NUTRITIONAL DISEASES AND NUTRIENT TOXICITIES: A SYSTEMATIC REVIEW OF THE DIETS AND NUTRITION FOR PREVENTION AND TREATMENT

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Abstract

The systematic review focused on nutritional diseases, nutrient toxicities, nutrients deficiency diseases, and the diets for health living. Nutritional diseases include obesity and eating disorders, and chronic diseases such as protein-energy malnutrition (Kwashiorkor and marasmus), cardiovascular disease, atherosclerosis, hypertension, cancer (colorectal cancer, prostate cancer, breast cancer), diabetes mellitus, dental caries. Others are gastroesophageal reflux disease, heartburn and peptic ulcer, diverticulitis (diverticulosis), constipation, diarrhea, Crohn disease (regional ileitis), ulcerative colitis,etc. Nutritional diseases also include some developmental abnormalities which can be prevented by diet, hereditary metabolic disorders which respond to dietary treatment, food allergies and intolerances, potential hazards in the food supply, and the interactions of foods and nutrients with drugs. The deficiencies or excesses of macronutrients and micronutrients are the cause of many diseases, and also exacerbate others and are acknowledged as having asignificant impact on health all over the world. Some important micronutrients include calcium, iodine, iron, zinc, selenium, fluorine, potassium, etc., and vitamins A, D, E, B_6, B_{12}, B_1, B_2, B_3, C, among others. Deficiencies of essential vitamins and minerals such as Vitamin A, zinc, and iron may be caused by long-term shortage of nutritious food or by many infections such as intestinal worms. They can also be caused or worsened when illnesses (such as malaria, diarrhoea) cause rapid loss of nutrients through vomit or feces. Dehydration (Water deficiency) may develop if consumption of water fails to satisfy thirst.Because of interactions, high intake of one mineral salt may adversely affect the absorption or the utilization of another. Excessive ingestion from food alone is not likely, but consumption of supplements or fortified foods increases the chance of toxicity. Additionally, occupational or environmental exposure to potentially toxic level of minerals presents additional risks for some populations. The acute effects of large alcohol intake are well known; a mental impairment starts when blood concentration of alcohol isapproximately 0.05%. Women who drink during pregnancy stand the risks of physical and mental damage to their babies (known as fetal alcohol syndrome). Many herbal products show sufficient potential in preventing and treating diseases that they are being tested in scientific studies, including clinical and subclinical trials. Maintaining a healthy diet, paleolithic diet, very low carbohydrate diet, low-fat diet, low-calorie diet, raw foodism, and/or ketogenic diet, in addition to proper food hygiene, can help prevent and treat nutritional diseases, food allergies, food intolerance, and nutrient toxicities.

Keywords: Nutritional diseases, Nutrient toxicities, Nutrients deficiency diseases, Diets for healthy living, Food allergies and intolerances.

1. Introduction

Nutritional diseases are the nutrient-related conditions and diseases that cause illness in human. They may include deficiencies or excesses of at least one nutrient in the diet, obesity and eating disorder, and chronic diseases such ashypertension, cardiovascular disease, cancer, and diabetes mellitus. Also, nutritional diseases include hereditary metabolic disorders which respond to dietary treatment, developmental abnormalities that are preventable by diet, food allergies and intolerances, potential hazards in the food supply, and the interaction of foods and nutrients with drugs. All these are systematically described in this article.

The so-called diseases of civilization, such as heart disease, cancer, diabetes, stroke, among others, are discussed in details, the most imperative nutrition-related disease is chronic undernutrition, which affects more than 925 million people in the whole world. Undernutrition is caused by insufficient food to meet the energy needs; it ischaracterized by weight loss, wasting of body fat, muscle wasting, and failure to thrive (Jean, 2019). Inadequate growth and development in children, low birth weight in infants, increased susceptibility to disease, and diminished mental function are among the several consequences of chronic persistent hunger that affects those living below the poverty line in both industrialized and developing nations. The largest number of chronically hungry individuals live in Asia, but hunger severity is greatest in sub-Saharan Africa. Many factors are responsible for this. At the beginning of the 21st century, about 20,000 people, majorly children, died per day due to undernutrition and related diseases and health complications that could have been prevented (Jean, 2019). The deaths of most of these children were as a result of the poor and unhealthy nutritional status of their mothers, and the lack of opportunity caused by poverty.

Micronutrient deficiencies affect more than 2 billion individuals of all ages in both industrialized and developing countries. They causemany diseases and exacerbate others, and are acknowledged as having asignificant impact on health worldwide. Some important micronutrients areiodine, iron, selenium, zinc, calcium, fluorine, and vitamins A, D, E, B_6, B_1,B_{12}, B_2, B_3, and C (Theodore, 2010). Micronutrient deficiencies are associated with about 10% of all children's deaths (Westspot, 2012), and are therefore of a special concern to those involved with children welfare. Deficiencies of essential vitamins and minerals such as Vitamin A, zinc, and iron may be caused by long-term shortage of nutritious food or by infection such as intestinal worms or both. They may also be caused or worsened when illnesses (such as malaria, diarrhoea) cause rapid nutrients loss through vomit or feces. Micronutrient deficiency or dietary deficiency is often caused by not enough of at least one of the micronutrients required for optimal health. In humans and animals they include both vitamin and mineral deficiencies (Young, 2012), while in plants the term refers to essential trace mineralsdeficiencies.

Small percentage of hunger deaths result from starvation due to catastrophic shortage of food. During the 1990s, for example, global famine (epidemic failure of food supply) more commonly resulted from complex political and social issues and the ravages of war rather than from natural disasters such as floods and droughts (Jean, 2019; Westspot, 2012). Malnutrition is theimpairment of body functions that result fromchronic deficiencies or excesses of total energy or specific nutrients such as carbohydrates, protein, vitamins, essential fatty acids, or minerals (Jean, 2019; Westspot, 2012). This condition can result from food shortage, fasting and anorexia nervosa; inability to swallow or persistent vomiting (as in bulimia nervosa); intestinal malabsorption and impaired digestion; or chronic illness that results in loss of appetite (such as AIDS, cancer). There have been increasing formulations of

different food blends to mitigate the problem of malnutrition (Awuchi, 2019b; Awuchi *et al.*, 2019a). Malnutrition can also result from inadequate food availability, overzealous use of dietary supplements, or unwise food choices. The production of some metabolites such as aflatoxins, patulins, ochratoxins, etc. in grains by molds also reduces the nutritional quality of the grains (Chinaza *et al.*, 2019b). Many factors have been implicated.

2. Nutritional disease and nutrient toxicities

2.1. Nutrient Deficiencies and associated diseases

Table 1: Selected nutrient-deficiency diseases

Diseases (and key nutrients involved)	Symptoms	Foods rich in key nutrient
Beriberi (Thiamin)	nerve degeneration, cardiovascular problems, altered muscle coordination	pork, whole and enriched grains, sunflower seeds, dried beans
Goitre (Iodine)	poor growth in infancy and childhood, enlarged thyroid gland, cretinism, possible mental retardation	iodized salt, saltwater fish
Iron-deficiency anemia (Iron)	reduced growth, decreased work output, increased health risk in pregnancy	meat, bran, spinach, seafood, broccoli, peas, whole-grain, enriched breads
Pellagra (Niacin)	skin inflammation, diarrhea, dementia	mushrooms, beef, peanuts, bran, tuna, chicken, whole and enriched grains
Rickets (Vitamin D)	bowed legs, weakened bones, other bone deformities	fish oils, fortified milk, sun exposure
Scurvy (Vitamin C)	internal bleeding, delayed wound healing, abnormal formation of teeth and bones	citrus fruits, broccoli, strawberries
Xerophthalmia (Vitamin A)	poor growth, blindness from chronic eye infections, dryness and keratinization of the epithelial tissues	liver, spinach, greens, carrots, fortified milk, sweet potatoes, cantaloupe, apricots

Source: Jean, 2019.

2.1.1. Protein-energy malnutrition (PEM)

Chronic undernutrition manifests mostly as PEM, which is the most commonlyencountered form of malnutrition globally. Also known as protein-calorie malnutrition, protein-energy malnutrition is a continuum in which individuals (often children) eat too little energy, protein, or both. At one end of the continuum is marasmus, an absolute deprivation of food with grossly limited amounts of both protein and energy, and at the other end iskwashiorkor, characterized by severe protein deficiency (Jean, 2019; Theodore, 2010; Westspot, 2012).

Infants with marasmus are extremely underweight and have lost most or all the subcutaneous fat. Their body has appearance of skin and bones, and they are highly susceptible to infections and profoundly weak. The cause is often diet extremely low in caloriesfrom all sources (protein inclusive), often from early weaning to bottled formula made with unsafe water and usually

diluted because of poverty (Jean, 2019). Poor hygiene and continuous depletion results in vicious cycle of gastroenteritis and the deterioration of the lining of gastrointestinal tract, which affects the absorption of the nutrients from the little food available, further reducing resistance to infections. If untreated, marasmus can lead to death due to heart failure or starvation.

Kwashiorkor, a Ghanaian word which means the disease first child gets when new child comes, is usually seen in a child weaned from high-protein breast milk to a carbohydratedietsource with no sufficient protein. Children with kwashiorkor, which is characterized by swollen belly due to fluid retention (edema), are weak, grow poorly, wasted, and are more prone to infectious diseases, which can result in lethal diarrhea. Other symptoms of kwashiorkor are hair discoloration, apathy, and dry, peeling skin with some sores that fail to heal. The weight loss may be disguised due to the presence of edema, intestinal parasites, and enlarged fatty liver; moreover, there might be little wasting of body fat and muscle.

Marasmus and kwashiorkor can also occur in hospitalized or institutionalized patients receiving intravenous glucosefor extended time, for example when recovering from surgery or illness, or in those with illness causing loss of appetite or nutrients malabsorption. Persons with eating disorders, AIDS, cancer, and other illnesses where absorption of nutrients is hampered or appetite fails may lose muscle, organ tissue, and fat stores.

Treatment of protein-energy malnutrition has three components;

(1) Nutritional status have to be restored as safely and quickly as possible; rapid weight gain may occur in a starving child in one or two weeks.
(2) Life-threatening conditions, such as electrolyte and fluid imbalances and infections, are required to be resolved.
(3) The focus of treatment then moves to ensuringlong-term nutritional rehabilitation.

The speed and the ultimate success of recovery depend on the severity of malnutrition, timeliness of treatment, and adequacy of ongoing support (Jean, 2019). Particularly during first year of life, starvation can result in poor brain growth and development, as well as poor intellectual functioning which cannot be fully restored later.

2.1.2. Carbohydrates

Under some circumstances, there is no totaland complete dietary requirement for carbohydrates; complex carbohydrates such as starches, simple sugars, and the indigestible carbohydrates called dietary fiber. Some cells, such as the brain cells, require glucose as fuel. If there is insufficient dietary carbohydrate, glucose synthesisdepends on breakdown of amino acids derived from the body protein, dietary protein, and the glycerol, which is derived from fat (Jean, 2019). The process is called gluconeogenesis, and occurs mostly in the liver. Long-term carbohydrate insufficiency results in a condition known as ketosis (increased production of some organic compounds called ketones), which imparts a distinct sweet odor to the breath. Ketosis and some other untoward effects of very-low-carbohydrate diet are prevented by daily consumption of 50 g to 100 g of carbohydrate; though, obtaining at least half of daily energy intake from carbohydrate is recommended and is characteristic of human diet, corresponding to at least 250 g of carbohydrate (1,000 calories in 2,000-calorie diet). A variation of diet containing fruits, legumes, whole-grain cereals, and vegetables, which are all rich in carbohydrates, also provides desirable dietary fiber intake. Obesity can be avoided by

substituting diet soda made with some sugar alcohols (Awuchi and Echeta, 2019; Awuchi, 2017), aspartame, and other sugar substitutes which contribute little or no calories.

2.1.3. **Essential fatty acids**

There is a minimum requirement for fat; not for the total fat, but only for fatty acids alpha-linolenic acid (it is an omega-3 fatty acid) and linoleic acid (known as omega-6 fatty acid). The deficiencies of these two omega fatty acids have been detected in hospitalized patients exclusively fed with intravenous fluids having no fat for weeks, infants given low fat formulas, young children fed low-fat diets or nonfat milk, and patients with medical conditions affecting the absorption of fat. Frying affects the properties of fats and oils (Awuchi *et al.,* 2018; Awuchi *et al.,* 2019a). Symptoms of deficiency include hair loss, impaired wound healing, and dry skin. Essential fatty acid requirements (few grams per day) can be met by eatingroughly a tablespoonful of polyunsaturated plant oils daily (Jean, 2019). Fatty fish also provides rich source of omega-3 fatty acids (alpha-linolenic acid). Even people following low-fat diets generally consume fat sufficient to meet requirements.

2.1.4. Vitamins

One of the main biological functions of vitamins is acting as coenzymes, especially the B vitamins. The eight B vitamins act in coordination in many enzyme systems and metabolic pathways; as a result, a deficiency of one can affect the functioning of others (Westspot, 2012; Theodore, 2010). Although deficiency diseases have been reported in laboratory animals and humans denied single vitamins, multiple deficiencies experiencein human are often present simultaneously.

2.1.4.1. Vitamin A (retinol, retinal, retinoic acid)

The deficiency of vitamin A is the leading cause of avoidable and preventable blindness in children and is also a major problem in the developing countries, especially in Africa, Southeast Asia, and some parts of South America; in the poorest countries hundreds to thousands of children become blind every year as a result of vitamin A deficiency. Even a mild deficiency has the potency to impair immune functions, thereby reducing resistance to disease (Westspot, 2012). Night blindness is aninitial sign of the deficiency of vitamin A, followed by abnormal eye dryness and xerophthalmia (ultimately scarring of the cornea). Other symptoms include hardening of epithelial cells elsewhere in the body (such as mucous membranes), dry skin, and impaired growth and development (Jean, 2019). In many regions where the deficiency of vitamin A is endemic, the incidence is reduced by giving children single large dose of the vitamin every six months (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). A genetically modified rice containing beta-carotene, vitamin A precursor, has the potential to reduce significantly the incidence of vitamin A deficiency, however the use of this alleged golden rice is controversial (Theodore, 2010).

2.1.4.2. Vitamin D (D_1; ergocalciferol+lumisterol, D_2; ergocalciferol, D_3; cholecalciferol, D_4; dihydroergocalciferol, D_5; sitocalciferol)

Vitamin D (also called vitamin D hormone) can be synthesized in the body in series of steps, beginningin the skin by action of ultraviolet rays from the sunlight on a precursor compound; therefore, without adequate dietary sources of vitamin D, deficiency of the vitamin may occur when sunlight exposure is limited. The deficiency of vitamin D in children results in rickets, a disease characterized by growth retardation, inadequate mineralization of bone, and skeletal deformities such as having bowed legs (Theodore, 2010). Osteomalacia, the adult form of

rickets, results in weak bones and weak muscles. Insufficient vitamin D may also contribute to thinning of bones seen in osteoporosis. People with limited exposure to sun (including women who cover their bodies entirely for religious reasons), elderly, homebound persons, institutionalized individuals, and those with dark skin, especially those who live in the northern latitudes, are at risks of vitamin D deficiency (Jean, 2019). Vitamin D is naturally found in very few foods; thus fortification of foods such as milk, margarine, breads, and cereals with vitamin D has helped protect those populations where sun exposure is inadequate (Jean, 2019; Young, 2012; Westspot, 2012). Vitamin D supplements may also help protect against bone fractures in elderly, who synthesize and activate vitamin D insufficiently even if exposed to sunlight.

