing fracture risk	Hypercalcemia Loss of appetite Kidney failure Metastatic calcifications

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Vitamin	Main sources	Functions	Deficiency effects	Toxicity effects
E (alpha-tocopherol, other tocopherols) [56] [57]	Vegetable oils, nuts, seeds, green leafy vegetables, and wheat germ	Antioxidant, protects cells from damage by free radicals	Hemolytic anemia (red blood cells rupture) Neurologic symptoms due to neuron degeneration (e.g., muscle weakness)	Tendency to bleed Muscle weakness Fatigue Nausea Diarrhea
K (K1: phylloquinone K2: menaquinone) [58] [59]	Vitamin K1: Green leafy vegetables (especially collards, spinach, salad greens), soy beans, vegetable oils Vitamin K2: Synthesized by bacteria in the gastrointestinal tract after neonatal period	Formation of prothrombin, other clotting factors, thus necessary for normal blood clotting Required for healthy bones and other tissues	Bleeding (e.g., easy bruising, mucosal bleeding) Bleeding risk is increased by warfarin or related anticoagulant use Osteopenia	Vitamin K1 (phylloquinone) is not toxic when consumed orally, even in large amounts. Menadione (synthetic, water-soluble vitamin K precursor) can cause toxicity (e.g., infants have developed jaundice, and hemolytic anemia due to red blood cell rupture)

DNA = deoxyribonucleic acid; RNA = ribonucleic acid

Oral manifestations of water-soluble vitamin deficiency [35] [44] [60] [61] [62] [63] [64]

Vitamin deficiency	Main sources	Oral manifestations
Vitamin B1 (thiamin)	Dried yeast, whole grains, meat (especially pork and liver), enriched cereal products, nuts, legumes, potatoes	• Glossitis (inflammation of tongue) • Recurrent aphthous stomatitis • Angular cheilitis • Burning mouth[28]
Vitamin B2 (riboflavin)	Milk, cheese, liver, meat, eggs, enriched cereal products	• Erythema of pharyngeal and oral mucous membranes • Atrophic glossitis • Burning mouth (glossodynia) • Cheilosis (pallor and maceration of lip vermillion) • Angular cheilitis
Vitamin B3 (niacin, nicotinic acid) Deficiency is known as pellagra	Dried yeast, liver, red meat, poultry, fish, legumes, whole-grain or enriched cereals and breads	• Mucosal edema and erythema • Cheilosis (dry, cracked lips) • Stomatitis • Angular cheilitis • Dark red glossitis • Burning mouth

[28] Refer to Episode 106 for information on burning mouth syndrome.

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Vitamin deficiency	Main sources	Oral manifestations
		• Gingival erythema • Oral ulcerations • Increased salivation • Dental caries
Vitamin B6 (pyridoxine)	Dried yeast, organ meats (e.g., liver), whole-grain cereals, fish, legumes	• Atrophic glossitis • Cheilosis • Angular cheilitis • Gingival erythema • Burning mouth
Vitamin B9 (folic acid)	Raw green leafy vegetables, asparagus, broccoli, fruits (especially citrus), liver, other organ meats, dried yeast, and enriched breads, pastas, and cereals (Extensive cooking destroys 50-95% of the folate in food)	• Atrophic glossitis with erythema and tongue swelling • Angular cheilitis • Burning mouth • Dysphagia • Recurrent aphthous stomatitis • Reduced taste
Vitamin B12 (cobalamin)	Meats (especially beef, pork, organ meats), poultry, eggs, fortified cereals, milk and milk products, clams, oysters, mackerel, salmon, tuna	• Generalized stomatitis • Taste disturbance • Red, atrophic, beefy, burning tongue with bald appearance due to loss of filiform papillae • Recurrent aphthous stomatitis
Vitamin C (L-ascorbic acid, ascorbic acid) Deficiency is known as scurvy	Citrus fruits, tomatoes, potatoes, broccoli, strawberries, sweet peppers	• Mucosal petechiae • Hemorrhagic gingivitis • Gingival bleeding • Gingival hypertrophy • Intraoral ulceration • Tooth mobility • Tooth loss • Impaired wound healing • Burning mouth

Oral manifestations of fat-soluble vitamin deficiency and toxicity [35] [38] [60] [65]

