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# Nutrigenomics and Nutraceuticals

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## CHAPTER 4

# ADVANCES IN FOOD AND NUTRITION RESEARCH

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**ABSTRACT**

Food and nutritional research are one among the most popular, efficient, and cost-effective methods for decreasing the problem of noncommunicable diseases (NCD) and their risk factors, such as nutritional deficits. The dietary research is crucial to learning more about the reasons of obesity and its comorbidities, and so it has the potential to have a significant impact on world health and the economy. Antioxidant (Singh et al., 2017a) characteristics in many functional foods, often recognized as common foods with health advantages beyond their nutritional value, can moderate the degenerative processes of aging. Most countries suffer from malnutrition and noncommunicable diseases, but there are no globally accepted standards for determining dietary superiority in populations and subgroups. Different nutritional assessment methods are used, such as domestic food production (Level 1), total food availability (Level 2), and household measurements

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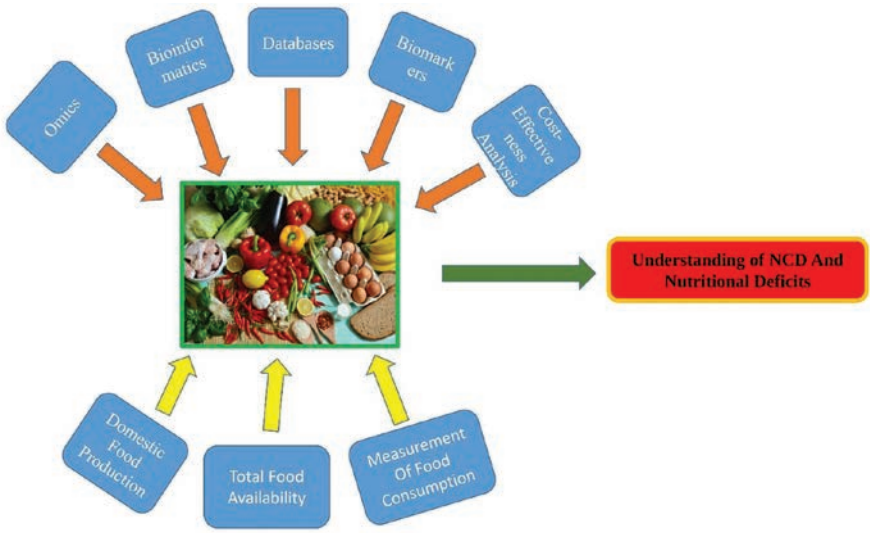
(Levels 3 and 4). Quantity of food ingesting in individuals (Level 5) is used. Omics, bioinformatics, records, biomarkers, and cost-effectiveness analysis are also key tools for the upgrading of nourishment research, according to the American Society for Nutrition (ASN). Microarray and nanotechnology are two developing technologies that have the potential to promote nutrition research by supporting in the discovery, progress, as well as delivery of a variety of intervention techniques to improve health and minimize the risk and complications of a variety of diseases. The study's key finding is that human health requires enough nourishment daily. Previous studies and review papers have found that both forms of malnutrition such as under nutrition and over nutrition are harmful to one's health.

## Graphical Abstract




## 4.1 INTRODUCTION

Developments in Food and Nutrition Research identify the essential connection amid the nutrition and dietary sciences (Keservani et al., 2010a; Keservani et al., 2010b; Keservani et al., 2020). Food is the source of nutrition. In the nutrition, body nurtures itself through transforming food into energy in addition to body components. Also, it includes exploiting food