2.1.4.3. Vitamin E (tocopherols and four tocotrienols)

Vitamin E deficiency is not common in humans, although it can develop in premature infants and in individuals with impaired absorption or metabolism of fat. In the former, hemolysis (the fragility of red blood cells) is seen; in the latter, where the deficiency is more prolonged, the neuromuscular dysfunction involving spinal cord and retina may lead to loss of reflexes, coordination and impaired balance, muscle weakness, and visual disturbances(Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). No specific metabolic function has been recognized for vitamin E; but it is an essential part of antioxidant system that prevents lipid peroxidation; that is, it protects cells and cell membranes against the destructive effects of free radicals (specifically reactive oxygen and nitrogen species) which are produced metabolically or come into the body from the environment (Jean, 2019). The requirements for vitamin E are increased with an increasing intake of polyunsaturated fatty acids. Individuals who smoke or are exposed to air pollution may also require more of the vitamin E to protect against the oxidative damage to lungs.

2.1.4.4. Vitamin K (K_1; phylloquinone, K_2; menaquinone)

Vitamin K is required for the formation of prothrombin and some other factors of blood-clotting in the liver. Also,it plays role in metabolism of the bone. A form of vitamin K is produced by bacteria in colon and can be used to some degree (Jean, 2019). Vitamin K deficiency results in impaired internal bleeding and blood clotting, even without injury. Owing to poor transport of vitamin K across placenta, newborn infants in developed nations are routinely given the vitamin orally or intramuscularly within 6 hours of birth to prevent a condition referred to as hemorrhagic disease of the newborn. The deficiency of vitamin K is rare in adults, apart from syndromes with poor absorption of fat, in disease of the liver, or during treatment with some anticoagulant drugs, which interfere with the metabolism of vitamin K (Young, 2012; Theodore, 2010; Westspot, 2012). Bleeding due to vitamin K deficiency can occur in patients whose gut bacteria are killed by antibiotics.

2.1.4.5. Thiamin (vitamin B_1)

Prolonged deficiency of vitamin B_1(thiamin) results in beriberi, an endemic disease in populations where the staple food is white rice. Vitamin B_1 deficiency is still seen in regions where white rice or flour is the bulk of the diet and vitamin B_1 lost in milling is not replaced by enrichment. Symptoms of the form called dry beriberi include confusion, loss of appetite, and other mental symptoms, painful calf muscles, poor coordination, muscle weakness, tingling and paralysis (Jean, 2019; Theodore, 2010). In wet beriberi edema is seen in addition to the possibility of heart failure and an enlarged heart. Thiamin deficiency may also occur in the populations eating large amounts of raw fish harboringthe intestinal microbes that contain an enzyme called thiaminase (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). In the

developed countries, thiamin deficiency is primarily linked to chronic alcoholism with poor dieting, manifesting as the Wernicke-Korsakoff syndrome, a disorder with rapid eye movements, mental confusion, memory loss, and loss of muscle coordination.

2.1.4.6. Riboflavin (vitamin B_2)

The deficiency of riboflavin (vitamin B_2), known as ariboflavinosis, is not likely without simultaneous deficiency of other nutrients (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). After several months of riboflavin lack, symptoms include fissures of the lips, an inflamed magenta-colored tongue, and cracks in the skin at the mouth corners (Young, 2012). Because riboflavin is readily damaged by ultraviolet light, infants with jaundice who are treated with a light therapy are administeredriboflavin. Milk, dairy products, and cereals, main sources of riboflavin in diet, are packaged to prevent light exposure.

2.1.4.7. Niacin (vitamin B_3)

Symptoms of pellagra develop about 2 months after the withdrawal ofniacin from diet. Pellagra is characterized by the styled three Ds (diarrhea, dementia, and dermatitis) and, if allowed to progress without treatment, death results. Pellagra was common in parts of the southern US in early 1900s and still common in parts of Africa, India, and China, affecting individuals who subsist primarily on corn (Jean, 2019). The vitamin B_3 in corn and other cereals is largely in bound form, not well absorbed. Soaking corn in lime water, as done by Native American people for centuries, frees the bound niacin and consequently protects against pellagra (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). In addition, unlike other cereal grains, corn is low in tryptophan, an amino acid, which can be partlyconverted to niacin. Enough high-quality protein (containing tryptophan) in diet can protect against the deficiency of niacin even if niacin intake itself is insufficient.

2.1.4.8. Vitamin B_6 (pyridoxine, pyridoxamine, pyridoxal 5'-phosphate, and other related compounds)

Vitamin B_6 (pyridoxine and other related compounds) is essential in the synthesis of neurotransmitters, protein metabolism, and other important functions in the body. Vitamin B_6 deficiency symptoms include microcytic hypochromic anemia (identifiable by small, pale red blood cells), depression, dermatitis, impaired immune function, confusion, and convulsions (Theodore, 2010; Young, 2012; Westspot, 2012; Jean, 2019). Although full-blown deficiency of vitamin B_6 is rare, marginal insufficiency is more common, especially among the elderly, who might have reduced ability to absorb vitaminB_6. People with alcoholism, especially individuals with the liver diseases hepatitis and cirrhosis, are at risk of deficiency (Jean, 2019). Many drugs, including isoniazid, a tuberculosis drug, interfere with the metabolism of vitamin B_6.

2.1.4.9. Folic acid (Vitamin B_9, folacin, folate)

Vitamin B_{12} and Vitamin B_9 (folate, folic acid) are two B vitamins with several closely related functions, especially participation in DNA synthesis (Jean, 2019). As a result, individuals with deficiencies of either vitamin show several of the same symptoms, such as fatigue and weakness due to megaloblastic anemia, a condition where red blood cells, insufficient in DNA for cell division, are immature and large. Deficiency of folic acid causes disruption of the cell division along the gastrointestinal tract, resulting in persistent diarrhea, and the impaired synthesis of the white blood cells and platelets (Theodore, 2010; Young, 2012; Westspot, 2012; Jean, 2019). Inadequate intake of vitamin B_9 in early pregnancy can cause neural tube

defects in fetus. Thus, women capable of getting pregnant are advised to take 400 μg of folic acid every day from fortified food (such as fortified cereals), supplements,or both, in addition to eating food rich in folic acid such as legumes and fresh fruits and vegetables (especially the leafy greens) (Theodore, 2010; Young, 2012; Westspot, 2012; Jean, 2019). The cancer drug methotrexate interferes with the metabolism of folic acid, causing side effects such as diarrhea and hair loss. Also, folic acid deficiency may result from heavy drinking of alcohol, which interferes with the vitamin absorption.

2.1.4.10. Vitamin B_{12}(cobalamin)

Like folic acid, the deficiency of vitamin B_{12}results in megaloblastic anemia (large and immature red blood cells), owing to interference with typical DNA synthesis. In addition, vitamin B_{12} maintains myelin sheath which protects nerve fibres; thus, an untreated deficiency vitamin B_{12}can result in degeneration of nerves and eventually paralysis. Large quantities of folic acid (above 1,000 μg per day) might conceal, and likely even exacerbate, an underlying deficiency of vitamin B_{12}. Animal foods are the only reliable vitamin B_{12}sources. Vegetarians, who do not consume animal foods, are at risk of deficiency of vitamin B_{12} and must obtain the vitamin by eating fortified food or a supplement (Jean, 2019). For people who regularly consume animal foods, deficiency of vitamin $B_{12}$is not likely, except there is an absorptiondefect. In order to be absorbed, the vitamin B_{12} must bind to intrinsic factor, a biochemical substance secreted by the stomach (Young, 2012; Westspot, 2012). If intrinsic factor is absent (because of an autoimmune disorder referred to as pernicious anemia) or if the production of hydrochloric acid (HCl) by the stomach is insufficient, absorption of vitamin B_{12}will be limited. Pernicious anemia occurs most commonly in the elderly and can be treated by the injections or the massive oral doses (1,000 μg) of the vitamin B_{12} (Theodore, 2010; Young, 2012; Westspot, 2012; Jean, 2019).

2.1.4.11. Pantothenic acid (Vitamin B_5)

Pantothenic acid (vitamin B_5) is very widespread in foods that its deficiency is not likely under normal circumstances. Deficiency of vitamin B_5has been seen only in subjects given pantothenic acid antagonistor in people fed semisynthetic diets insufficient in the vitamin (Theodore, 2010; Young, 2012; Westspot, 2012; Jean, 2019). Symptoms of deficiency include sleep disturbances, abdominal distress, fatigue, irritability, and neurological symptoms such as the tingling in the hands (Jean, 2019; Westspot, 2012). Deficiency of vitamin $B_5$was suspected during the World War II when the prisoners of war in Asia who showed burning feet syndrome, characterized by tingling and numbness in the toes and some other neurological symptoms, onlyresponded to the administration of vitamin B_5.

2.1.4.12. Biotin (also called vitamin H or vitamin B_7)

Biotin deficiencyis rare, and this may be partly due to synthesis of the vitamin by the bacteria in the colon, though the importance of this source is not clear. Biotin deficiency has been detected in people who regularly consume large amounts of raw egg white, which contains avidin, a glycoprotein that binds biotin and inhibits its absorption (Jean, 2019). A rare genetic defect that makes some infants not capableof absorbing a form of biotin in foods can be treated with a biotin supplement. Long-term use of some anticonvulsant drugs may also impair the absorption of biotin. Symptoms of deficiency include hair loss, skin rash, and eventually neurological abnormalities (Theodore, 2010; Westspot, 2012; Jean, 2019).

2.1.4.13. Vitamin C (ascorbic acid, ascorbate, L-ascorbic acid)

Vitamin C, also known as ascorbic acid, ascorbate, and L-ascorbic acid, functions as water-soluble antioxidant and as cofactor in many enzyme systems, such as the enzymes involved in the synthesis of neurotransmitters and connective tissue components. Symptoms of scurvy, a vitamin C deficiencydisease, include bleeding gums, joint pain, impaired wound healing, and petechiae (pinpoint hemorrhages) under the skin (Theodore, 2010; Young, 2012; Westspot, 2012; Jean, 2019). Although rare in developed nations, scurvy is occasionallyseen in infants fed boiled milk from cow and no source of vitamin C, or in people eating restricted diets, especially those containing few fruits and vegetables. Scurvy can be prevented by consuming relatively small amounts of vitamin C (10 mg/day), though recommended intakes of the vitamin, which aim to provide antioxidant protectionsufficiently, are closer to 100 mg/day (Jean, 2019). Disease states, drugs, environmental toxins, and other stresses can increase aperson's vitamin C requirements. Smokers, for example, can require an additional 35 mg of the vitamin per day to maintain the levels of vitamin C comparable to nonsmokers.

2.1.5. Minerals

Mineral deficiency is lack of the mineral salts, the micronutrients that are required for an organism's proper health (Larry, 2018). The cause may be poor diet, impaired uptake of minerals that are eaten or a dysfunction in organism's utilization of the mineral after absorption. These deficiencies can result in numerous disorders including anemia, goitre (Larry, 2018), and many others. Examples of mineral deficiency include, magnesium deficiency, zinc deficiency, iron deficiency, calcium deficiency, among others.

2.1.5.1. Iron

Iron deficiency is the most commonly encounteredamong all nutritional deficiencies, with much of the population of the worldbeing deficient in the mineral to some extent. Premenopausal women and young children are the most vulnerable to iron deficiency. The main function of iron is in hemoglobinformation, the red pigment of the blood which carries oxygen from lungs to other tissues in the body. Since everymilliliter of blood contains 0.5 milligram of iron (as a hemoglobincomponent), bleeding drains the body's iron reserves (Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012). When iron stores get depleted, a condition known as microcytic hypochromic anemia arises, characterized by small red blood cells which contain less hemoglobin than usual. Symptoms of severe iron deficiency anemia arepale skin, difficulty breathing on exertion, fatigue, weakness, apathy, and low resistance to cold temperatures (Jean, 2019). During childhood, iron deficiency can affect the behavior and learning abilities as well as development and growth. Severe anemia increases the risks of maternal death and pregnancy complications. Iron deficiency anemia is mostly common during early childhood and late infancy, when iron stores present from birth have been exhausted and milk, which is very poor in iron, is a main food; during the adolescent growth spurt; as well as in women during childbearing years, due to blood loss during menstruation and the additional iron requirements of pregnancy (Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012). Intestinal blood loss and the subsequent iron deficiency anemia in adults can also stem from ulcers, tumours, hemorrhoids (Jean, 2019) or chronic use of some drugs such as aspirin. In developing nations, blood loss due to hookworm and some other infections, coupled with insufficient dietary iron intake, worsens iron deficiency in both adults and children.

2.1.5.2. Iodine

Iodine deficiency disorders are the utmost common cause of preventable brain damage, affecting an estimated 50 million people all over the world. During pregnancy, severe

deficiency of iodine may impair fetal development, and results in cretinism (an irreversible mental retardation with developmental abnormalities and short stature) as well as in miscarriage or stillbirth (Theodore, 2010; Jean, 2019; Young, 2012; Larry, 2018). Other more prevalent consequences of chronic deficiency of iodine are lower cognitive and neuromuscular deficits. Ocean is a reliablesource of iodine, but further than coastal areas iodine in food varies and largely reflects the quantity in soil. In chronic deficiency of iodine the thyroid gland enlarges due to its attempts to trap more and more iodide (a form in which the iodine functions in the body) from blood for the synthesis of thyroid hormones; it eventually grows into a visible lump at the front of the neck, a condition known as a "goitre". Many foods, such as cassava, sweet potato, certain beans, millet, and members of cabbage family, contain substances called goitrogens which interfere with thyroid hormone synthesis. The substances, although destroyed by cooking, may be a significant factor in people with coexisting deficiency of iodine who depend on goitrogenic foods as staples. Ever since the strategy of worldwide iodization of salt was adopted in the year 1993, there has been remarkable progress in the improvement of iodine status worldwide (Jean, 2019; Larry, 2018). Nonetheless, millions of individuals living in iodine-deficient areas, mostly in Central Africa, Central and Southeast Asia, and even in Eastern and Central Europe, remain at risk.

2.1.5.3. Zinc

Zinc is a constituent of numerous enzymes, and plays structural roles in proteins and also regulates gene expression. The deficiency of zinc in humans was first reported in 1960s inIran and Egypt, where children and adolescent males with undeveloped genitalia and stunted growth responded to treatment with zinc(Jean, 2019). Deficiency of the micronutrient was attributed to the diet in the region, which was low in meat and high in unleavened breads, legumes, and whole-grain dietswhich containphytic acid, fibre, and other anti-nutritive factors that inhibit the absorption of zinc. The practice of clay eating, which affects the absorption of zinc, iron, as well as other minerals also contributes to zinc deficiency. Severe deficiency of zinc has also been described in the patients fed intravenous solutions insufficient in zinc and in inherited zinc-responsive syndrome called acrodermatitis enteropathica (Theodore, 2010; Jean, 2019; Larry, 2018; Young, 2012; Westspot, 2012). Symptoms of zinc deficiency may include diarrhea, increased susceptibility to infections, skin lesions, night blindness, poor appetite, hair loss, reduced taste and smell acuity, slow wound healing, impotence, and low sperm count(Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012). Zinc is highest in the protein-rich foods, particularly red meat and shellfish. Zinc status could be low in protein-energy malnutrition. In developed countries, young children, the elderly, strict vegetarians, pregnant women, people with alcoholism, and individuals with malabsorption syndromes are even vulnerable to deficiency of zinc.

2.1.5.4. Calcium

Almost all calcium in the body is in bones and the teeth, the skeleton serving as reservoir for calcium required in blood and elsewhere. During the childhood and the adolescence stages, adequate intake of calcium is critical for the bone growth and calcification. A low intake of calcium during childhood, and especially during adolescent growth spurt, may predispose individual to osteoporosis (a disease characterized by a reduced bone mass) later in life (Theodore, 2010; Young, 2012). As bones lose density, they develop fragility and inability to withstand ordinary strains; resulting fractures, mostly of the hip, may result in incapacitation and even death (Jean, 2019). Osteoporosis is mainly common in postmenopausal women in industrialized societies. Some processes foods undergo reduce the nutrients in them, including calcium (Awuchi and Nwankwere, 2018). Not a disease of calcium deficiency per se,

osteoporosis is heavily influenced by heredity; the risks of the disease can be reduced by ensuring sufficient calcium intake all through life and doing regular weight-bearing exercise(Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012). Sufficient calcium intake in immediate postmenopausal years does seem to slow bone loss, though not to the same degree as do bone-conserving drugs.