Vitamin deficiency / toxicity	Main sources	Oral manifestations
Vitamin A (retinol) deficiency	As vitamin A: fish liver oils, liver, egg yolks, butter, vitamin A-fortified dairy products As carotenoids (converted to vitamin A in the body), such as beta-carotene: dark green, yellow, and orange vegetables and yellow and orange fruits	• Xerostomia • Periodontal disease • Increased intraoral infection • Impaired tooth development in children

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Vitamin A (retinol) toxicity	As above	• Cheilitis • Cheilosis • Gingivitis • Impaired healing
Vitamin D (calciferol, cholecalciferol, ergocalciferol) deficiency	Direct ultraviolet B irradiation of the skin (main source), fortified dairy products (main dietary source), fish liver oils, fatty fish, liver	• Loss of periodontal attachment • Recurrent aphthous stomatitis • Associated with higher risk of tooth defects, caries, tooth loss, gingival bleeding[29]
Vitamin K (phylloquinone) deficiency	Green leafy vegetables (especially collards, spinach, salad greens), soy beans, vegetable oils	• Submucosal hemorrhage • Gingival bleeding

Microminerals

Essential trace minerals are required in small amounts. They include chromium, copper, iodine, iron, manganese, molybdenum, selenium, and zinc. Each of these minerals is incorporated into enzymes or hormones required in metabolism, except chromium, which helps maintain blood glucose levels. [66]

Trace minerals, such as arsenic, cobalt, fluoride, nickel, silicon, and vanadium, have not been established as requirements in human nutrition. However, fluoride helps prevent dental caries by enhancing enamel resistance to acid dissolution and promoting remineralization. [30] [67]

All trace minerals are toxic at high levels, and some, including arsenic, nickel, and chromium, can cause cancer. [1] [30]

Trace mineral deficiencies, except for iodine, iron, and zinc, do not often develop spontaneously in adults on ordinary diets; infants are more vulnerable because their growth is rapid and intake varies. [66]

Trace mineral imbalances can result from:
- Hereditary disorders (e.g., hemochromatosis, Wilson disease)
- Kidney dialysis
- Parenteral nutrition
- Restrictive diets prescribed for individuals with inherited metabolism disorders
- Various popular diet plans. [66]

[29] Refer to Episode 22 for additional information on vitamin D and oral health.

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Trace minerals [66] [68] [69] [70] [71] [72] [73] [74]

Mineral	Main sources	Functions	Effects of deficiency	Effects of toxicity
Chromium	Liver, processed meats, whole-grain cereals, nuts	Promotes glucose tolerance	Impaired glucose tolerance, increasing risk of diabetes Weight loss Confusion Impaired coordination	Workplace exposure to hexavalent chromium (e.g., welding plants, steel mills) may irritate the skin, lungs, and gastrointestinal tract and may cause nasal septum perforation and lung carcinoma.
Cooper	Organ meats, shellfish, nuts, dried legumes, dried fruits, whole-grain cereals, peas, cocoa, mushrooms, tomato products	Enzyme component, hematopoiesis, bone formation	Anemia in undernourished children Can be present in Menkes (kinky-hair) syndrome	Copper poisoning; can be present in Wilson disease
Fluoride	Seafood, tea, fluoridated water	Bone and tooth formation	Possibly osteoporosis[30]	Exostoses of spine
Iodine	Seafood, iodized salt, eggs, cheese, drinking water (content varies)	Thyroxine (T4) and triiodothyronine (T3) synthesis, development of fetus	Simple goiter Congenital hypothyroidism with deaf-mutism, impaired fetal growth and brain development	Hyperthyroidism or hypothyroidism
Iron	Many foods (except dairy products), soybean flour, beef, kidney, liver, fish, poultry, beans, clams, molasses, enriched grains and cereals (bioavailability variable in plant sources)	Hemoglobin and myoglobin formation, cytochrome enzymes, iron-sulfur proteins	Anemia Pica	Cirrhosis, diabetes, skin pigmentation can be present in hemochromatosis

[30] Refer to Episodes 41 and 42 for additional information on osteoporosis and oral health.