for development, metabolism, and restoration of tissues, and encompasses ingestion, digestion, absorption, transport, assimilation into cells, and excretion. Good nutrition is dependent on an integrated supply of food. Foods obtained through plants and animals, and their major elements, are the principal sources of nutrition for humans (Ensminger, 1993). Nutrition is crucial for human and animal growth and development, and also for the prevention and treatment of numerous diseases. Moreover, nutrition is necessary for the conservation of better health and functionality. The foundations for healthy populations and thriving economies include research on interrelationships between nutrition and noncommunicable illnesses, nutritional composition, and nutrition monitoring. As a result, improvements in food and nutrition research are laying the groundwork for answers to bigger health-related challenges, allowing people to live healthier in addition to supplementary productive lives (Lawrence, 1964). Currently, the human populace is increasing at a breakneck speed consequently the Earth's capability to refill its own resources on a constant and dramatic basis. Recently, experts have developed radical procedures to increase food production and discover new ingredients. Also, experts design and construct innovative food structures, as well as integrate technology into the food system (Ehrlich, 1971; Henderson, 2018). The food and nutrition research is one among the most popular, successful, and cost-efficient approaches to minimize the impact of a variety of disorders and their related risk factors, such as obesity. Nutrition study is used to understand the origins of overweightness and its comorbidities, and so has the potential to have a significant impact on world health and economics (Surana et al., 2021; Ahire et al., 2020). Improved study will help us better understand and reduce the harmful consequences of both low and high nutrient intakes on disease progression and overall health. Research will aid in determining the optimal consumption of nutrients that are both necessary and not-necessary on their own and in combination with other nutrients in the diet. According to the American Society for Nutrition (ASN), omics, bioinformatics, databases, biomarkers, and cost-effectiveness analysis are key tools for advancing nutrition research (Skinner, 2012). New technologies such as microarray technology and nanotechnology are emerging to advance nutrition research and its ability to promote nutrition research by supporting in the research and development, and implementation of a variety of intervention techniques to improve health and minimize the risk and complications of a variety of diseases. Emerging technologies can help in several areas, including identifying the site of action for bioactive food components, discovering biomarkers that represent exposure, reaction,

and allergy to food and its components, and identifying new target delivery systems for improving health (Page, 2003; Muller, 2003). World Health Organization (WHO) had revealed that for the wellbeing and development, nutrition is the central aspect. Proper nutrition is attributed to healthier neonatal, kid, sturdier immunity, safer gravidity, and labor, a lesser risk of noncommunicable illnesses, and higher life expectancy (WHO, 2009; WHO, 2014). The consequences of nutritional deficiencies lead to causing malnutrition and under nutrition which are related to nutritional diseases. It can include obesity and eating disorders that are all caused by nutritional deficiencies or excesses, as well as chronic diseases like hypertension, cardiovascular disease, cancer, and diabetes mellitus. Malnourish condition is produced by inadequate food to encounter the energy requirements; weight loss, body fat waste, muscle wasting, and letdown to flourish are all signs. The majority of children resulted in the death from their mothers' low and unhealthy nutritional status, as well as lack of possibilities enacted by poverty. Under nutrition is a global problem that affects over 925 million people. Nutrient toxicity is another parameter that may affect human health (Elia, 2000). It entails consuming an extreme quantity of a nutrient such as iron, vitamin A, and may lead to occurrence of poisoning, acute toxicity, and even death in severe condition. Excessive intake of most nutrients can result in negative health effects or chronic toxicity. Overconsumption of calorie-producing foods (fat, carbohydrate, and protein) as well as alcohol raises the risk of obesity and chronic diseases (including the health hazards connected with obesity). The nutrient's need is in a safe range, and there is no risk of negative consequences if it is exceeded (Jorgensen, 2018; and Surana et al., 2021).

## 4.2 NUTRITION AND HEALTH

### *4.2.1 BASIC OF NUTRITION*

The term "Food" can be considered any edible substance which is essential for the nourishment of body or maintaining the physiological and anatomical functions of cells, tissues, or organ and which is directly reflected in system. The term nutrition may be defined as the method of taking and utilizing the food for proper physiological and anatomical functions of body. Plants are autrotrophs as they can produce their own foods by photosynthesis reactions whereas human and other animals are heterotrophs in respect to nutrition as they depend on plants or another animal.