2.1.5.5. Fluoride

Fluoride contributes to the bones and teeth mineralization and protects against tooth decay. The epidemiological studies in the US in the 1930s and 1940s showed an inverse association between the natural fluoride in water and the rates of dental caries (Jean, 2019). In areas where levels of fluoride in drinking water are low, prescribed fluoride supplements are recommended for the children older than 6 months; also dentists may apply fluoride gels or rinses periodically to the teeth of their patients (Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012). Fluoridated toothpastes areimportant sources of fluoride for the children and also for the adults, who continue to benefit from intake of fluoride.

2.1.5.6. Sodium

Sodium is often provided in ample amounts by foods, even without additional table salt (sodium chloride). Additionally, the body's sodium-conservation mechanisms are greatly developed, and thus deficiency of sodium is rare, even for individuals on low-sodium diets (Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012). Sodium depletion may occur during persistent heavy sweating, diarrhea, or vomiting, or in cases of kidney disease (Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012). Symptoms of low blood sodium (hyponatremia), include muscle weakness, cramps, nausea, dizziness, and eventually shock and then coma. After protracted high-intensity exertion in the heat, the sodium balance can be restored through drinking beverages containing sodium and glucose (referred to as sports drinks) and by consuming salted food(Jean, 2019). Drinking 1liter of water containing 2ml (one-third teaspoon) of the table salt also should meet one's requirements.

2.1.5.7. Chloride

Chloride is also lost from the body under the conditions that parallel those of loss of sodium. Severe chloride depletion results in condition known as metabolic alkalosis (excessive alkalinity in body fluids)(Jean, 2019). Table salt (sodium chloride) is excellent source of chloride.

2.1.5.8. Potassium

Potassium is widely distributed in food and the deficiency in the dietis rarely. However, some diuretics used in treatment of hypertension usually deplete potassium. Potassium is also lost during sustained diarrhea or vomiting or with chronic use of laxatives. The symptoms of potassium deficiency include muscle cramps, confusion, weakness, and loss of appetite. Severe low blood potassium (hypokalemia) may result in cardiac arrhythmias (Jean, 2019). Potassium-rich foods, such as bananas andoranges, can help replace potassium losses, as can potassium chloride supplements, which ought tobe taken under medical supervision (Theodore, 2010; Jean, 2019; Young, 2012; Westspot, 2012).

2.1.6. Water deficiency (dehydration)

Water is the largest constituent of the body, accounting for over half of the weight of the body. To replace fluid losses, a normal adult generally needs to consume 2 – 4 liters of fluid per day in cool climates, depending on the degree and type of activity, and from 8 – 16 liters per day in very hot climates (Jean, 2019). Dehydration may develop if consumption of water fails to satisfy the thirst; if there is excess fluid loss, as with vomiting or diarrhea, orif thirst mechanism is not properlyfunctioning, as during intense physical exercise. By the time the thirst is apparent, there is some degree of dehydrationalready, which is defined as the loss of fluid amounting to no less than 1 to 2% of body weight (Jean, 2019). Symptoms can progress rapidly if not corrected.The symptoms of water deficiency include sunken eyes, poor skin turgor, dry mouth, cold hands and feet, rapid and shallow breathing, confusion, exhaustion,weak and rapid pulse, and coma. Fluid loss constituting more than 10% of body weight can be fatal. The elderly (whose sensation of thirst may be dulled), individuals who are ill, and people flying in airplanes are mostly vulnerable to dehydration. The infants and children with a chronic undernutrition who develop gastroenteritis canbecome severely dehydrated from vomiting or diarrhea. Treatment is with an oral or intravenous solution of salts and glucose.

2.2. Nutrient Toxicities

The need for every nutrient falls within safe or desirable range. Above these safe or desirable range is a risk of adverse health effects. Any nutrient, including water, can be toxic if consumed in very large or excessive amounts. It all depends on doses. Overdoses of some nutrients, such as iron, vitamin A, can cause poisoning or acute toxicity and even death in severe cases. For most nutrients, habitual excessive intake poses risks of adverse health effects or chronic toxicity. Persistent overconsumption of calorie-yielding nutrients (fat, carbohydrate, and protein) and alcohol increases risks of obesity and specific chronic diseases (including the health risks associated with obesity), and use of isolated amino acidsmayresult in imbalances and toxicities (Jean, 2019). However, for most people, the risk of harm as a result of excessiveconsumption of vitamins or minerals in foods is low.

The US Institute of Medicine in 1997 established a reference value known as the Tolerable Upper Intake Level (UL) just for selected nutrients, which is being used as model for other countries (Jean, 2019). The Tolerable Upper Intake Level (UL) is the maximum level of nutrient intake per day likely to pose no risks of adverse health effect for almost all the people in the general population. It is not meant to apply to individuals under medical supervision. Most ULs for children, infants, and adolescents are remarkably lower than for adults.

Table 2: Nutrients and their tolerable upper intake level (UL) per day

Nutrient	UL per day

Calcium	2,500 mg
Copper	10 mg
Fluoride	10 mg
folic acid*	1,000 µg
Iodine	1,100 µg
Iron	45 mg
magnesium**	350 mg
Manganese	11 mg
niacin*	35 mg
Phosphorus	4 grams
Selenium	400 µg
vitamin A***	3,000 µg(10,000 IU)
vitamin B_6	100 mg
vitamin C	2,000 mg
vitamin D	50 µg(2,000 IU)
vitamin E*	1,000 mg
Zinc	40 mg

*The UL for vitamin E, niacin, and folic acid applies to synthetic forms obtained from supplements or fortified foods.
**The UL for magnesium represents intake from a pharmacological agent only and does not include food or supplements.
***As preformed vitamin A only (does not include beta-carotene).
Source: Jean, 2019

The Tolerable upper intake level for selected nutrients for adults is discussed below.

2.2.1. Vitamins

As they can be stored in liver and fatty tissue, the fat-soluble vitamins, especially vitamins A and D, have more potentials for toxicity than do the water-soluble vitamins, which are readily excreted through the urine if taken excessively, with the exception of vitamin B_{12}(Young, 2012; Theodore, 2010; Westspot, 2012). Nonetheless, water-soluble vitamins may be toxic if consumed as supplements or in fortified foods.

Symptoms of acute vitamin A acute toxicity (poisoning), which generally require a dose of no less than 50,000 IU (15,000 µg) in adults, include nausea, vomiting, headache, abdominal pain, dizziness, lack of muscular coordination, and blurred vision. Chronic hypervitaminosis A, often resulting from sustained daily intake of 100,000 IU (30,000 µg) for months or years, may cause wide-ranging effects, including liver damage and loss of bone density (Young, 2012; Theodore, 2010; Westspot, 2012). Vitamin A toxicity in infants may be observed in swelling of the fontanelles (the soft spots) as a result of increased intracranial pressure. The large doses of vitamin A consumed by a pregnant woman can also cause developmental abnormalities in fetus, especially if taken during first trimester; precise threshold for causing birth defect is still not known, but less than 10,000 IU (3,000 µg) per day appears to be a safe intake (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). Although most naturally occurring vitamins in foods do not cause adverse effects, the toxic levels of vitamin A could be found in liver of some animals. For instance, early Arctic explorers were reported to be poisoned by consuming the liver of polar bear. High intake of beta-carotene, from carrots or from supplements or other foods that are very high in beta-carotene, may impart a yellowish cast to the skinafter several weeks, but does not cause same toxic effects as already formed vitamin A.

High vitamin D intake can result in a range of debilitating effects, particularly calcification of soft tissues and renal and cardiovascular damage. While not a concern for most individuals, young children are mostly vulnerable to vitamin D toxicity (Jean, 2019;Theodore, 2010). Individuals with high intakes of the fortified milk or fish or people who take several supplements may exceed the level of safe intake of 2,000 IU (50 μg) per day.

Due to its function as an antioxidant, the supplementation with large doses (many hundred mg per day) of vitamin E in hopefulness of protecting against heart diseases and other chronic diseases has become common. Such doses are many times the amount generally found in foods, and appear safe for most individuals, but their effectiveness inslowing the aging process or preventing disease has not been demonstrated (Jean, 2019). Daily intakes more than 1,000 mg are not recommended because they can interfere with blood clotting, resulting in hemorrhagic effects.

Large doses ofnicotinic acid (niacin), given for its effect of cholesterol-lowering, may produce reddening of the skin, together with burning, itching, and tingling. Known as niacin flush, this is first indicator of niacin excessiveness, and this symptom is the basis for safe daily intake of 35 mg(Young, 2012; Theodore, 2010; Westspot, 2012). Liver toxicities and other adverse effects have been reported with numerous grams of niacin per day.

Large doses of the vitamin B_6 have been administered in the hopes of treating conditions such as premenstrual syndrome and carpal tunnel syndrome. The most critical adverse effect found from such supplementation has been severe sensory neuropathy of the extremities, with the inclusion of inability to walk (Young, 2012; Theodore, 2010; Westspot, 2012; Jean, 2019). A daily intake up to 100 mg is considered safe, though only 1 – 2 mg are needed for good health.

Use of thesupplements of vitamin Chas been common since 1970, when Linus Pauling, a chemist and Nobel laureate, suggested that vitamin C was protective against common cold. Some studies have found moderate benefit of vitamin C in decreasing the severity and duration of common-cold episodes, but many studies have failed to find significant effect on incidence (Jean, 2019). The most common side effects of high vitamin C intake are diarrhea and other gastrointestinal symptoms, possibly due to the unabsorbed vitamin C traversing the intestine (Young, 2012; Theodore, 2010). The safe intake of 2,000 mg per day is based on avoidance of these gastrointestinal symptoms. Though other likely adverse effects of high intake of vitamin C have been examined, none has been validated in healthy individuals.

2.2.2. Minerals

A desirable dietary intake of minerals generally falls in fairly narrow range. Due to interactions, high intake of one mineral may have adversely effect on the absorption or utilization of anothermineral. Excessive intake from foods alone is not likely, but consuming fortified foods or supplements increases chance of toxicity (Jean, 2019). Additionally, occupational or environmental exposure to potentially toxic level of minerals presents added risks for some populations.

Widespreadsupplementation of calcium, mostly by women hoping to prevent osteoporosis and by the children who do not drink milk, has raised concerns about likely adverse consequences of high intake of calcium (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). A major concern has been nephrolithiasis (kidney stones), the bulk of which are composed ofa

compound of calcium oxalate. For years, low-calcium diets were recommended for individuals at risks of developing nephrolithiasis, despite disappointing efficacy and fair number of research challenging the approach. Although, a recent study has provided a strong evidence that diets relatively low in sodium content and animal protein content with normal amounts of calcium content (1,200 mg per day) are much more effective in preventing the recurrent stone formation than was traditional low-calcium diet (Jean, 2019; Young, 2012; Theodore, 2010). In fact, dietary calcium may be protecting against kidney stones as it helps bind the oxalates in the intestine. Constipation is common side effect of high intake of calcium, but daily consumption up to 2,500 mg is regarded safe for children at least 12 months old and for adults.

The use of magnesium salts as medications, such as laxatives and antacids, may result in diarrhea, abdominal cramps, and nausea. Impaired kidney function renders one more vulnerable to magnesium toxicity. Excessive magnesium intake is not likely from foods alone (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012).

Selenium is toxic in large quantities. Chronic selenium toxicity, known as selenosis, results in symptoms such as the disturbances of gastrointestinal and nervous system, a garlic-like odour to the breath, skin rash, and brittleness and losses of hair and nails (Jean, 2019; Young, 2012; Westspot, 2012). There also have been reports of both acute toxicity and death from consumption of gram amounts of selenium. Excess selenium can be damaging whether consumed as selenomethionine, the form mainly found in food, or as the inorganic forms commonly found in the supplements. A daily intake up to 400 μg from all the sources most likely has no risk of selenium toxicity (Jean, 2019).

High-dose iron supplements, usually used to treat iron deficiency anemia, can cause constipation and other gastrointestinal effects (Jean, 2019). A daily iron intake up to 45 mg presents low risk of gastrointestinal distress. Acutetoxicity and death due to ingestion of iron supplements is major poisoning hazard for the children. In those with genetic disorder hereditary hemochromatosis, a disease known by iron over absorption, or in individuals who have repetitive blood transfusions, iron may build up to unsafe levels, resulting in severe organ damage, mostly of the liver and heart (Theodore, 2010; Westspot, 2012). It is considered prudent for the men and postmenopausal women to shun iron supplements and high intakes of iron from fortified foods (Jean, 2019). Toxicity from dietary iron was reported inZimbabwe and South Africa in people consuming traditional beer with extremely high iron levels.

Excessive zinc has been shown to cause gastrointestinal symptoms such as vomiting and nausea. Chronic intake of large quantities of zinc may interfere with body's utilization of copper, reduce the levels of high-density lipoprotein cholesterol (called good cholesterol), and impair immune response (Jean, 2019). A safe consumption of 40 mg of zinc per day is not likely to be exceeded by diet alone, though it may be exceeded by zinc supplements or zinc lozenges, which are widely used regardless of a lack of data regarding their safety or effectiveness(Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012).

Impaired thyroid gland function, known as goitre, and other adverse effects can result from high iodine intakesfrom food, pharmaceutical preparations, or iodized salt intended to treat or prevent iodine deficiency or other disorders (Jean, 2019; Young, 2012; Theodore, 2010; Westspot, 2012). Although most people are not likely to exceed safe levels, those with some conditions, such as the autoimmune thyroid disease, are mostly sensitive to excess intake of iodine.

Before the teeth erupt and while they are developing, excess fluoride intake can result in mottled tooth enamel; though, this is a cosmetic effectonly. In adults, excess fluoride consumption is associated with effects ranging from an increased bone mass to a joint pain and stiffness and, in extreme circumstances, crippling skeletal fluorosis (Jean, 2019; Young, 2012; Theodore, 2010). Even in the communities where water supplies provide fluoride levels naturally in amounts several times higher than recommended, the skeletal fluorosis is extremely rare and unlikely to occur.

High phosphorus intakes (as phosphate) mayadversely affect calcium metabolism and interfere with absorption of trace elements such as zinc, iron, and copper. However, even with the intake of phosphate additives in various foods and in cola beverages, exceeding the safe levels is unlikely (Jean, 2019; Theodore, 2010; Westspot, 2012).

Copper toxicity is not likely to result from excess dietary intake, except in people with acquired disorders or hereditary of copper metabolism.Manganese toxicity, with central nervous system (CNS) damage and symptoms similar to the Parkinson disease, is a common occupational hazard of inhaling manganese dust, although it is unlikely to come from the diet (Jean, 2019).

2.2.3. Alcohol

The acute effects of large alcohol intake are well known. A mental impairment starts when blood concentration of alcohol is about 0.05% (Jean, 2019). A 0.40%concentration of alcohol in the blood of usually causes unconsciousness, and 0.50% can be fatal. Violence and accidents, which are often alcohol-related, are the major causes of death for young people. Women who drink during pregnancy risk mental and physical harm to their babies (fetal alcohol syndrome). Also, alcohol can dangerouslyinteract with a range of medications, such as antidepressants, pain relievers, and tranquilizers.