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Mineral	Main sources	Functions	Effects of deficiency	Effects of toxicity
Manganese	Whole-grain cereals, pineapple, nuts, tea, beans, tomatoes	Healthy bone structure Component of several enzymes	Has not been conclusively documented	Neurologic symptoms resembling those of parkinsonism or Wilson disease
Molybdenum	Milk, legumes, whole-grain breads and cereals, dark green vegetables	Component of several coenzymes	Tachycardia, headache, nausea, vomiting, coma	Data are limited. Possibly joint pain
Selenium	Meats, seafood, poultry, eggs, Brazil nuts, breads, grains, garlic, mushrooms	Component of specific enzymes Antioxidant	Keshan disease (viral cardiomyopathy) Muscle weakness Selenium deficiency may work with iodine deficiency to cause goiter and hypothyroidism	Nausea, diarrhea, hair loss, abnormal nails, dermatitis, peripheral neuropathy, fatigue, irritability, garlic breath odour
Zinc	Meat, liver, oysters, seafood, fortified cereals, peanuts, whole grains (bioavailability variable in plant sources)	Enzyme component, skin integrity, wound healing, growth	Impaired growth and delayed sexual maturation, hypogonadism, impaired taste and smell, impaired immunity, loss of appetite, dermatitis, night blindness, anemia, lethargy, impaired wound healing. Low birth weight and preterm birth	Red blood cell microcytosis, neutropenia, impaired immunity

Oral manifestations of mineral deficiency [60] [66] [75]

Mineral deficiency	Main sources	Oral manifestations
Iron	Many foods (except dairy products), soybean flour, beef, kidney, liver, fish, poultry, beans, clams, molasses, enriched grains and cereals (bioavailability variable in plant sources)	• Angular cheilitis • Atrophic glossitis • Burning mouth • Recurrent aphthous stomatitis
Zinc	Meat, liver, oysters, seafood, fortified cereals, peanuts, whole grains (bioavailability variable in plant sources)	• Burning mouth syndrome • Recurrent aphthous stomatitis • Perioral or intraoral erosions • Dysgeusia • Angular cheilitis

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Mineral deficiency	Main sources	Oral manifestations
		• Impaired wound healing • Impaired taste

Oral manifestations of fluoride deficiency and toxicity [66]

Mineral	Main sources	Functions	Effects of deficiency	Effects of toxicity
Fluoride	Seafood, tea, fluoridated water	Bone and tooth formation	Increased risk of dental caries	Fluorosis, mottling and pitting of teeth

Take home messages

- Nutritional health requires adequate intake of carbohydrates, proteins, fats, water, vitamins, and minerals to support life.
- Good nutrition promotes oral and systemic health, and good oral health supports nutritional and systemic health.
- Both overnutrition and undernutrition can impact oral health.
- Oral health professionals play a key role in the early detection of nutrient-related oral conditions, for enabling timely diagnosis, treatment, and referral as required, emphasizing the importance of being knowledgeable about oral and systemic conditions associated with nutritional disorders.
- Increasing client awareness about the relationship between diet, nutrition, and oral health is crucial, which includes following Canada's Food Guide.
- Interprofessional collaboration with physicians, nurse practitioners, medical specialists, and registered dieticians is essential to help clients improve their nutrition to support oral and systemic health.

References

[1] S. Bhupathiraju and F. Hu, "Overview of Nutrition," Merck Manual Professional Version, April 2024. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/nutrition-general-considerations/overview-of-nutrition. [Accessed 20 October 2025].

[2] S. Bhupathiraju and F. Hu, "Overview of Nutrition," Merck Manual Consumer Version, September 2023. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/overview-of-nutrition/overview-of-nutrition. [Accessed 20 October 2025].

[3] World Health Organization, "Nutrition," 2025. [Online]. Available: https://www.who.int/health-topics/nutrition#tab=tab_1. [Accessed 20 October 2025].

[4] World Health Organization, "Sugars and dental caries," 14 August 2025. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/sugars-and-dental-caries. [Accessed 20 October 2025].

[5] S. Bhupathiraju and F. Hu, "Overview of Undernutrition," Merck Manual Professional Version, April 2024. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/undernutrition/overview-of-undernutrition. [Accessed 1 November 2025].

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[6] P. Mathur and R. Pillai, "Overnutrition: Current scenario & combat strategies," *Indian Journal of Medical Research,* vol. 149, no. 6, pp. 695-705, June 2019.

[7] S. Svacina, "Basic concepts in nutrition: Overnutrition – Functional and clinical consequences," *European e-Journal of Clinical Nutrition and Metabolism,* vol. 3, no. 4, pp. e173-e178, August 2008.