Food and utilization of food, that is, nutrition can fulfill the following functions in living multi-cellular living system:

i. Growth and multiplication cells
ii. Energy production of cells
iii. Differentiation tissues and organ
iv. Adaptability to external environment
v. Maintenance of homoeostasis
vi. Synthesis of biochemical for growth, development, and communication with external environment
vii. In this book, we will only discuss the role of food and nutrition related to human subject not to other animals and plants.

### *4.2.2 ROLE OF DIET IN NUTRITION AND HEALTH*

Food includes **nutrients** and other ingredients which are essential for maintaining the physiological and anatomical functions of the body. **Diet** or different varieties of food consumed by individual human being play an important role in human health and physiological and anatomical function (Bendale, 2022). The human nutrition process involves the following stages:

**TABLE 4.1** Human Nutrition Process.

| Ingestion | Process of food taking in |
|---|---|
| **Digestion** | Process of breaking down of complex food material into simpler with the help of enzymes |
| **Absorption** | Process of entering and diffusion of simpler components of food in blood stream and required part |
| **Assimilation** | Incorporation of nonliving components of food in living protoplasm and utilization for energy production and other physiological purposes |
| **Metabolism** | Process of utilization of food for energy production |
| **Egestion** | Process of removal of residue left in the process of nutrition |

As we discussed, the role of nutrients or the components of food is essential for normal physiological and anatomical function of body, so a proper balanced diet is a fundamental requirement for every individual human life.

Living cell consists of mainly **protein (or amino acids), carbohydrate, and** fat (Singh et al., 2017b; Keservani et al., 2015), so for the structure and function of cells all 3 components or nutrients are required in large quantity in human diet and called **macronutrients. Vitamins and minerals** are

compulsory in less quantity for the functioning of cells so they are called **micronutrients.** Along with this sufficient quantity of water is essential for the role of cells. Nonstarch polysaccharide (NSP) or dietary fibers are important part of human diet for roughage production and should be present in Human diet.

### *4.2.3 NUTRITIONAL REQUIREMENT OF HEALTHY SUBJECT-MACRO AND MICRO NUTRIENTS*

For a healthy subject, healthy diet consumption is essential to prevent malnutrition and protect the body from different lifestyle-mediated diseases; macro- and micronutrients constituents of healthy diet are discussed as follows:

### *4.2.4 DIETARY FIBERS*

Dietary fibers are also known as roughage. Dietary fibers are components in plant meals that cannot be entirely broken down by human digestive enzymes, according to the British Nutrition Federation. In his article ‘‘Dietary ‘Fibre’ and Pregnancy Toxaemia,” Dr. Eben Hipsley developed the term “dietary fiber,” referring to dietary fiber (Keservani et al., 2020) as a nondigestible element of the plant cell wall. Dietary fibers are defined by the American Association of Cereal Chemists as the edible fraction of a plant or its equivalent (carbohydrates) that are resistant to absorption and digestion in the small intestine but can be thoroughly fermented in the large intestine.

According to European commission, carbohydrate polymers having three or more monomeric units are known as dietary fibers. In the small intestine, they are unable to be absorbed and digested.

Dietary fiber consists of:

- Carbohydrate polymers obtained from food raw material using a physical, chemical, or enzymatic approach;
- Carbohydrate polymers obtained from food raw material using a physical, chemical, or enzymatic technique;
- Synthetic carbohydrate polymers that have been shown in scientific studies to have a favorable physiological effect.

Dietary fibers include waxes, lignin, and nonstarch polysaccharides (NSP) such as cellulose and pectin. Some of the dietary fibers can be fermented