Although numerous studies have establishedand validated that light to moderate drinkers have lesser heart disease and have a tendency to live longer than either nondrinkers and heavy drinkers, increasing chronic consumption of alcohol has significant risks as well: liver disease; suicide; hemorrhagic stroke; pancreatitis; mouth, liver, colorectal, and esophageal cancers; and possibly breast cancer. Some traditionally made alcoholic drinks such as burukutu can contain methanol and ethyl carbamate which may have effect when consumed (Igwe *et al*., 2018a; Igwe *et al*., 2018b). In alcoholics, nutritional impairment can result from displacement of nutrient-rich food, and also from complications of gastrointestinal dysfunction and prevalent metabolic alterations. Thedeficiency of thiamin, as seen in a neurological condition called Wernicke-Korsakoff syndrome, is hallmark of alcoholism and needs urgent treatment.

2.3. Diets, Chronic Disease, and Dietary recommendations

The relationship between food and chronic disease is complicated, not only because several diseases take years to develop but also due to identifying a specific dietary cause is often extremely difficult. A number of prospective epidemiologic studies seek to overcome this difficulty by following the subjects for many years. Even at then, the sheer complexity of the diet, in additionto the multifactorial origins and roots of chronic diseases, makes everything difficult to prove the causal links (Jean, 2019). Furthermore, many substances in food seem to act in synergistic fashion (in the context of whole diet rather than as the individual agents) and single-agent studies can miss these effects of interactive.

The risk factorsconcept has been part of the public lexis for several decades, since the landmark Framingham Heart Study, started in 1948, first reported in early 1960s that smoking elevated high blood pressure and blood cholesterol were predictors of likelihood of individual dying from heart disease. Further studies confirmed and additionally elucidated these discoveries, and an extensive research body has since shown that specific conditions or behaviors are greatly associated with specific diseases. Not every individual with risk factor eventually develop a specific disease; however, chance of developing disease is greater when known risk factor is present and grows further when many risk factors are present. Some risk factors, such as food, physical activity, and use of alcohol, tobacco, and other drugs, are modifiable, though it is usually difficult to make such change, even if individual is facing likely disability or premature death (Jean, 2019). Others, including heredity, sex, and age, are not. Certain risk factors are modifiable to some degrees; these include the exposure to sunlight and other form of radiation, biological agents, as well as chemical agents (e.g., water and air pollution) that may play role in causing genetic mutations which have been associated with increased risks of some diseases, mostly cancer.

Although plaque formation begins in childhood, infants or the children under 2 years should not have any dietary restrictions placed on fat and cholesterol. After age two, dietary recommendations to decreasethe risk of Coronary heart disease (CHD) generally focus on controlling intakes of total fat, dietary cholesterol, and saturated and *trans*-fatty acids combined with weight management and physical activity (Jean, 2019). Since atherosclerosis is so widespread, such diets are taken to be useful not only for the public but also for individuals with high LDL cholesterol (referred to as bad cholesterol) or other CHD risk factors.The preventive diet for adults may include 20 to 35% of kilocalories as dietary fat, with a low intake of the saturated and *trans*-fatty acids (below 10% of kilocalories), and cholesterol intakes below 300 mg per day. A therapeutic diet, which have to be managed by registered dietitian or other qualified nutritionist, is even more restricting. Practical suggestions include reducing intakes of organ meats, fatty meats, full-fat dairy products, fatty spreads, egg yolks, baked goods and fried foods; removing the skin from poultry; and thoroughly reading food labels to lessen hidden fats in processed food. An emphasis on oats, oat meals, and other whole grains, fruits, and vegetables, with the inclusion of low-fat or nonfat dairy products, fish, poultry, lean meats, and legumes, is likely to benefit overall health, not only cardiovascular health.

2.3.1. Cardiovascular disease

Cardiovascular disease, a general terminologywhich encompasses diseases of the heart and the blood vessels, is the main cause of death in developed nations. Coronary heart disease (CHD), also called ischemic heart disease or coronary artery disease, is the most deadly and the most common form of cardiovascular disease. Coronary heart disease occurs when the arteries carrying the blood to the heart, and thus nutrients and oxygen, become narrow and obstructed. The narrowing is often the result of atherosclerosis, a condition wherein fibrous plaques (the deposits of lipids and other materials) build up on the arteries inner walls, making them rigid and less responsive to the changes in blood pressure(Jean, 2019). If there is interruption of blood flow in coronary arteries surrounding the heart, heart attack (called a myocardial infarction) may occur. The restriction of blood flows to the brain because of a blood clot or hemorrhage can lead to a stroke, or cerebrovascular accident, and narrowing in abdominal aorta, its major branches, or the arteries of the legs might result in peripheral arterial disease. Many strokes and heart attacks are caused not by the total blockage of arteries by plaque but by

the blood clots that readily form more where small plaques are already partly blocking the arteries (Jean, 2019).

Although atherosclerosis normally takes decades to manifest in stroke or heart attack, the disease may actually start from childhood, with appearance of fatty streaks, the precursors to plaque. Deposition of plaque is, in essence, inflammatory response directed to repairing injuries in arterial wall. Smoking, diabetes, hypertension, and high blood levels of LDL (low-density lipoprotein) cholesterol are among many factors associated with vessel injury (Jean, 2019). Infection by certain bacteria or viruses may also contribute to inflammation and vessel damage. Particularly vulnerable to premature coronary heart disease are middle-aged men, particularly those with family history of the disease, and people with hereditary conditions such as family hypercholesterolemias. The declining of fishes in oceans is also a threat (Awuchi and Awuchi, 2019a).

Diet and weight loss have influence in modifying 4 major risk factors for CHD: hypertension, low level of high-density lipoprotein (HDL) cholesterol, diabetes, and high levels of LDL cholesterol. However, the roles of food in influencing the established risk factors are not as clear as the roles of the risk factors themselves. Additionally, dietary strategies are most beneficial when combined with the other approaches, such as regular exercise and smoking cessation. Drug therapy can include cholesterol-lowering drugs such as bile acid sequestrants, niacin, and statins, as well as anticoagulants or aspirin to prevent the formation of blood clots and antihypertensive medications to lower blood pressure (Jean, 2019). Some medicinal plants have been alleged to help the treatment (Awuchi, 2019a), although many of these claims are yet to be scientifically established. While endogenous estrogen (produced by the body) is believed to confer protection against CHD in the premenopausal women, recent studies call to question the value of the hormone therapy in reducing CHD risks in women who have passed through menopause.

2.3.2. Hypertension (high blood pressure)

Hypertension, also known as high blood pressure (HBP) or high BP, is one of the most common health issues in developed nations. It is asignificant risk factor for other diseases, like coronary heart disease, stroke, aneurysm, kidney disease, and congestive heart failure. Most people with HBP have primary, or essential, hypertension, for which no specific cause may be determined. Heredity plays role in development of hypertension, but so do some modifiable factors such as high alcohol intake, diets high in salt, excess weight, and physical inactivity (Jean, 2019). For reasons that are not completely clear, African Americans have one of the highest rates of hypertension worldwide.

Hypertension is commonly defined as a blood pressure ≥140/90 mm Hg, that is, equivalent to pressure exerted by column of mercury 140 mm high during the heart contraction (systole) and 90 mm high during heart relaxation (diastole); systolic or diastolic blood pressure, or both, can be elevated in hypertension. People with HBP can be asymptomatic for several years and then suddenly experience heart attack or fatal stroke. Management and prevention of hypertension can decrease the chance of complicationssignificantly (Jean, 2019). Early hypertension identification is important so that lifestyle modification maystart as early as possible.

Overweight individuals, especially those with excessive abdominal fat, have much greater risks of developing hypertension than lean people. Only weight loss, sometimes as little as 10 pounds (4.5 kg), can be extremely effective in decreasing high blood pressure. Increasing the

physical activity can, of course, aid weight control, but it also seems to independentlylower blood pressure. Large studies examining intake of table salt and blood pressure in the communitiesworldwide have clearly found that blood pressure is positively correlated to dietary intake of sodium in table salt (Jean, 2019). Primitive societies wherethere is low sodium intake have very little hypertension, and the rise in blood pressure which typically occurs with age in the industrialized societies fails to occur. Conversely, in countries with extremely high consumption of table salt, hypertension is common and stroke is the leading cause of death. Additionally, experimental studies show that decreasing sodium intake can decrease blood pressure.

Some people seem to be genetically sensitive to salt. Though salt restriction may only help decrease blood pressure in individuals who are salt sensitive, many people consume more salt than is required. Dietary recommendations usually encourage the general public to limit sodium intake to below 2,400 mg daily, which amounts toslightly more than a teaspoon of table salt. This level can be realized by restricting the salt used in cooking, not adding table salt at the table, and limiting highly salted foods, so-called fast foods, and processed foods (lots of which have hidden sodium). Canned vegetables, luncheon meats, and breakfast cereals are mostly high in sodium.

Heavy consumption of alcohol (more than two drinks a day for men and more than a drink a day for women) is associated with hypertension. Vegans, and particularly vegetarianswho do not eat foods of animal origin, including eggs and milk, tend to have a lower blood pressure than meat consumers (Jean, 2019). The diets recommended for the reduction of blood pressure, which also benefit cardiovascular health, emphasize vegetables, fruits, and low-fat dairy products; includes fish, nuts, whole grains, and poultry; and contains only little amounts of red meat and sugary diets and beverages. Reducing intake of salt should further increase effectiveness of the diets.

A variety of medications is used for hypertensiontreatment, some of which have nutritional repercussions. For example, thiazide diuretics increase the loss of potassium from the body, usually requiring the intake of morepotassium, which is mostlyabundant in foods such as bananas, vegetables, potatoes, and citrus fruits. Use of the potassium-based salt substitutes is not advisable without medical supervision.

2.3.3. Cancer

Second only to cardiovascular diseases as a cause of death in the world, cancer is a major cause of death of adults 45 years and above. The various types of cancer differ in location in the body, affected cell type, treatments, in the course of the disease, and suspected contributory or causal factors.Studies of identical twins show that, even for those with identical genetic makeup, the risks for most cancers are still largely related to the environmental factors. Another set of evidence supporting the limited roles of heredity in most cancers are studies of migrant populations, where cancer rates have a tendency to grow more like group's adopted country with every passing generation (Jean, 2019). For example, rates of colorectal and breast cancers in people who migrate from the rural Asia to the US gradually increase to match higher cancer rates of the US (Jean, 2019). On the other hand, the risk of stomach cancer gradually reduces after Japanese migrants move to the US. Nutrition is among the critical lifestyle and environmental factors investigated in migration studies, though identifying specific dietary constituents that affect the changing rates of disease has been more elusive. Many cancer

organizations round the world have estimated that 30% to 40% of all the cases of cancer may be prevented by proper dietary means.

Studies attempting to relate the total fat or the specific types of fat to many cancers have been unreliable. High intake of dietary fat can promote cancer, but this may be due in part to the extra calories (energy) that fat gives. Obesity is associated with various types of cancer, including uterine, pancreatic, breast, colorectal, and prostate cancers (Jean, 2019). A likely mechanism for this effect is higher circulating levels of insulin, estrogen, and other hormones that accompany the increased body fat. Additionally, regular exercise has been demonstrated in various studies to lessen the risk of colon and breast cancers. In laboratory animals, restricting intake of energy is the most effective method for decreasing cancer risks; chronic underfeeding prevents the growth of most experimentally induced tumors and several spontaneous tumors.

Most carcinogens (cancer-causing substances), including mycotoxins (Awuchi *et al*., 2019b), probably enter the body via the alimentary canal in food as well as beverages. Although various foodborne toxins, food additives, and pesticides may be carcinogenic if consumed in sufficient amounts, it is primarily foodstuffs themselves which are associated with cancer. Many dietary components or patterns may promote cancer, whereas others may prevent it. Substances in the food, or other environmental factors, may act anywhere along the multistage processes of cancer development (carcinogenesis): the initiation, in which the DNA, the genetic material in the cell, is altered; the promotion, wherein cells with the altered DNA multiply; and the progression, wherein cancer cells spread to the surrounding tissues and distant sites (metastasis) (Jean, 2019).

High alcohol consumption is another risk factor that has been linked with the development of numerous cancers, especially of the liver, mouth, throat, and esophagus (where it acts with tobaccosynergistically) and possibly of the breast, rectum, and colon. The fact that the moderate use of alcohol has beneficial effect on cardiovascular disease underlines how complex and potentially puzzling is the connection between foods and health.

Foods contain substances that provide some protection against cancer. For instance, fresh fruits and vegetables, as well as specifically vitamins E and C, eaten same time as nitrate-containing diets (such as ham, frankfurters, luncheon meats, bacon, and sausages), inhibit production of nitrosamine and thus help to protect against stomach cancer. Hundreds of studies have found strong association between diets high in fruits and vegetables and lower risk for numerous cancers, although the identification of specific protective factors in such foods has been more difficult. Vitamins C andE, carotenoids such as the beta-carotene (a plant precursor of the vitamin A), and selenium, a trace mineral, act in the antioxidant systems of the body to help prevent damage to DNA by reactive molecules called free radicals(Jean, 2019). Specific vegetables, especially the cruciferous vegetables(cauliflower, broccoli,kale, Brussels sprouts, and other members of cabbage family), contain sulforaphane and a few other compounds known as isothiocyanates, that induce the enzymes that detoxify carcinogens and have been shown to protect against cancer in studies involving animals. Dietary fibre in plant diets might also be protective: by diluting potential carcinogens, binding to them, and speeding up transit time via the gut, thereby limiting exposures. Fruits and vegetables are rich in biologically active plant substances (known as phytochemicals), which are currently under investigation for potential anticarcinogenic activity (Awuchi, 2019a; Jean, 2019). Animal studies suggest that antioxidant compounds called polyphenols (Awuchi, 2019a; Jean, 2019), which are found in both green and black tea, may protect against the growth of cancer (Awuchi, 2019a). Regular

consumption of tea, particularly inChina and Japan, where green tea is the most preferred type, has been connected with a reduced risk of many cancers, especially the stomach cancer, but evidence has been inconsistent.

The dietary approaches most likely to decrease cancer risksare ones that are rich in diets from plant sources, such as vegetables (especially cruciferous ones), fruits,whole grains, nuts, and beans; has limited fat intake, especially animal fats; includes balance of physical activity and energy intake to maintain healthy body weight; and includes moderate alcohol, if at all. Intake of carcinogens can also be decreased by removing burned portions and trimming fat from meat before consumption.

2.3.3.1Colorectal cancer

Meat consumption, particularly processed meat and red meat, is associated with modest increase in risks of colorectal cancer. However, it is not clear whether this effect is connected to a specific meat component; to the known fact that other nutrients, such as fiber, may be in short supply in high-meat diets; or to the carcinogenic substances, such as polycyclic aromatic hydrocarbons and heterocyclic amines, which are produced during high-temperature broiling and grilling, particularly of fatty muscle meats. The high consumption of alcohol and low intakes of folic acid and calcium have also been linked to increased rate of colorectal cancer (Jean, 2019).Although fiber-rich diets also seem toprotect against colorectal cancer in several studies, attempts to show a specific protection effect of dietary fiber, distinct from the non-fiber components of fruits and vegetables, have been inconclusive (Jean, 2019). Obesity is asignificant risk factor for the colorectal cancer in the men and the premenopausal women, and moderate or mild physical activity is strongly associated with decreased risk of the colon cancer.

2.3.3.2. Prostate cancer

There is a growing evidence that diets low in fat and animal products and mostly rich in fruits and vegetables, including cruciferous type, is very protective against prostate cancer. The protection may be partially explained by the fibre called pectin, found in fruits and vegetables, which has been showed to possess anticancer properties. Lowerriskof prostate cancer has been associated with consumption of tomatoes as well as tomato products, which are common rich sources of lycopene, a carotenoid antioxidant (Jean, 2019). The rates of prostate cancer are low in countries like Japan where soy foods are regularly consumed, but no direct evidence that soy is protective against the disease exists. The likely protective effect against prostate cancer of selenium and vitamin E is under investigation.