[8] H. Arbildo-Vega, F. Cruzado-Oliva, F. Coronel-Zubiate, et al., "Association between periodontal disease and obesity: Umbrella review," *Medicina,* vol. 60, no. 4, pp. 1-25, 11 April 2024.

[9] B. Heath, W. Gong, H. Taner, et al., "Saturated fatty acids dampen the immunogenicity of cancer by suppressing STING," *Cell Reports,* vol. 42, no. 4, pp. 1-25, 25 April 2023.

[10] S. Bhupathiraju and F. Hu, "Undernutrition," Merck Manual Consumer Version, October 2023. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/undernutrition/undernutrition. [Accessed 1 November 2025].

[11] Z. Malik, "Overview of Malabsorption," Merck Manual Professional Version, 2025 March. [Online]. Available: https://www.merckmanuals.com/professional/gastrointestinal-disorders/malabsorption-syndromes/overview-of-malabsorption. [Accessed 1 November 2025].

[12] Z. Malik, "Overview of Malabsorption," Merck Manual Consumer Version, March 2025. [Online]. Available: https://www.merckmanuals.com/home/digestive-disorders/malabsorption/overview-of-malabsorption. [Accessed 1 November 2025].

[13] American Psychiatric Association, "What are Eating Disorders?," 2023. [Online]. Available: https://www.psychiatry.org/patients-families/eating-disorders/what-are-eating-disorders#section_0. [Accessed 2 October 2023].

[14] National Institute of Mental Health, "Eating Disorders," January 2023. [Online]. Available: https://www.nimh.nih.gov/health/topics/eating-disorders. [Accessed 12 October 2023].

[15] I. Lamster, L. Asadourian, T. Del Carmen and P. Friedman, "The aging mouth: Differentiating normal aging from disease," *Periodontology 2000,* vol. 72, no. 1, pp. 96-107, 8 August 2016.

[16] L. Cassiano, F. Leite, S. Alves-Costa, et al., "Oral conditions are associated with salt taste disability among American adults," *Oral Diseases,* vol. 30, no. 8, pp. 5475-5482, 2 April 2024.

[17] V. Doddawad, F. Mehrin, K. Raghavendraswamy, et al., "Evaluation of different taste sensations along with body mass index (BMI) in geriatric patients with and without complete dentures," *Journal of Education and Health Promotion,* vol. 13, no. 1, pp. 1-5, 2024.

[18] E. Juzikis, J. Klimenko, Ž. J and E. Ivanauskienė, "The effect of new acrylic full removable dentures on food taste," *Stomatologija,* vol. 23, no. 2, pp. 48-50, 2021.

[19] R. Carvalho da Silva, W. Lacerda, I. Henn and etal., "Relationship between taste perception and use of upper complete dentures," *Special Care in Dentistry,* vol. 41, no. 2, pp. 244-250, 5 January 2021.

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[20] American Dental Association, "Nutrition and Oral Health," 30 August 2023. [Online]. Available: https://www.ada.org/resources/ada-library/oral-health-topics/nutrition-and-oral-health. [Accessed 20 October 2025].

[21] World Health Organization, "Oral health," 2025. [Online]. Available: https://www.who.int/health-topics/oral-health#tab=tab_1. [Accessed 27 October 2025].

[22] Cleveland Clinic, "Kwashiorkor," 18 May 2022. [Online]. Available: https://my.clevelandclinic.org/health/diseases/23099-kwashiorkor. [Accessed 1 November 2025].

[23] Bhupathiraju, S; Hu, F, "Carbohydrates, Proteins, and Fats," Merck Manual Consumer Version, August 2025. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/overview-of-nutrition/carbohydrates-proteins-and-fats. [Accessed 28 October 2025].

[24] J. Holesh, S. Aslam and A. Martin, "Physiology, Carbohydrates," StatPearls [Internet], 12 May 2023. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK459280/. [Accessed 29 October 2025].

[25] Britannica, "carbohydrate," 27 October 2025. [Online]. Available: https://www.britannica.com/science/carbohydrate. [Accessed 28 October 2025].

[26] S. Bhupathiraju and F. Hu, "Fiber," Merck Manual Consumer Version, February 2023. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/overview-of-nutrition/fiber. [Accessed 29 October 2025].

[27] Government of Canada, "Fibre," 11 July 2025. [Online]. Available: https://www.canada.ca/en/health-canada/services/nutrients/fibre.html. [Accessed 29 October 2025].

[28] Government of Canada, "Dietary reference intakes tables: Reference values for macronutrients," 18 December 2023. [Online]. Available: https://www.canada.ca/en/health-canada/services/food-nutrition/healthy-eating/dietary-reference-intakes/tables/reference-values-macronutrients.html. [Accessed 29 October 2025].

[29] Government of Canada, "Dietary reference intakes tables: Overview," 18 December 2023. [Online]. Available: https://www.canada.ca/en/health-canada/services/food-nutrition/healthy-eating/dietary-reference-intakes/tables.html. [Accessed 29 October 2025].

[30] Bhupathiraju, S; Hu, F, "Vitamins and Minerals," Merck Manual Consumer Version, February 2023. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/overview-of-nutrition/vitamins-and-minerals. [Accessed 29 October 2025].

[31] Government of Canada, "Health Promotion - Facts on fluids: How to stay hydrated," 12 August 2021. [Online]. Available: https://www.canada.ca/en/department-national-defence/corporate/news/regional-news/western-sentinel/2021/08/facts-on-fluids-how-to-stay-hydrated.html. [Accessed 29 October 2025].

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[32] Dietitians of Canada, "Facts on Fluids - How to Stay Hydrated," 25 October 2021. [Online]. Available: https://www.unlockfood.ca/en/articles/water/facts-on-fluids-how-to-stay-hydrated.aspx. [Accessed 29 October 2025].

[33] Canadian Dental Association, "Nutrition," 2025. [Online]. Available: https://www.cda-adc.ca/en/oral_health/cfyt/dental_care/nutrition.asp. [Accessed 29 October 2025].

[34] Government of Canada, "Make water your drink of choice," 16 October 2025. [Online]. Available: https://food-guide.canada.ca/en/healthy-eating-recommendations/make-water-your-drink-of-choice/. [Accessed 29 October 2025].

[35] L. Johnson, "Overview of Vitamins," Merck Manual Professional Version , August 2024. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/overview-of-vitamins. [Accessed 29 October 2025].

[36] L. Johnson, "Overview of Vitamins," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/overview-of-vitamins. [Accessed 29 October 2025].

[37] L. Johnson, "Vitamin A Deficiency," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-a-deficiency. [Accessed 29 October 2025].

[38] L. Johnson, "Vitamin A Excess," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-a-excess. [Accessed 28 October 2025].

[39] L. Johnson, "Thiamin Deficiency," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/thiamin-deficiency. [Accessed 28 October 2025].

[40] J. Martel, H. Doshi, R. Sina and D. Franklin, "Vitamin B1 (Thiamine)," StatPearls [Internet], 31 January 2024. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK482360/. [Accessed 29 October 2025].

[41] L. Johnson, "Riboflavin Deficiency," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/riboflavin-deficiency. [Accessed 28 October 2025].

[42] L. Johnson, "Riboflavin Deficiency," Merck Manual Professional Version, August 2024. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/riboflavin-deficiency. [Accessed 28 October 2025].

[43] B. Peechakara, R. Sina and M. Gupta, "Vitamin B2 (Riboflavin)," StatPearls [Internet], 1 February 2024. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK525977/. [Accessed 29 October 2025].

[44] L. Johnson, "Niacin Deficiency," Merck Manual Professional Version, August 2024. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/niacin-deficiency. [Accessed 29 October 2025].

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[45] L. Johnson, "Niacin Excess," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/niacin-excess. [Accessed 29 October 2025].

[46] L. Johnson, "Biotin and Pantothenic Acid," Merck Manual Professional Version, August 2024. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/biotin-and-pantothenic-acid. [Accessed 29 October 2025].

[47] T. Sanvictores and S. Chauhan, "Vitamin B5 (Pantothenic Acid)," StatPearls [Internet], 29 February 2024. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK563233/. [Accessed 29 October 2025].

[48] L. Johnson, "Vitamin B6 Deficiency," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-b6-deficiency. [Accessed 29 October 2025].

[49] L. Johnson, "Vitamin B6 Excess," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-b6-excess. [Accessed 29 October 2025].