2.3.3.3. Breast cancer

The relationship between breast cancer and diet is not clear. High-fat diets have been alleged tocontribute to breast cancer, based on the international correlations between breast cancer rates and fat intake, as well as animal studies. Though, large prospective studies have not proved this connection, although a diet high in fat might not be advisable for other reasons. In the same way, diets high in fruits and vegetables are certainly healthful but offers no known protective effect against breast cancer (Jean, 2019). Alcohol intake is connected with breast cancer, but increased risk seemsto be only related to heavy drinking. Lasting regular exercise can be protective against breast cancer, likely because it helpsweight control, and obesity is connected with increased risks of postmenopausal breast cancer.

Geneticinheritance and levels of estrogenduring a lifetime are the major established influences on breast cancer risks.

Enthusiasm for soy food and soy products for protection against breast cancer is recentlygrowing in the industrialized countries. Although Japanese women, with low rates of breast cancer, have lifelong exposure to high soydiet, their situation is not necessarily similar to midlife supplementation with estrogen-like compounds (called isoflavones) in soy in Western women. Isoflavones seem to compete with the estrogen (for example, in premenopausal women), and in so doingblunt its effect; when in low-estrogen environment (for example,in postmenopausal women) they wield weak estrogenic effects. There is no reliable evidence that soy in the diets provide protection against any cancer (including breast cancer); and the effects of dietary soy whencancer has been initiated are not known; estrogen itself promotes cancer (Jean, 2019). Ongoing research on the health benefits of soy is promising, and the consumption of soy diets such as tofu is encouraged; however, the consumption of isolated soy components such as isoflavones, which have no known risks, is unwarranted.

2.3.4. Diabetes mellitus and metabolic disorders

Diabetes mellitus (DM), simply called diabetes, is a metabolic disorder of carbohydrate metabolism characterized byhyperglycemia (a high blood glucose level) and often resulting from insufficient production of insulin (type 1 diabetes) or ineffective cells response to insulin (type 2 diabetes); other types of diabetes exist, including gestational diabetes. Secreted by the pancreas, the hormone insulin is required to transport blood sugar (glucose) into cells. Diabetesmellitus is asignificant risk factor for cardiovascular disease, and a leading cause of blindness in adults. Other long-term complications include nerve damage, kidney failure,and lower limb amputation as a result of impaired circulation (Jean, 2019).

Type 1 diabetes was previously known as insulin-dependent or juvenile-onset diabetes, and can occur at any age but usually begins in late childhood with pancreas failing to secrete sufficient amounts of insulin. The type 1 diabetes has strong hereditaryconnection, but most cases are often the result of an autoimmune disorder, likely set off by viral infection, environmental toxin, or foreign protein. Although elevated blood glucose level is a significant feature of diabetes, sugars or carbohydrates in the diet are not the cause of diabetes, although they are among the risk factors. Type 1 diabetes is managed by the injections of insulin, together with small, low carbohydrate, and regularly spaced meals and snacks which spread the intake of glucose throughout the day and reduce blood glucosefluctuations.

Type 2 diabetes was previously known as non-insulin-dependent or adult-onset diabetes, and is the most common type of diabetes, constituting 90% to 95% of all cases of DM. With this condition, insulin resistance makes cells unable to take glucose, which consequently accumulates in the blood. Though type 2 diabetes in generalbegins in middle age, it has been increasingly reported in childhood, mostly in obese children. Genetic vulnerability to type 2 diabetes might not be expressed except a person has excessive body fat, especially abdominal obesity. Loss of weight often helps to normalize the regulation of blood glucose, and oral anti-diabetic agents can also be used. Lifestyle interventions, such as diet and exercise, are highly effective in preventing or delaying type 2 diabetes in people at high-risk of developing the disease.

Specific treatment plans for people with diabetes mellitus (DM) are designed after medical assessment of individual and consultation with qualified nutrition professional or

registered dietitian. The therapeutic diet, which of course has changed significantly over the years, focuses more on dietary fiber (particularly the soluble fiber), complex carbohydrates, and regulated proportions of protein, fat, and carbohydrate. As the leading cause of death among diabetics is heart disease, saturated fatty acids as well as *trans*-fatty acids are restricted too, while weight control and physical activity are strongly encouraged. Earlier dietary recommendations restricted sugars in the diabetic diets, but recent guidelines allow moderate sugar intakes, provided that other carbohydrates are reduced in the diets. Exercise and diets are also used to manage another type of diabetes known as gestational diabetes, which develops in small percentage of pregnant women and normally resolves itself after child delivery, although such women are consequently at increased risk of developing the type 2 diabetes.

Migration studies showed that urbanization and the adoption of Western diets and habits can increase the rates of type 2 diabetesdramatically. For example, high prevalence of type 2 diabetesis seen in Pima Indians of Arizona, who live a sedentary lifestyle and consume a high-fat diet, while prevalence is low in closely related group of the Pimas living traditional lifestyle—physically active, eat a diet that is less in fat, and with lower body weight—in a remote, mountainous area of Mexico(Jean, 2019). Type 2 diabetes is a severe health problem among the Native Americans and most other ethnic minorities in the US. Globally, the prevalence of the type 2 diabetes has increased markedly, along with the increase in obesity.

Research in 1990s led to development of new tool, known as the glycemic index, which mirrors the discovery that different carbohydrate foods have blood glucose levelseffects that cannot be predicted on basis of their chemical structures. For example, the simple sugars from digestion of some starchy rich foods, such as potatoes or bread, are absorbed more rapidly and cause faster rise in blood glucose levels than does table sugar (sucrose), milk, or fruit. In practical terms, if a carbohydrate food is consumed as part of a mixed diet, its so-called glycemic effects are less consequential (Jean, 2019). The glycemic index may be a useful option for planning a diabeticdiet, but it by no means obviates the requirement for other proven therapeutic practices, such as managing body weight and limiting total carbohydrate intake.

Chromium, a trace element, is a cofactor for insulin and is key for glucose tolerance. Malnourished infants and children with impaired glucose tolerance have been demonstrated to benefit from additional chromium, however there is lack of evidence that most individuals with diabetes are chromium deficient or require chromium supplementation.

If a diabetic injects insulin excessively, blood glucose level may drop to dangerous low levels; headache, confusion, irritability, shakiness, and sweating that ensue are signs of low blood sugar level, known as hypoglycemia (Jean, 2019). Severe hypoglycemia, if untreated, can result incoma, seizures, and even death. The reactive hypoglycemia of a non-diabetic origin is distinct disorder of the metabolism of carbohydrate in which blood glucose levels fall unduly (lower than 50 mg/dl) after overproduction of the body's own of the hormone insulin in response to meal high in the simple sugars; symptoms of hypoglycemia simultaneouslyoccur. However, this condition is not common.

Many inherited metabolic disorders, also called inborn errors of metabolism, respond to treatment with diets. Most of these relatively uncommon disorders are inherited as the autosomal recessive traits (that is, both parents must be carriers) and also result in a specific cofactor or enzyme that has decreased activity or is absent altogether (Jean, 2019). Biochemical pathways of fatty acid, amino acid, or carbohydrate metabolism may be affected, each having a few likely enzyme defects. In most cases, newborn screening programs, as well

as even prenatal diagnosis, allow for the early identification and successful intervention. In the absence of prompt and aggressive treatment, many of these disorders have poor prognosis, leading to severe intellectual impairment and other forms of illness (Jean, 2019). Phenylketonuria (PKU), a condition wherein the phenylalanine (an amino acid) is improperly metabolized to tyrosine (an amino acid too), is the most known of these disorders. Treatment usually involves restriction of phenylalanine in the diets and tyrosine supplementation. With meticulous management and early detection, intellectual functioning and normal growth are possible. The endocrine disruptive effects of some additives in plastics may also be a threat (Awuchi and Awuchi, 2019b)

2.3.5. Obesity and weight control

The World Health Organization has recognized obesity as a global epidemic affecting at least 500 million adults and paradoxically simultaneously existing with undernutrition in both industrialized and developing countries (WHO, 2019). There also have been reports of an alarming increase in childhood obesity worldwide (Jean, 2019; WHO, 2019). Obesity, characterized by excessive body fat for stature, contributes to the adverse health consequences such as blood lipid abnormalities, high blood pressure, coronary heart disease, ischemic stroke, type 2 diabetes, congestive heart failure,gallbladder disease, osteoarthritis, reduced life expectancy, and manycommon cancers (including uterine,colorectal, and postmenopausal breast cancers) (Jean, 2019). Genes play a significant role in body weightregulation. Nevertheless, some environmental factors such as calorie-rich foods and a sedentary lifestyle can also be instrumental in determining how a person's genetic heritage unfolds. Dietary carbohydrates are not always the problem in obesity. In many Asian cultures, for instance, where carbohydrate diets such as rice are the major food, individuals are relatively thin and the rates of heart disease and diabetes are lower than they are in the Western cultures. What matters most in control of weight is the ratio of calories (food energy) consumed to energy expended with time.

Height-weight tables as reference for healthy weights have been replaced by the parameter referred to as the body mass index (BMI). BMIestimates the total body fat, though it is less sensitive than using skinfold caliper or other methods of measuring body fat indirectly. BMI is defined as weight in kg divided by the square of height in meters: i.e., BMI = weight ÷ height^2. In 1997 the World Health Organization recommended global adoption of definition of healthy BMI for adult men and women as between 18.5 and 24.9 (Jean, 2019). A BMI less than 18.5 is regarded as underweight, while BMI between 25 and 29.9 indicates overweight and BMI 30 or above indicates obesity. Definitions of obesity and overweight are more difficult to quantify for infants and children, whose BMI (body mass index) changes with age.

Healthful eating plan for gradual loss of weight in adults will likely contain around 1,200 to 1,500 kcal (kilocalories) per day, possibly accompanied by balanced vitamins and minerals supplement. A desirable weight loss is around one pound per week from the fat stores (as opposed to the lean tissue), which needs an energy deficit of 3,500 kilocalories, or around 500 kilocalories per day. Eating less than 1,000 kilocalories per day is not recommended; preferred approach should be to increase physical activities, which has the added benefits of helping to maintain lean tissue (Jean, 2019). Individuals with severely obesity and unable to lose weight can, after medical consultation, consider using weight-loss medications which suppress appetite or reduce nutrient absorption or even surgery to decrease the stomach volume or bypass it in total. Carbohydrate-restricted foods, very-low-fat foods, and novelty foods—those wherein one food or group of food is emphasized—may lead to weight loss but mostly fail to

establish good dietary and exercise practices required to maintain desired weight, and weight is usually regained soon after the diet is stopped.

Successful approach to long-term management of weight requires establishing new lifestyle patterns: eating healthily, but eating less portions; engaging in regular physical activities; and changing behavior patterns which are counterproductive, such as eating large quantities of food while watching television or eating food uncontrollably. Limiting intake of fatty diets, which are more energy-dense, is also useful, as is consuming smaller portions and drinking water as an alternative to calorie-containing drinks. Also, drinking soda made with sugar substitutes such as sugar alcohols (Awuchi and Echeta, 2019; Awuchi, 2017) or other sugar substitutes with little or no calories will help. Low-fat foods are not at all times low in total calories, as fat may be replaced by sugars such as sucrose, which themselves provide calories. People who use nonnutritive or artificial sweeteners do not necessarily decrease their total calorie intake.

Various researches with the genetically obese laboratory animals led to discovery of the *ob* gene in rats and humans. Under direction of this gene, the cells of adipose (fat) tissue secrete leptin, a protein hormone (Jean, 2019). When the fat stores increase, leptin sends signal to hypothalamus (a regulatory center in the brain) that stimulates individual to eat less and spend more energy. Some genetic mutations result in deficient production of the functional leptin or in failure to respond to leptin signal. Treatment with leptin might prove useful for small percentage of obese people who have defect in *ob* gene, though it is still unknown whether leptin therapy will induce loss of weight in individuals who do not have mutations in *ob* gene or who are leptin-resistant.

2.3.6. Eating disorders

Eating disorders such as bulimia nervosa and anorexia nervosa are serious health problems reflectingundue concern with body weight. Young women and girls are most vulnerable to pressures of the society to be in shape or thin, although boys and men may also fall prey to these conditions, which have lifetime consequences and may even be fatal (Jean, 2019). The incidences of eating disorders have risen during the past 50 years, especially in the US and Western Europe.

Anorexia nervosa is characterized by propensity for drastic under eating, low body weight, and intense fear of weight gainor becoming fat (even though being underweight), and distorted body image (Jean, 2019). Consequences include impaired immunity, diminished digestive function, and anemia. Without intervention or diet improvement, a state of semi-starvation similar to PEM (marasmus) may occur, requiring hospitalization and force-feeding to prevent death. The treatment usually requires coordinated approach, with participation of physician, dietitian, psychiatrist, and possibly other trained health professionals.

Bulimia nervosa is believed to be more common than anorexia nervosa, and both disorders can even occur in the same individual. In bulimia nervosa, recurring episodes of binge eatingof food are followed by a kind of purging, such as fasting, excessive exercise, self-induced vomiting, or the use of laxatives, diuretics, or enemas. Treatment often involves structured eating plan (Jean, 2019).

Young athletes usually restrict energy intakes in order to meet the weight guidelines and the body-image expectations required by their sports. Females are mostly affected, but the male athletes, such as gymnasts, jockeys, wrestlers, and boxers, are also vulnerable. The intense training among the young female athletes, together with food energy restrictions, usually

results in amenorrhea (the failure to menstruate for at least 3 consecutive months) and loss of bone similar to that at menopause. A calcium supplementation may be needed.

2.3.7. Tooth decay

Dental caries (tooth decay) is an oral infectious disease in which bacteria, primarily *Streptococcus mutans*, in the dental plaque metabolize simple sugars and other fermentable carbohydrates into acids that dissolve tooth enamel. Dental plaque (not to be confused with the lipid-containing plaque found in arteries) is a mass of bacteria and sticky polymers that shield the tooth from saliva and the tongue, thereby facilitating decay (Jean, 2019). All dietary forms of sugar, including honey, molasses, brown sugar, and corn syrup, can cause tooth decay; fermentable carbohydrates in crackers, breads, cereals, and other grain products, as well as milk, fruits, and fruit juices, also have cariogenic (decay-causing) potential. Eating sugary or starchy foods between meals, especially sticky foods that stay on the teeth longer, increases the time that teeth are exposed to destructive acids. Artificial sweeteners are not cariogenic, and xylitol, a sugar alcohol used in some chewing gums, is even cariostatic, i.e., it reduces new tooth decay by inhibiting plaque and suppressing decay-causing bacteria. Putting an infant to sleep with a bottle, especially one containing juice or other sweetened beverages, milk, or infant formula can lead to a condition called "baby bottle tooth decay."

Fluoride is extremely effective at protecting tooth enamel from decay, especially while enamel is being formed in the jaws before the permanent teeth erupt (Jean, 2019). Fluoridation of water in communitieswhere fluoride is not naturally high is a safe and effective public health measure. Water with approximately one part per million of fluoride protects against dental caries without causing the mottling of teeth that can occur at higher levels. In areas without fluoridated water, fluoride supplements are recommended for children. Brewed tea, marine fish consumed with bones, and seaweed are significant food sources of fluoride.

Regular brushing and flossing of the teeth and gums, as well as rinsing the mouth after meals and snacks, are important measures that protect against periodontal (gum) disease as well as dental caries (Jean, 2019). Gum health also depends on a properly functioning immune system and good overall nutrition. Key nutrients include vitamin C, which helps protect against gingivitis (inflamed gums), and calcium and vitamin D, which help ensure a strong jawbone and teeth.

2.3.8. Heartburn and peptic ulcer

When gastric contents, containing hydrochloric acid, flow backward from the stomach, the lining of the esophagus becomes inflamed, leading to the burning sensation known as heartburn. Occasional heartburn (also known as acid indigestion) is a common occurrence, typically precipitated by eating certain foods. However, some people experience heartburn regularly, a condition known as gastroesophageal reflux disease (GERD) (Jean, 2019). Individuals with GERD are advised to limit their intake of alcohol and caffeine, which relax the lower esophageal sphincter and actually promote reflux, as well as their intake of fat, which delays gastric emptying (Jean, 2019). Chocolate, citrus fruit and juices, tomatoes and tomato products, spearmint and peppermint oils, and certain spices may aggravate heartburn, but these foods do not appear to cause the condition.