[50] K. Bistas and P. Tadi, "Biotin," StatPearls [Internet], 3 July 2023. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK554493/. [Accessed 29 October 2025].

[51] L. Johnson, "Folate Deficiency," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/folate-deficiency. [Accessed 29 October 2025].

[52] L. Johnson, "Vitamin B12 Deficiency," Merck Manual Consumer Version, 2024 August. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-b12-deficiency. [Accessed 29 October 2025].

[53] L. Johnson, "Vitamin C Deficiency," Merck Manual Consumer Version , August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-c-deficiency. [Accessed 29 October 2025].

[54] L. Johnson, "Vitamin C Excess," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-c-excess. [Accessed 29 October 2025].

[55] L. Johnson, "Vitamin D Deficiency," Merck Manual Consumer Version, September 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-d-deficiency. [Accessed 29 October 2025].

[56] L. Johnson, "Vitamin E Deficiency," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-e-deficiency. [Accessed 29 October 2025].

[57] L. Johnson, "Vitamin E Excess," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-e-excess. [Accessed 29 October 2025].

[58] L. Johnson, "Vitamin K Deficiency," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-k-deficiency. [Accessed 29 October 2025].

Disclaimer: This document is educational and not intended to provide clinical advice nor should it be used as a replacement for professional dental or medical advice. Dental hygienists are encouraged to consult with CDHO practice advisors and refer to CDHO guidelines. Dental hygienists are responsible for the decisions they make and for the consequences associated with those decisions. © ODHA

[59] L. Johnson, "Vitamin K Excess," Merck Manual Consumer Version, August 2024. [Online]. Available: https://www.merckmanuals.com/home/disorders-of-nutrition/vitamins/vitamin-k-excess. [Accessed 29 October 2025].

[60] H. Rosengard, D. Messadi, G. Mirowski and etal, "Oral Manifestations of Systemic Diseases," Medscape, 29 June 2018. [Online]. Available: https://centrodontoiatriconocerino.it/wp/wp-content/uploads/2016/12/Oral-Manifestations-of-Systemic-Diseases-Overview-Gastrointestinal-Diseases-Nutritional-Disease.pdf. [Accessed 28 October 2025].

[61] Pocket Dentistry, "Oral Manifestation of Systemic Diseases," 7 January 2020. [Online]. Available: https://pocketdentistry.com/oral-manifestation-of-systemic-diseases/. [Accessed 7 May 2022].

[62] P. López-Jornet, F. Camacho-Alonso, P. Andujar-Mateos and etal., "Burning mouth syndrome: Update," *Med Oral Patol Oral Cir Bucal,* vol. 15, no. 4, pp. e562-e568, July 2010.

[63] S. Lešić, Z. Ivanišević, B. Špiljak, et al., "The impact of vitamin deficiencies on oral manifestations in children, Volume 12, Issue 4, April 17, 2024, p," *Dentistry Journal,* vol. 14, no. 4, pp. 1-20, 17 April 2024.

[64] H. Tan and T. Renton, "Burning mouth syndrome: An update," *Cephalalgia Reports,* vol. 3, pp. 1-18, 2020.

[65] J. Botelho, V. Machado, L. Proença and etal, "Vitamin D deficiency and oral health: A comprehensive review," *Nutrients,* vol. 12, no. 5, pp. 1-16, 19 May 2020.

[66] L. Johnson, "Overview of Minerals," Merck Manual Professional Version, May 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/overview-of-minerals. [Accessed 29 October 2025].

[67] L. Samaranayake, P. T, J. Tsoi and N. Tuygunov, "Facts and fallacies of the fluoride controversy: A contemporary perspective, , Volume 75, Issue 4, August 2025, p 1-12," *International Dental Journal,* vol. 75, no. 4, pp. 1-12, August 2025.

[68] L. Johnson, "Chromium Deficiency," Merck Manual Professional Version, May 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/chromium-deficiency. [Accessed 29 October 2025].

[69] L. Johnson, "Chromium Toxicity," Merck Manual Professional Version, May 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/chromium-toxicity. [Accessed 29 October 2025].

[70] L. Johnson, "Manganese Deficiency," Merck Manual Professional Version, May 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/manganese-deficiency. [Accessed 29 October 2025].

[71] L. Johnson, "Selenium Deficiency," Merck Manual Professional Version, May 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/selenium-deficiency. [Accessed 29 October 2025].