For overweight or obese individuals with GERD, weight loss may have a beneficial effect on symptoms. Eating smaller meals, chewing food thoroughly, eating more slowly, avoiding tight-

fitting clothes, not smoking, and not lying down before about three hours after eating are among the factors that may improve the condition (Jean, 2019). Without medical supervision, drugs such as antacids and acid controllers should be used only infrequently. It is now known that a peptic ulcer (a sore on the lining of the stomach or duodenum) is not caused by stress or eating spicy foods, as was once thought; rather, most peptic ulcers are caused by the infectious bacterial agent *Helicobacter pylori* and can be treated by a simple course of antibiotics. However, stress and dietary factors—such as coffee, other caffeinated beverages, and alcohol—can aggravate an existing ulcer.

2.3.9. Bowel conditions and diseases

Constipation, a condition characterized by the difficult passage of relatively dry, hardened feces, may arise from insufficient dietary fibre (roughage) or other dietary factors, such as taking calcium or iron supplements, in addition to daily routines that preclude relaxation. Straining during defecation can also contribute to diverticulosis, small outpouchings in the colonic wall, which may become inflamed (diverticulitis) and present serious complications. Another possible consequence of straining is hemorrhoids, swollen veins of the rectum and anus that typically lead to pain, itching, and bleeding (Jean, 2019). Constipation can usually be treated by eating high-fibre foods such as whole-grain breads and cereals, drinking sufficient amounts of water, and engaging in regular exercise. By drawing water into the large intestine (colon), fibre—especially the insoluble type—helps form a soft, bulky stool. Eating dried fruits such as prunes, which contain a natural laxative substance (dihydroxyphenyl isatin) as well as being high in fibre, also helps stimulate the bowels. Although laxatives or enemas may be helpful, frequent use may upset fluid, mineral, and electrolyte (salt) balances and interfere with vitamin absorption. Any persistent change in bowel habits should be evaluated by a physician.

In contrast to constipation, diarrhea—loose, watery stools, and possibly an increased frequency of bowel movements—can be a cause for immediate concern. Acute diarrhea of bacterial origin is relatively common and often self-limiting. Other common causes of acute diarrhea include viral infections, parasites, food intolerances or allergies, medications, medical or surgical treatments, and even stress. Regardless of cause, drinking fluids is important for treating a temporary bout of diarrhea (Jean, 2019). However, if severe and persisting, diarrhea can lead to potentially dangerous dehydration and electrolyte imbalances and requires urgent medical attention, especially in infants and children. Prolonged vomiting presents similar risks.

Inflammatory bowel disease (IBD), such as Crohn disease (regional ileitis) or ulcerative colitis, results in impaired absorption of many nutrients, depending upon which portion of the gastrointestinal tract is affected. Children with IBD may fail to grow properly. Treatment generally includes a diet low in fat and fibre, high in protein and easily digestible carbohydrate, and free of lactose (milk sugar). Increased intakes of certain nutrients, such as iron, calcium, and magnesium, and supplementation with fat-soluble vitamins may also be recommended, along with additional fluid and electrolytes to replace losses due to diarrhea.

Irritable bowel syndrome (IBS) is a common gastrointestinal disorder characterized by a disturbance in intestinal peristalsis (Jean, 2019). Symptoms include excessive gas, abdominal discomfort, and cramps, as well as alternating diarrhea and constipation. Although it can be extremely uncomfortable, IBS does not cause intestinal damage. Dietary treatment involves identifying and avoiding "problem" foods, notably legumes and other gas-producing vegetables and dairy products, and possibly reducing caffeine consumption. For most people with IBS, a low-fat diet, smaller meals, and a gradual increase in fibre intake are helpful.

2.3.10. Blood lipoproteins

Because lipids such as cholesterol, triglycerides, and phospholipids are nonpolar and insoluble in water, they must be bound to proteins, forming complex particles called lipoproteins, to be transported in the watery medium of blood. Low-density lipoproteins, which are the main transporters of cholesterol in the blood, carry cholesterol from the liver to body cells, including those in the arteries, where it can contribute to plaque. Multiple lines of evidence point to high levels of LDL cholesterol as causal in the development of CHD, and LDL is the main blood lipoprotein targeted by intervention efforts. Furthermore, clinical trials have demonstrated that LDL-lowering therapy reduces heart attacks and strokes in people who already have CHD (Jean, 2019). High-density lipoproteins, on the other hand, are thought to transport excess cholesterol to the liver for removal, thereby helping to prevent plaque formation. HDL cholesterol is inversely correlated with CHD risk; therefore intervention efforts aim to increase HDL cholesterol levels. Another blood lipoprotein form, the very-low-density lipoprotein (VLDL), is also an independent CHD risk factor, but to a lesser extent than LDL and HDL. As the major carrier of triglyceride (fat) in the blood, VLDL is particularly elevated in people who are overweight and in those with diabetes and metabolic syndrome.

Although LDL cholesterol is popularly referred to as “bad” cholesterol and HDL cholesterol is often called “good” cholesterol, it is actually the lipoprotein form—not the cholesterol being carried in the lipoprotein—that is related to CHD risk (Jean, 2019). Total cholesterol levels, which are highly correlated with LDL cholesterol levels, are typically used for initial screening purposes, although a complete lipoprotein evaluation is more revealing. A desirable blood lipid profile is a total cholesterol level below 200 milligrams per decilitre (mg/dl), an HDL cholesterol level of at least 40 mg/dl, a fasting triglyceride level of less than 150 mg/dl, and an LDL cholesterol level below 100, 130, or 160 mg/dl, depending on degree of heart attack risk.

2.3.11. Dietary fat

It is widely accepted that a low-fat diet lowers blood cholesterol and is protective against heart disease. Also, a high-fat intake is often, although not always, linked to obesity, which in turn can increase heart disease risk. Yet, the situation is complicated by the fact that different fatty acids have differing effects on the various lipoproteins that carry cholesterol (Jean, 2019). Furthermore, when certain fats are lowered in the diet, they may be replaced by other components that carry risk. High-carbohydrate diets, for example, may actually increase cardiovascular risk for some individuals, such as those prone to metabolic syndrome or type 2 diabetes. Heredity also plays a role in an individual’s response to particular dietary manipulations. In general, saturated fatty acids, which are found primarily in animal foods, tend to elevate LDL and total blood cholesterol (Jean, 2019). However, the most cholesterol-raising saturated fatty acids (lauric, myristic, and palmitic acids) can come from both plant and animal sources, while stearic acid, derived from animal fat as well as from cocoa butter, is considered neutral, neither raising nor lowering blood cholesterol levels.

When saturated fatty acids are replaced by unsaturated fatty acids—either monounsaturated or polyunsaturated—LDL and total blood cholesterol are usually lowered, an effect largely attributed to the reduction in saturated fat. However, polyunsaturated fatty acids tend to lower HDL cholesterol levels, while monounsaturated fatty acids tend to maintain them (Jean, 2019). The major monounsaturated fatty acid in animals and plants is oleic acid; good dietary sources are olive, canola, and high-oleic safflower oils, as well as avocados, nuts, and seeds. Historically, the low mortality from CHD in populations eating a traditional Mediterranean diet has been linked to the high consumption of olive oil in the region, although the plentiful supply

of fruits and vegetables could also be a factor. Olive oil consumption is also associated with decreased levels of amyloid-beta plaque formation and a reduction of inflammation in the brain; such plaques and inflammation are indicative of Alzheimer disease. Studies in animals suggest that a diet rich in olive oil helps preserve memory and learning ability.

The two types of polyunsaturated fatty acids found in foods are omega-3 fatty acids and omega-6 fatty acids. Linoleic acid, the primary omega-6 fatty acid in most diets, is widespread in foods; the major source is vegetable oils such as sunflower, safflower, and corn oils. Low cardiovascular disease rates in Eskimo populations eating traditional diets high in omega-3 fatty acids initially provoked the speculation that these fatty acids may be protective against CHD. The primary lipid-altering effect of omega-3 fatty acids is the reduction of blood triglycerides. The suction piles in our oceans (Ezenwankwo *et al*., 2017) may have direct contact with fishes, thereby bruising them; which may lead to death, and decrease in fishes available for omega fatty acids. Omega-3 fatty acids may also protect the heart and blood vessels by lowering blood pressure, reducing blood clotting, preventing irregular heart rhythms, and acting as anti-inflammatory agents. The long-chain omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are derived from alpha-linolenic acid, a shorter-chain member of the same family (Jean, 2019). Fatty fish such as salmon, herring, sardines, mackerel, and tuna are high in both EPA and DHA. Flaxseed is an excellent source of alpha-linolenic acid, which the body can convert to the long-chain omega-3 fatty acids. Other sources of omega-3 fatty acids include walnuts, hazelnuts, almonds, canola oil, soybean oil, dark green leafy vegetables such as spinach, and egg yolk. A diet high in polyunsaturated fatty acids may increase LDL lipid oxidation and thereby accelerate atherosclerosis; therefore, it should be accompanied by increased intakes of vitamin E, an antioxidant. Fish oil supplements are not advised without medical supervision because of possible adverse effects, such as bleeding.

The safety of *trans* (as opposed to naturally occurring *cis*) unsaturated fatty acids has been called into question because *trans*-fatty acids in the diet raise LDL cholesterol to about the same extent as do saturated fatty acids, and they can also lower HDL cholesterol (Jean, 2019). *Trans*-fatty acids are found naturally in some animal fats, such as beef, butter, and milk, but they are also produced during the hydrogenation process, in which unsaturated oils are made harder and more stable. Certain margarines, snack foods, baked goods, and deep-fried products are major food sources of *trans*-fatty acids.

2.3.12. Dietary cholesterol

Cholesterol in food and cholesterol in the blood are distinct entities, and they are often confused. Dietary cholesterol is found only in foods of animal origin, and it is particularly high in egg yolk and organ meats. Cholesterol in the diet raises LDL cholesterol but not as much as saturated fatty acids do (Jean, 2019). If dietary cholesterol is already high, consuming even more cholesterol may not increase blood cholesterol levels further because of feedback control mechanisms. Also, there is great individual variation in response to dietary cholesterol. For healthy people, a cholesterol intake averaging less than 300 mg daily is recommended; however, because cholesterol is synthesized by the body, none is required in the diet.

2.3.13. Other dietary factors

Ingestion of soluble fibre, a component of dietary fibre (indigestible plant material), lowers LDL and total blood cholesterol levels and has been linked to decreased mortality from cardiovascular disease. Sources of soluble fibre include whole oats, barley, legumes, some vegetables, and fruits, particularly apples, plums, apricots, blueberries, strawberries, and citrus fruits; psyllium and other fibre supplements may also be recommended (Jean, 2019). The mechanism whereby soluble fibre lowers cholesterol levels is unclear, although it is probably related to its ability to bind with cholesterol and bile acids in the gut, thereby removing them from circulation. Other factors may contribute as well, such as fermentation of fibre by bacteria in the colon, resulting in compounds that inhibit cholesterol synthesis.

Light to moderate alcohol intake (up to two drinks per day for men and one drink per day for women) is associated with reduced CHD risk, primarily because of its ability to raise HDL cholesterol levels and possibly because it helps prevent blood clot formation. Alcohol intake may help explain the so-called French paradox: heart disease rates in France are low despite a CHD risk profile comparable to that in the United States, where rates are relatively high. Wine also contains antioxidant compounds, such as resveratrol from grape skins, that may inhibit LDL oxidation, but the beneficial effect of these substances is likely far less than that of alcohol itself.

Mortality from stroke and heart disease is significantly associated with dietary sodium (salt) intake, but only in overweight individuals, who may have an increased sensitivity to dietary sodium. Sodium intake also appears to have a direct effect on risk of stroke beyond its effect on blood pressure, which itself influences stroke risk. On the other hand, diets rich in potassium are linked to reduced risk of stroke.

Soy foods are associated with decreased LDL and total blood cholesterol levels, as well as other vascular effects associated with reduced CHD risk. Tofu, tempeh, miso, soy flour, soy milk, and soy nuts are among the soy foods that contain isoflavones, estrogen-like compounds that are thought to be responsible for these beneficial cardiovascular effects (Jean, 2019). Antioxidant substances found in food and taken as dietary supplements include vitamin C, vitamin E, and beta-carotene (a plant precursor to vitamin A). Dietary antioxidants may lower CHD risk, although clinical trials have not yet supported this notion.

2.3.14. Other factors

For blood pressure that is equal to or greater than the “prehypertension” level of 120/80 millimetres of mercury (mm Hg), the more elevated the blood pressure, the greater the risk of heart disease. Hypertension (140/90 mm Hg and above) and atherosclerosis are mutually reinforcing: hypertension injures artery walls, thereby encouraging plaque formation; and once plaque has formed and arteries are less elastic, hypertension is aggravated. If hypertension is treated, the incidence of CHD, stroke, and congestive heart failure decreases.

Obesity is also an important factor in cardiovascular disease, primarily through its influence on other simultaneously present risk factors. Obese individuals often have an abnormal glucose tolerance and diabetes, hypertension, and blood lipoprotein abnormalities, including higher triglyceride levels and lower HDL cholesterol levels. Fat accumulation around the waist (the so-called apple shape) puts one at greater risk for premature heart disease than does fat accumulation around the hips (pear shape) (Jean, 2019). A waist circumference greater than 102 cm (40 inches) for men or 88 cm (35 inches) for women is considered a high risk. Besides helping to control weight, regular exercise is thought to decrease CHD risk in several ways:

slowing the progression of atherosclerosis, increasing the blood supply to the heart muscle, increasing HDL cholesterol, reducing VLDL levels, improving glucose tolerance, and reducing blood pressure. At a minimum, 30 minutes of moderate aerobic activity, such as brisk walking, on most days is recommended.

Diabetes—often accompanied by hypertension, high blood triglyceride levels, and obesity—is an important risk factor for heart disease and also warrants aggressive intervention (Jean, 2019). Furthermore, for people with diabetes who have a heart attack, there is an unusually high death rate, immediately or in the ensuing years. If blood glucose levels are strictly controlled, vascular complications will be decreased.

A newly described constellation of CHD risk factors called metabolic syndrome is marked by abdominal obesity, low HDL cholesterol, elevated blood triglycerides, high blood pressure, and insulin resistance. First named Syndrome X in 1988 by American endocrinologist Gerald Reaven, this condition is exacerbated when susceptible people eat high-carbohydrate diets. Individuals with metabolic syndrome benefit from regular physical activity and weight reduction, along with a diet lower in carbohydrates and saturated fat and higher in unsaturated fat.

Individuals with the genetic disease hereditary hemochromatosis excessively absorb iron, which can build up to dangerously high levels and damage the heart, liver, and other organs. Approximately 1 in 9 people of European descent are carriers (i.e., have one of two possible genes) for the disease and have an increased risk of heart disease. However, studies examining the possible role of dietary iron in heart disease risk for those who lack the gene for hemochromatosis have been inconclusive.

The amino acid homocysteine, when present in elevated amounts in blood, may damage arteries and promote atherosclerosis. Inadequate intake of vitamin B_6, vitamin B_{12}, or folic acid can increase blood homocysteine levels, although folic acid deficiency is the most common cause. While elevated homocysteine is not yet an established risk factor for CHD, it is prudent to ensure adequate intake of folic acid.