Disclaimer: This document is educational and not intended to provide clinical advice nor should it be used as a replacement for professional dental or medical advice. Dental hygienists are encouraged to consult with CDHO practice advisors and refer to CDHO guidelines. Dental hygienists are responsible for the decisions they make and for the consequences associated with those decisions. © ODHA

[72] A. Shreenath, M. Hashmi and J. Dooley, "Selenium Deficiency," StatPearls [Internet], 29 October 2023. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK482260/. [Accessed 29 October 2025].

[73] L. Johnson, "Selenium Toxicity," Merck Manual Professional Version, May 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/selenium-toxicity. [Accessed 29 October 2025].

[74] L. Johnson, "Zinc Deficiency," Merck Manual Professional Version, May 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/zinc-deficiency. [Accessed 30 October 2025].

[75] L. Harbison, "Importance of Micronutrients in Both Systemic and Oral Health," Dimensions of Dental Hygiene, 7 April 2022. [Online]. Available: https://dimensionsofdentalhygiene.com/article/importance-micronutrients-both-systemic-oral-health/. [Accessed 7 May 2022].

[76] S. Bhupathiraju and F. Hu, "Protein-Energy Undernutrition (PEU)," Merck Manual Professional Version, April 2025. [Online]. Available: https://www.merckmanuals.com/professional/nutritional-disorders/undernutrition/protein-energy-undernutrition-peu. [Accessed 29 October 2025].

Client resources

Canada's Food Guide, Government of Canada
https://food-guide.canada.ca/en/

Nutrition and Oral Health, ODHA Factsheet
https://odha.on.ca/wp-content/uploads/2016/08/Nutrition.19.1-copyright.pdf

Additional Resources

Overview of Nutrition, Bhupathiraju, S; Hu, F. *Merck Manual Professional Version*, April 2024 https://www.merckmanuals.com/professional/nutritional-disorders/nutrition-general-considerations/overview-of-nutrition

Overview of Undernutrition, Bhupathiraju, S; Hu, F. *Merck Manual Professional Version*, April 2024 https://www.merckmanuals.com/professional/nutritional-disorders/undernutrition/overview-of-undernutrition

Overview of Malabsorption, Malik, Z. *Merck Manual Professional Version*, March 2025 https://www.merckmanuals.com/professional/gastrointestinal-disorders/malabsorption-syndromes/overview-of-malabsorption

Basic concepts in nutrition: Overnutrition – Functional and clinical consequences, Svacina, S. *European e-Journal of Clinical Nutrition and Metabolism*, Volume 3, Issue 4, August 2008, p e173-e178 https://www.clinicalnutritionespen.com/article/S1751-4991(08)00029-2/fulltext

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Association between periodontal disease and obesity: Umbrella review, Arbildo-Vega, H; Cruzado-Oliva, F; Coronel-Zubiate, F; et al. *Medicina*, Volume 60, Issue 4, April 11, 2024, p 1-25 https://www.mdpi.com/1648-9144/60/4/621

Saturated fatty acids dampen the immunogenicity of cancer by suppressing STING, Heath, B; Gong, W; Taner, et al. *Cell Reports*, Volume 42, Issue 4, April 25, 2023, p 1-25 https://www.cell.com/cell-reports/fulltext/S2211-1247(23)00314-5

Oral conditions are associated with salt taste disability among American adults, Cassiano, L; Leite, F; Alves-Costa, S; et al. *Oral Diseases*, Volume 30, Issue 8, April 2, 2024, p 5475-5482 https://onlinelibrary.wiley.com/doi/10.1111/odi.14926

Evaluation of different taste sensations along with body mass index (BMI) in geriatric patients with and without complete dentures, Doddawad, V; Mehrin, F; Raghavendraswamy, K; et al. *Journal of Education and Health Promotion*, Volume 13, Issue 1, March 2024, p 1-5 https://journals.lww.com/jehp/fulltext/2024/03280/evaluation_of_different_taste_sensations_along.109.aspx

The effect of new acrylic full removable dentures on food taste, Juzikis, E; Klimenko, J; Žilinskas, J; Ivanauskienė, E. *Stomatologija*, Volume 23, Issue 2, 2021, p 48-50 https://sbdmj.lsmuni.lt/212/212-03.pdf