2.4. Food-Drug Interactions

Drugs may interfere with or enhance the utilization of nutrients, sometimes leading to imbalances. A common example is the increased loss of potassium that results from the use of certain diuretics to treat high blood pressure. Nutrient absorption can also be affected by drugs that change the acidity of the gastrointestinal tract, alter digestive function, or actually bind to nutrients. For example, regular use of laxatives, antacids, or mineral oil can reduce nutrient absorption and over time may lead to deficiency. Elderly individuals who take multiple medicines are particularly at risk of impaired nutritional status.

On the other hand, foods can alter drug absorption or interact with drugs in undesirable ways, resulting in drug ineffectiveness or toxicity. For example, protein and vitamin B_6 interfere with the effectiveness of levodopa, used to treat Parkinson disease. Tyramine, an amino-acid derivative found in certain aged cheeses and red wines, may cause hypertension in individuals being treated for depression with monoamine oxidase (MAO) inhibitors. Grapefruit juice contains unique substances that can block the breakdown of some drugs, thereby affecting their absorption and effectiveness. These drugs include certain cholesterol-lowering statins, calcium channel blockers, anticonvulsant agents, estrogen, antihistamines, protease inhibitors, immunosuppressants, antifungal drugs, and psychiatric medications. Eating grapefruit or

drinking grapefruit juice within a few hours or even a few days of taking these medications could result in unintended consequences.

Vitamin and mineral supplements and herbal products can also interact with medicines. For example, one or more of the supplemental antioxidants studied—vitamin C, vitamin E, beta-carotene, and selenium—may blunt the effectiveness of certain drugs (e.g., high-dose niacin, when used in combination with statins) in raising HDL cholesterol levels and improving cardiovascular health. Also, the herbal supplement St. John's wort can alter the metabolism of drugs such as protease inhibitors, anticlotting drugs, and antidepressants, and it can reduce the effectiveness of oral contraceptives.

2.5. Toxins in Foods

Edible skins of fruits and vegetables are rich in vitamins, minerals, and fibre; however, pesticide residues and other environmental contaminants are typically more plentiful in the outer layers of these foods. Pesticides also tend to accumulate in the fat and skin of animals. Intake of toxic substances is reduced by consuming a wide variety of foods; washing fruits and vegetables carefully; and trimming fat from meat and poultry and removing skin from poultry and fish. Even organic produce requires thorough washing: it may not have synthetic chemicals, but mold, rot, fecal matter or other natural substances can contaminate it at any point from field to market. Peeling helps reduce these unwanted chemicals and microbes, although valuable nutrients will be lost as well (Jean, 2019). Wastes should be properly managed to avoid their reintegration into the food cycle (Awuchi and Igwe, 2017).

A greenish tinge on potatoes, although merely the harmless substance chlorophyll, indicates that the natural toxicant solanine may be present. Solanine builds up when a potato is handled roughly, exposed to light or extremes of temperature, or is old. Symptoms of solanine poisoning include diarrhea, cramps, and headache, although many damaged potatoes would have to be eaten to cause serious illness (Jean, 2019). Peeling away green areas or removing sprouts or the entire skin (despite its high nutrient content) reduces solanine intake.

Swordfish and shark, as well as tuna steaks, may contain high levels of methylmercury (which remains after cooking) and should be avoided by pregnant women. Nonbacterial toxins in seafood include scombrotoxin (histamine) in spoiled fish, which can result in a severe allergic reaction when eaten (Jean, 2019); dinoflagellates (microscopic algae), associated with the so-called red tide, which can cause paralytic shellfish poisoning when consumed; and ciguatera, found in certain warm-water reef fish.

Natural toxins in some species of mushrooms cause symptoms ranging from gastrointestinal upset to neurological effects, even hallucinations. Most mushroom fatalities are due to consumption of amatoxins in *Amanita phalloides*, the mushroom species known as the death cap, which, if not lethal, can cause lasting liver and kidney damage. The lectins in foods are hemagglutinins (Udeogu and Awuchi, 2016). As there are no antidotes for mushroom poisoning, and identification of mushroom species by inexperienced mushroom pickers is often imprecise, consumption of wild mushrooms is not advised.

2.6. Botanicals and Functional Foods

Many herbal products show sufficient promise in preventing or treating disease that they are being tested in rigorous scientific studies, including clinical trials. However, the "botanicals" currently on the market in many countries are untested with regard to safety and efficacy, and consumers should approach their use in an informed and cautious way (Jean, 2019). Just as with pharmaceuticals, herbal products can have mild to severe side effects, and "natural" does not mean "safe." Furthermore, the amounts of active ingredients in supplements can vary widely and, according to laboratory analyses, the potency specified on labels is often inaccurate. Some preparations even contain none of the active ingredients listed on the label or may have unwanted contaminants.

Potentially dangerous herbal products include comfrey and kava, which can cause liver damage, and ephedra (ma huang), which has caused fatal reactions in some people, especially those with high blood pressure or heart disease. Because of possible complications, patients scheduled to undergo surgery or other medical procedures may be advised to discontinue certain supplements for days or even weeks before surgery. Safety and efficacy concerns also need to be addressed, as "designer foods" fortified with herbs and bioactive substances continue to proliferate (Jean, 2019).

The distinction between foods, dietary supplements, and drugs is already being blurred by the burgeoning market in so-called functional foods (such as cholesterol-lowering margarine), which aim to provide health benefits beyond mere nutrient value (Jean, 2019). Moreover, recent advances in molecular biology offer the possibility of using genetic profiles to determine unique nutrient requirements, thereby providing customized dietary recommendations to more effectively delay or prevent disease.

2.7. Food allergies and intolerances

A true food allergy involves an abnormal immunologic response to an otherwise harmless food component, usually a protein. In the case of antibody-mediated (immediate hypersensitivity) food allergies, within minutes or hours of exposure to the allergen, the body produces specific immunoglobulin E antibodies and releases chemical mediators such as histamine, resulting in gastrointestinal, skin, or respiratory symptoms ranging from mild to life-threatening. Much less common are cell-mediated (delayed hypersensitivity) food allergies, in which a localized inflammatory process and other symptoms may not start for up to a day (Jean, 2019). Adverse food reactions that do not involve the immune system, aside from foodborne infection or poisoning, are called food intolerances or sensitivities. Most common of these is lactose intolerance, which is a genetically determined deficiency of the enzyme lactase that is needed to digest the milk sugar, lactose.

Milk allergy and lactose intolerance are distinct conditions that are often confused. Only about 1 percent of the population has a true allergy to the protein in cow's milk. Milk allergy is found most often in infants, whose immune and digestive systems are immature. On the other hand, much of the world's population, except those of northern European descent, is to some degree lactose intolerant after early childhood. Undigested lactose reaching the large intestine can cause abdominal discomfort, flatulence, and diarrhea. Lactose-intolerant individuals can often handle with little or no discomfort small quantities of dairy products, especially yogurt or other milk products containing the bacterium *Lactobacillus acidophilus*; alternatives are the use of lactose-hydrolyzed milk products or lactase tablets or drops, which convert lactose to simple, digestible sugars (Jean, 2019).

Celiac disease (also known as celiac sprue, nontropical sprue, or gluten-sensitive enteropathy) is a hereditary disorder in which consumption of wheat gluten and related proteins from rye and barley is not tolerated. Recent studies indicate that oats may be safe if not contaminated with wheat (Jean, 2019). Celiac disease, which may be a type of cell-mediated food allergy, affects primarily individuals of European descent and rarely those of African or Asian descent. It is characterized by inflammatory damage to the mucosal cells lining the small intestine, leading to malabsorption of nutrients and such symptoms as diarrhea, fatigue, weight loss, bone pain, and neurological disturbances. Multiple nutritional deficiencies may ensue and, in children, growth is impaired. The disorder is often associated with autoimmune conditions, particularly autoimmune thyroid disease and type 1 diabetes. Although celiac disease can be life-threatening if untreated, patients can recover if gluten is eliminated from the diet.

Other adverse reactions to foods or beverages may be drug effects, such as those caused by caffeine or alcohol. Certain foods, such as ripened cheese, chocolate, red wine, and even ice cream, trigger headaches in some individuals. Food additives that can cause reactions in susceptible people include sulfite preservatives, used in some wines, dried fruits, and dried potato products; nitrate and nitrite preservatives, used in processed meats; certain food colorants, particularly tartrazine (also known as FD&C Yellow #5); and the flavour enhancer monosodium glutamate (MSG). Some adverse reactions to food are purely psychological and do not occur when the food is served in a disguised form (Jean, 2019).

Nearly any food has allergenic potential, but foods that most commonly cause antibody-mediated allergic reactions are cow's milk, eggs, wheat, fish, shellfish, soybeans, peanuts, and tree nuts (such as almonds, walnuts, and cashews). Depending on processing methods, edible oils and other products derived from these foods may still contain allergenic protein residues (Jean, 2019). Severely allergic people may react to extremely small amounts of an offending food, even inhaled vapours.

Studies differ significantly as to the percentage of adults and children who have true food allergies. However, most seem to agree that few adults (about 2 to 5 percent) and slightly more children (roughly 3 to 8 percent) are affected. Most children outgrow food allergies, particularly if the offending food is avoided for a year or two. However, food allergies can develop at any time, and some allergies, such as those to peanuts, tree nuts, and shellfish, may be lifelong (Jean, 2019). Common symptoms of antibody-mediated food allergy include tightening of the throat, swelling of the lips or tongue, itchy lips, wheezing, difficulty breathing, headache, nasal congestion, skin rash (eczema), hives, nausea, vomiting, stomach cramps, diarrhea and, in severe cases, life-threatening anaphylactic shock. People susceptible to anaphylaxis are advised to carry a syringe loaded with epinephrine at all times and to seek emergency medical care if an allergic reaction begins.

Food allergies are often hard to document, even by physicians trained in allergy and immunology. Blood tests for antibodies to specific allergens, skin tests, and even an elimination diet, in which suspect foods are eliminated from the diet and then added back one at a time, may not be definitive. The most conclusive diagnostic test is a so-called double-blind food challenge, in which neither doctor nor patient knows whether a suspect food or a harmless placebo is being given; however, these controlled clinical tests are expensive and time-consuming (Jean, 2019).

Labels are important for identifying hidden ingredients in packaged foods, although they are often imprecise and cannot be relied on naively (Jean, 2019). For example, even if a product is labeled as nondairy, a listing of casein, caseinate, or whey indicates the presence of milk

protein. Peanuts may be found in unlikely foods, such as chili, stew, processed meats, oils, flours, cream substitutes, and desserts.

Research has indicated that, at least in some instances, the severity of an allergy may be reduced through desensitization, in which a person is exposed over time to increasing amounts of the antigen to which he or she is allergic (Jean, 2019). Methods of desensitization differ; for example, allergy shots involve the injection of antigens, whereas sublingual immunotherapy involves small doses of antigen given as drops under the tongue. Sublingual immunotherapy in particular is considered a safe and effective means of building tolerance to food allergens.

2.8. Diets for healthy living

2.8.1. Raw Foodism

Raw foodism, also known as rawism or following a raw food diet, is the dietary practice of eating only or mostly food that is uncooked and unprocessed. Depending on the philosophy, or type of lifestyle and results desired, raw food diets may include a selection of fruits, vegetables, nuts, seeds, eggs, fish, meat, and dairy products (Wong, 2007). The diet may also include simply processed foods, such as various types of sprouted seeds, cheese, and fermented foods such as yogurts, kefir, kombucha, or sauerkraut, but generally not foods that have been pasteurized, homogenized, or produced with the use of synthetic pesticides, fertilizers, solvents, and food additives. Raw food diets are diets composed entirely or mostly of food that is uncooked or that is cooked at low temperatures.

Medical authorities have described raw foodism as a fad diet. Raw food diets, specifically raw veganism, fail to provide essential minerals and nutrients such as calcium, iron and protein. Claims held by raw food proponents are pseudoscientific (Fitzgerald, 2014).

2.8.2. Ketogenic diet

The ketogenic diet is a high-fat, adequate-protein, low-carbohydrate diet that in medicine is used primarily to treat difficult-to-control (refractory) epilepsy in children. The diet forces the body to burn fats rather than carbohydrates. Normally, the carbohydrates contained in food are converted into glucose, which is then transported around the body and is particularly important in fueling brain function. However, if little carbohydrate remains in the diet, the liver converts fat into fatty acids and ketone bodies. The ketone bodies pass into the brain and replace glucose as an energy source. An elevated level of ketone bodies in the blood, a state known as ketosis, leads to a reduction in the frequency of epileptic seizures. Around half of children and young people with epilepsy who have tried some form of this diet saw the number of seizures drop by at least half, and the effect persists even after discontinuing the diet (Martin-McGill *et al*., 2018). Some evidence indicates that adults with epilepsy may benefit from the diet, and that a less strict regimen, such as a modified Atkins diet, is similarly effective. Potential side effects may include constipation, high cholesterol, growth slowing, acidosis, and kidney stones.

The ketogenic (keto) diet, high in fat and low in carbs, can potentially change the way your body stores and uses energy, easing diabetes symptoms. With the keto diet, your body converts fat, instead of sugar, into energy. The diet was created in 1924 as a treatment for epilepsy, but the effects of this eating pattern are also being studied for type 2 diabetes. The ketogenic diet may improve blood glucose (sugar) levels while also reducing the need for insulin. However,

the diet does come with risks. The ketogenic diet has been studied for potential therapeutic use in various neurological disorders other than epilepsy: Alzheimer's disease (AD), amyotrophic lateral sclerosis (ALS), autism, headache, neurotrauma, pain, Parkinson's disease (PD) and sleep disorders (Gano *et al.*, 2014).

2.8.3. Healthy diet

A healthy diet is any diet that helps to improve or maintain overall health. Healthy diet provides the body with the essential nutrition: fluid, micronutrients, macronutrients, and adequate calories (Lean, 2015). A healthy diet is essential for nutrition and good health. It protects an individual against numerous chronic noncommunicable diseases, such as diabetes (especially type 2), heart disease, and cancer (WHO, 2019). Eating a variety of diets and consuming less salt, saturated and industrially-produced trans-fats, and sugars are essential for a healthy diet.

A healthy diet may contain whole grains, fruits, and vegetables, and includes little or no processed foods and sweetened beverages. Requirements for a healthy diet may be met from a variety of animal-based and plant-based foods, though a non-animal source of the vitamin B12 is required for those following a vegan diet (Melina *et al.*, 2016). Various nutrition guides are published by the governmental, medical, and nutritional institutions to educate people on what to be eating to be healthy. The nutrition facts labels are also compulsory in many countries to allow the consumers to choose foods based on components relevant to health, rather than just merely satisfying their appetite.

The World Health Organization makes the following 5 recommendations with respect to both individuals and populations: (WHO, 2019)

1. Eat at least 400 g of fruits and vegetables per day (cassava, potatoes, sweet potatoes, and other starchy root crops do not count). A healthy diet also contains legumes (for example, beans, lentils), whole grains and nuts.
2. Limit intake of fats. Less than 30% of total calories should come from fat. Prefer unsaturated fats to saturated fats. Shun trans fats.
3. Limit the intake of the simple sugars to below 10% of calorie (below 25 grams or below 5% of calories per day may even be better).
4. Limit sodium and salt from all sources and make sure that salt is iodized. Below 5 g of salt per day have been shown to reduce the risks of cardiovascular diseases.
5. Maintain a healthy weight by consuming roughly the same number of calories the body is using.

Table 3: The three healthy patterns

Food group/subgroup (units)	U.S. style	Med-style	Vegetarian

Fruits (cup equivalent, eq)	2	2.5	2
Vegetables (cup eq)	2.5	2.5	2.5
Dark green	1.5 per week	1.5 per week	1.5 per week
Red/orange	5.5 per week	5.5 per week	5.5 per week
Starchy	5 per week	5 per week	5 per week
Legumes	1.5 per week	1.5 per week	3 per week
Others	4 per week	4 per week	4 per week
Grains (ozeq)	6	6	6.5
Whole	3	3	3.5
Refined	3	3	3
Dairy (cup eq)	3	2	3
Protein Foods (ozeq)	5.5	6.5	3.5
Meat (red and processed)	12.5 per week	12.5 per week	--
Poultry	10.5 per week	10.5 per week	--
Seafood	8 per week	15 per week	--
Eggs	3 per week	3 per week	3 per week
Nuts/seeds	4 per week	4 per week	7 per week
Processed Soy (including tofu)	0.5 per week	0.5 per week	8 per week
Oils (g)	27	27	27
Solid fats limit (g)	18	17	21
Added sugars limit (g)	30	29	36

USDA and the US Department of Health and Human Services (2015).