Relationship between taste perception and use of upper complete dentures, Carvalho da Silva, R; Lacerda, W; Henn, I; et al. *Special Care in Dentistry*, Volume 41, Issue 2, January 5, 2021, p 244-250 https://onlinelibrary.wiley.com/doi/10.1111/scd.12559

Nutrition and Oral Health, American Dental Association, August 30, 2023 https://www.ada.org/resources/ada-library/oral-health-topics/nutrition-and-oral-health

Physiology, Carbohydrates, Holesh, J; Aslam, S; Martin, A. *StatPearls [Internet]*, National Library of Medicine, May 12, 2023 https://www.ncbi.nlm.nih.gov/books/NBK459280/

Protein-Energy Undernutrition (PEU), Bhupathiraju, S; Hu, F. *Merck Manual Professional Version*, April 2025 https://www.merckmanuals.com/professional/nutritional-disorders/undernutrition/protein-energy-undernutrition-peu

Overview of Vitamins, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/overview-of-vitamins

Vitamin A Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-a-deficiency

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Vitamin A Toxicity, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-a-toxicity

Thiamin Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/thiamin-deficiency

Riboflavin Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/riboflavin-deficiency

Niacin Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/niacin-deficiency

Niacin Toxicity, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/niacin-toxicity

Biotin and Pantothenic Acid, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/biotin-and-pantothenic-acid

Vitamin B6 Deficiency and Dependency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-b6-deficiency-and-dependency

Vitamin B6 Toxicity, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-b6-toxicity

Folate Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/folate-deficiency

Vitamin B12 Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-b12-deficiency

Vitamin C Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-c-deficiency

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Vitamin C Toxicity, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-c-toxicity

Vitamin D Deficiency and Dependency, Johnson, L. *Merck Manual Professional Version*, April 2025 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-d-deficiency-and-dependency

Vitamin D Toxicity, Johnson, L. *Merck Manual Professional Version*, April 2025 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-d-toxicity

Vitamin E Deficiency, Johnson, L. *Merck Manual Professional Version*, April 2025 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-e-deficiency

Vitamin E Toxicity, Johnson, L. *Merck Manual Professional Version*, July 2025 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-e-toxicity

Vitamin K Deficiency, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-k-deficiency

Vitamin K Toxicity, Johnson, L. *Merck Manual Professional Version*, August 2024 https://www.merckmanuals.com/professional/nutritional-disorders/vitamin-deficiency-dependency-and-toxicity/vitamin-k-toxicity

Burning mouth syndrome: Update, López-Jornet, P; Camacho-Alonso, F; Andujar-Mateos, P; et al. *Med Oral Patol Oral Cir Bucal*, Volume 15, Issue 4, July 2010, p e562-e568 http://www.medicinaoral.com/pubmed/medoralv15_i4_pe562.pdf

Burning mouth syndrome: An update, Tan, H; Renton, *Cephalalgia Reports*, Volume 3, 2020, p 1-18 https://journals.sagepub.com/doi/pdf/10.1177/2515816320970143

The impact of vitamin deficiencies on oral manifestations in children, Lešić, S; Ivanišević, Z; Špiljak, B; et al. *Dentistry Journal*, Volume 12, Issue 4, April 17, 2024, p 1-20 https://www.mdpi.com/2304-6767/12/4/109

Facts and fallacies of the fluoride controversy: A contemporary perspective, Samaranayake, L; Porntaveetus T; Tsoi, J; Tuygunov, N. *International Dental Journal*, Volume 75, Issue 4, August 2025, p 1-12 https://www.sciencedirect.com/science/article/pii/S0020653925001224

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Overview of Minerals, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/overview-of-minerals

Chromium Deficiency, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/chromium-deficiency

Chromium Toxicity, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/chromium-toxicity

Manganese Deficiency, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/manganese-deficiency

Molybdenum Toxicity, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/molybdenum-toxicity

Selenium Deficiency, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/selenium-deficiency

Selenium Deficiency, Shreenath, A; Hashmi, M; Dooley, J. *StatPearls [Internet],* October 29, 2023 https://www.ncbi.nlm.nih.gov/books/NBK482260/

Selenium Toxicity, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/selenium-toxicity

Zinc Deficiency, Johnson, L. *Merck Manual Professional Version*, May 2025 https://www.merckmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/zinc-deficiency

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