2.8.4. Low-fat diet

A low-fat diet is a diet that restricts fats, and often cholesterol and saturated fat as well. Low-fat foods are intended to reduce occurrence of conditions such as heart diseases and obesity, which increases the risks of diabetes and can worsen diabetes in already diabetic patients. For weight loss, low-fat diets perform similarly to low-carbohydrate diets, since macronutrients compositions do not determine weight loss success (Schwartz *et al.*, 2017). Fat provides 9 calories/g while carbohydrates and protein each provide 4 caloriee/g. The Institute of Medicine recommends restricting fat intake to 35% or less of total calories to control the intake of saturated fat (Makris and Foster, 2002). Although low fats may affect the functional properties of foods (Awuchi *et al.*, 2019; Awuchi, 2019b), restricting fats intake within the recommended limit is required for healthy living and managing diabetes.

According to the *National Academies Press*, high-fat diet often contains unacceptably high amounts of saturated fats, even if saturated fats from tropical oils and animal products are avoided. This is due to all fats contain some levels of saturated fatty acids. For instance, if an individual chose fats with 20% saturated fatty acids, the setting of fat intake at 35% of the total calories mean that 7% of the calories would come from the saturated fat. For this reason, Institute of Medicine and many nutritional institutions recommend consuming not more than 35% of the calories from fat (Food and nutrition board, the institute of medicine of national academies, 2005).Low-fat diets have been promoted to prevent heart disease and obesity. Lowering fat intake from 35 to 40% of total calories to 15 to 20% of total calories has shown to reduce total and LDL cholesterol by 10 – 20%; however, most of this reduction is due to a decrease in saturated fat intake (Lichtenstein and Van Horn, 1998).

2.8.5. Paleolithic diet

The Paleolithic diet, caveman diet, stone-age diet, or Paleo diet is a modern fad dietrequiring sole or predominant consumption of foods acknowledged to have been available to human during the Paleolithic era (Tarantino *et al.*, 2015). The digestive abilities of the anatomically modern humans, however, are, to a large extent, different from those of the pre-*Homo sapiens* humans, and has been used to criticize the core premise of the diet (Zuk, 2013).While there is wide variation in the way the paleo diet is interpreted (Katz and Meller, 2014), the diet typically includes vegetables, fruits, nuts, roots, and meat and typically excludes foods such as sugar, processed oils, salt, alcohol, etc. The diet is based on avoiding not just processed foods, but rather the foods that humans began eating after the Neolithic Revolution when humans transitioned from hunter-gatherer lifestyles to settled agriculture (Tarantino *et al.*, 2015).

The scientific literature generally uses the term "Paleo nutrition pattern", which has been variously described as:

- "vegetables, fruits, nuts, roots, meat, and organ meats";
- "vegetables (including root vegetables), fruit (including fruit oils, e.g., olive oil, coconut oil, and palm oil), nuts, fish, meat, and eggs, and it excluded dairy, grain-based foods, legumes, extra sugar, and nutritional products of industry (including refined fats and refined carbohydrates)"; and
- "avoids processed foods, and emphasizes eating vegetables, fruits, nuts and seeds, eggs, and lean meats" (Katz and Meller, 2014).

As of 2016 there are limited data on the metabolic effects on humans eating a paleo diet, but the data are based on clinical trials that have been too small to have a statistical significance sufficient to allow the drawing of generalizations (Tarantino *et al.*, 2015; Katz and Meller, 2014). These preliminary trials have found that participants eating a paleo nutrition pattern had better measures of cardiovascular and metabolic health than people eating a standard diet (Tarantino *et al.*, 2015; Manheimer *et al.*, 2015), though the evidence is not strong enough to recommend the paleo diet for treatment of metabolic syndrome (Manheimer *et al.*, 2015). As of 2014 there was no evidence the paleo diet is effective in treating inflammatory bowel disease (Hou *et al.*, 2014).

2.8.6. Low-carbohydrate diets (carbohydrate-restricted diets)

Low-carbohydrate diets or carbohydrate-restricted diets (CRDs) are diets that restrict carbohydrate consumption relative to the average diet. Foods high in carbohydrates (e.g., sugar, bread, pasta) are limited, and replaced with foods containing a higher percentage of fat and protein (e.g., meat, poultry, fish, shellfish, eggs, cheese, nuts, and seeds), as well as low carbohydrate foods (e.g. spinach, kale, chard, collards, and other fibrous vegetables). There is a lack of standardization of how much carbohydrate low-carbohydrate diets must have, and this has complicated research (Seckold *et al.*, 2018). One definition, from the American Academy of Family Physicians, specifies low-carbohydrate diets as having less than 20% carbohydrate content (Last and Wilson, 2006).

There is no good evidence that low-carbohydrate dieting confers any particular health benefits, apart for weight loss where loss low-carbohydrate diets achieve similar outcomes to other diets as weight loss is mainly determined by calorie restriction and adherence (Thom and Lean, 2017). An extreme form of low-carbohydrate diet – the ketogenic diet – is established as a medical diet for treating epilepsy (British Dietetic Association, 2017). Through celebrity endorsement it has become a popular weight-loss fad diet, but there is no evidence of any distinctive benefit for this purpose, and it may have a number of initial side effects (British

Dietetic Association, 2017). The British Dietetic Association named it one of the "top 5 worst celeb diets to avoid in 2018" (British Dietetic Association, 2017).

There is little evidence for the effectiveness of low-carbohydrate diets for people with type 1 diabetes (Seckold *et al*., 2018). For certain individuals, it may be feasible to follow a low-carbohydrate regime combined with carefully-managed insulin dosing, this can be hard to maintain and there are concerns about potential adverse health effects caused by the diet (Seckold *et al*., 2018). In general, people with type 1 diabetes are advised to follow an individualized eating plan (Seckold *et al*., 2018).

The proportion of carbohydrate in a diet is not linked to the risk of type 2 diabetes, although there is some evidence that diets containing certain high-carbohydrate items – such as sugar-sweetened drinks or white rice – are associated with an increased risk (Public Health England, 2015). Some evidence indicates that consuming fewer carbohydrate foods may reduce biomarkers of type 2 diabetes (Meng *et al*., 2017; van Zuuren *et al*., 2018).

A 2018 report on type 2 diabetes by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) found that a low-carbohydrate diet may not be as good as a Mediterranean diet for improving glycemic control, and that although having a healthy body weight is important, "there is no single ratio of carbohydrate, proteins, and fat intake that is optimal for every person with type 2 diabetes" (Davies *et al*., 2018). There is no good evidence that low-carbohydrate diets are better than a conventional healthy diet, in which carbohydrates typically account for more than 40% of calories consumed (Brouns, 2018). Low-carbohydrate dieting has no effect on the kidney function of people who have type 2 diabetes (Suyoto, 2018).

Limiting carbohydrate consumption generally results in improved glucose control, although without long-term weight loss (Meng *et al.,* 2017). Low-carbohydrate diets can be useful to help people with type 2 diabetes lose weight, but "no single approach has been proven to be consistently superior" (American Diabetes Association Professional Practice Committee, 2019). According to the ADA, people with diabetes should be "developing healthy eating patterns rather than focusing on individual macronutrients, micronutrients, or single foods". They recommended that the carbohydrates in a diet should come from "vegetables, legumes, fruits, dairy (milk and yogurt), and whole grains", while highly-refined foods and sugary drinks should be avoided (American Diabetes Association Professional Practice Committee, 2019). The ADA also wrote that "reducing overall carbohydrate intake for individuals with diabetes has demonstrated the most evidence for improving glycemia and may be applied in a variety of eating patterns that meet individual needs and preferences", and for individuals with type 2 diabetes who can't meet the glycemic targets or where reducing anti-glycemic medications is a priority, low or very-low carbohydrate diets are a viable approach (Evert et al., 2019).

2.8.7. Very-low-calorie diet (VLCD)

A very-low-calorie diet (VLCD), also known as semistarvation diet and crash diet (Bonet, 2018), is a type of fad diet with very or extremely low daily food energy consumption. It is defined as a diet of 800 kilocalories (3,300 kJ) per day or less (Thorell *et al*., 2016; Holderbaum *et al*., 2018). Modern medically supervised VLCDs use total meal replacements, with regulated formulations in Europe and Canada which contain the recommended daily requirements for vitamins, minerals, trace elements, fatty acids, protein and electrolyte balance. Carbohydrates may be entirely absent, or substituted for a portion of the protein; this choice has important metabolic effects. Medically supervised VLCDs have specific therapeutic applications for rapid weight loss, such as in morbid obesity or before a bariatric surgery, using

formulated, nutritionally complete liquid meals containing 800 kilocalories or less per day for a maximum of 12 weeks (Thorell *et al.*, 2016). Unmonitored VLCDs with insufficient macronutrient and mineral intake have the potential to cause an electrolyte imbalance and sudden death via ventricular tachycardia either by starvation or upon refeeding (Sours *et al.*, 1981).

3. Conclusion

Nutritional disease, any of the nutrient-related diseases and conditions that cause illness in humans; they may include deficiencies or excesses in the diet, obesity and eating disorders, and chronic diseases such as protein-energy malnutrition (Kwashiorkor and marasmus), cardiovascular disease, hypertension, cancer (colorectal cancer, prostate cancer, breast cancer), diabetes mellitus. Others are gastroesophageal reflux disease, heartburn and peptic ulcer, diverticulitis (diverticulosis), constipation, diarrhea, Crohn disease (regional ileitis), ulcerative colitis, food Allergies and Intolerances,foodborne Illnesses,etc. Nutritional diseases also include developmental abnormalities that can be prevented by diet, hereditary metabolic disorders that respond to dietary treatment, the interaction of foods and nutrients with drugs, food allergies and intolerances, and potential hazards in the food supply. The deficiencies of micronutrients are the cause of some diseases, and also exacerbate others and are recognized as having an important impact on worldwide health. Important micronutrients include iodine, iron, zinc, calcium, selenium, fluorine, potassium, etc., and vitamins A, D, E, B_6, B_{12}, B_1, B_2, B_3, C, among others. Deficiencies of essential vitamins or minerals such as Vitamin A, iron, and zinc may be caused by long-term shortages of nutritious food or by infections such as intestinal worms. They may also be caused or exacerbated when illnesses (such as diarrhoea or malaria) cause rapid loss of nutrients through feces or vomit. Dehydration (Water deficiency) may develop if water consumption fails to satisfy thirst; if the thirst mechanism is not functioning properly, as during intense physical exercise; or if there is excessive fluid loss, as with diarrhea or vomiting. The need for each nutrient falls within a safe or desirable range, above which there is a risk of adverse effects. Any nutrient, even water, can be toxic if taken in very large quantities. Overdoses of certain nutrients, such as iron, can cause poisoning (acute toxicity) and even death. For most nutrients, habitual excess intake poses a risk of adverse health effects (chronic toxicity). Sustained overconsumption of the calorie-yielding nutrients (carbohydrate, fat, and protein) and alcohol increases the risk of obesity and specific chronic diseases, and use of isolated amino acids can lead to imbalances and toxicities. However, for most individuals, the risk of harm due to excess intake of vitamins or minerals in food is low. Because they can be stored in the liver and fatty tissue, fat-soluble vitamins, particularly vitamins A and D, have more potential for toxicity than do water-soluble vitamins, which, with the exception of vitamin B_{12}, are readily excreted in the urine if taken in excess. A desirable dietary intake of the minerals generally falls in a fairly narrow range. Because of interactions, a high intake of one mineral may adversely affect the absorption or utilization of another. Excessive intake from food alone is unlikely, but consumption of fortified foods or supplements increases the chance of toxicity. Furthermore, environmental or occupational exposure to potentially toxic levels of minerals presents additional risks for certain populations. The acute effects of a large intake of alcohol are well known. Mental impairment starts when the blood concentration is about 0.05 percent. A concentration of alcohol in the blood of 0.40 percent usually causes unconsciousness, and 0.50 percent can be fatal. Accidents and violence, which are often alcohol-related, are major causes of death for young persons. Women who drink during pregnancy risk physical and mental damage to their babies (fetal alcohol syndrome). Alcohol also can interact dangerously with a variety of medications, such as

tranquilizers, antidepressants, and pain relievers. Although plaque formation starts in childhood, infants or children under two years of age should not have any dietary restriction placed on cholesterol and fat. After age two, dietary recommendations to reduce Coronary heart disease (CHD) risk generally focus on controlling intake of total fat, saturated and *trans*-fatty acids, and dietary cholesterol, combined with physical activity and weight management. Since atherosclerosis is so common, such diets are considered useful not only for the general public but also for people with high LDL cholesterol or other CHD risk factors. A preventive diet for adults might include 20 to 35 percent of kilocalories as dietary fat, with low intake of saturated and *trans*-fatty acids (no more than 10 percent of kilocalories), and cholesterol intake below 300 mg daily. A therapeutic diet, which should be managed by a registered dietitian or other qualified nutrition professional, is even more restrictive. Obesity (excess body fat for stature) contributes to adverse health consequences such as high blood pressure, blood lipid abnormalities, coronary heart disease, congestive heart failure, ischemic stroke, type 2 diabetes, gallbladder disease, osteoarthritis, several common cancers (including colorectal, uterine, and postmenopausal breast cancers), and reduced life expectancy. What matters most in weight control is the ratio of food energy (calories) consumed to energy expended, over time. A healthful eating plan for gradual weight loss in adults will likely contain about 1,200 to 1,500 kilocalories (kcal) per day, probably accompanied by a balanced vitamin and mineral supplement. Individuals who are severely obese and unable to lose weight may, after medical consultation, consider weight-loss medications that suppress appetite or decrease nutrient absorption or even surgery to reduce the volume of the stomach or bypass it altogether. Eating disorders such as anorexia nervosa and bulimia nervosa are serious health problems reflecting an undue concern with body weight. Girls and young women are most vulnerable to the pressures of society to be thin, although boys and men can also fall prey to these disorders, which have lifelong consequences and can even be fatal. All dietary forms of sugar, including honey, molasses, brown sugar, and corn syrup, can cause tooth decay, dental caries; fermentable carbohydrates in crackers, breads, cereals, and other grain products, as well as milk, fruits, and fruit juices, also have cariogenic (decay-causing) potential. Eating sugary or starchy foods between meals, especially sticky foods that stay on the teeth longer, increases the time that teeth are exposed to destructive acids. Fluoride is extremely effective at protecting tooth enamel from decay, especially while enamel is being formed in the jaws before the permanent teeth erupt. Fluoridation of water in communities where fluoride is not naturally high is a safe and effective public health measure. Most cases of foodborne illness are caused by bacteria and the toxins they produce. *Campylobacter jejuni*, found in raw or undercooked foods of animal origin, especially poultry, is responsible for more diarrheal illness throughout the world than any other bacterium. Travelers' diarrhea is often caused by specific types of *Escherichia coli* bacteria, while other *E. coli* types cause much of the diarrhea in infants, particularly during weaning, in developing countries. Many herbal products show sufficient promise in preventing or treating disease that they are being tested in rigorous scientific studies, including clinical trials. Maintaining a healthy diet, low-fat diet, low-calorie diet, paleolithic diet, very low carbohydrate diet, raw foodism, and/or ketogenic diet, in addition to proper food hygiene, can help prevent the risks of nutritional diseases, foodborne illnesses, and nutrient toxicities.

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