**TABLE 4.2** Macro Nutrients.

| Name of nutrient | Chemical nature | Dietary sources | Major role |
|---|---|---|---|
| Carbohydrate (energy value: **4 Kcal/g**) | Polyhydroxy aldehyde /ketone; monosaccharide (glucose, fructose) Disaccharide (sucrose) Polysaccharide (starch) | Monosaccharide: - fruits, vegetables, and honey Disaccharide: sugar and jaggery Polysaccharide: root vegetables, cereals, pulses | • Main source of energy • Spare proteins for body construction purpose • Ingredient of cell |
| Protein (energy value: **4 Kcal/g**) | Complex polymer of amino acids | Milk, fish, meat, and eggs; legumes and pulses | • Primary organizational and purposeful components of cell • Development, upkeep, and reparation of tissues • Essential for the creation of hormones, enzymes, antibodies, hemoglobin, etc. • Source of energy • Source of essential amino acids (not synthesized by human body) |
| Fats and Lipids (energy value: **9 Kcal/g**) | Triglycerides of fatty acids Compound phospholipid Derived lipid (Cholesterol) | Oils, butter, ghee, oil-seeds, nuts Meat, poultry, fish, eggs, and milk products | • Concentrated source of energy • Means of transportation for fat-soluble vitamins A, D, E, and K and carotenes, they also encourage their absorption • Sources of essential polyunsaturated fatty acids • Maintain body temperature • Reduce the use of proteins for energy • Protects certain vital organs |

**TABLE 4.3** Micronutrients.

**a. Minerals**

| Micronutrient | Major food source | Function |
|---|---|---|
| **Zinc** | Breast milk; meat; egg; seafood; cereals, whole-grain breads, and other grain products; legumes | Components of various enzyme systems |
| | | Helps in activity of enzymes |
| | | Stimulates insulin activity |
| | | Assists antioxidant enzymes |
| | | Boosts immunity |
| **Sodium** | Table salt | Regulates acid–base equilibrium |
| | | Upholds liquid and electrolyte equilibrium |
| | | Essential for appropriate nerve transmission and muscle retrenchment |
| **Calcium** | Breast milk, yogurt, cheese, paneer, tofu, fishes (sardines, salmon) | Bones and teeth; development and maintenance, essential in blood clotting; controls ions transmission across cell membranes; necessary in nerve transmission |
| **Iron** | Meat; legumes and pulses; whole-grain breads, cereals | Necessary for the establishment of hemoglobin and oxygen transportation; boosts resistance to infection |
| **Fluoride** | Fluorinated drinking water | Helps protect teeth against decay; helps in reducing bone loss |
| **Chloride** | Breast milk, sodium chloride (table salt) | Helps to adjust acid–base balance of body fluids |
| **Selenium** | Sea foods, whole-grain breads, cereals, grain products, meats, onions | Necessary to tissue respiration; connected with fat metabolism and vitamin E; used as an antioxidant |
| **Chromium** | Meat, whole-grain breads, cereals, and other fortified or enriched grain products | Essential for normal glucose metabolism |
| **Potassium** | Soy products; vegetables, fruits; meat; yogurt; potatoes; fish; poultry | Regulates acid–base equilibrium and osmotic pressure of body fluids; influences muscle activity, especially heart muscle |

**TABLE 4.3** *(Continued)*

| | | |
|---|---|---|
| **Copper** | Liver; kidney; poultry; legumes and pulses; whole-grain breads, cereals, and other grain products | Catalyzes the function of numerous enzymes and iron; important part of RNA, DNA |
| **Iodine** | Breast milk, seafood, iodized salt | Control thyroid hormones |
| **Phosphorus** | Breast milk; fishes; cheese; egg yolk; meat; poultry; fish; whole-grain breads, cereals, and other grain products; legumes | Constituents of bone and teeth; component of nucleic acids, phospholipids; as coenzyme functions in energy metabolism; buffers intra cellular fluid |

**b. Vitamins**

| Micronutrient | Major food source | Function |
|---|---|---|
| | **Fat-soluble vitamins** | |
| **Vitamin** A | Carrots, cod liver oil, tomatoes, pumpkin, green leafy vegetables, milk, butter, and egg | Maintains epithelial cell integrity; produces rhodopsin for low-light vision; and is required for wound healing, growth, and appropriate immunological function |
| **Vitamin** D | Sunlight, milk, cheese, butter, fish liver oil, green vegetables | It is required for appropriate bone development and enhances calcium and phosphorus absorption in the intestine |
| **Vitamin** E | Whole grains, nuts, seeds, leafy vegetables, vegetable oils, whole grains, butter, milk, nuts, seeds, spinach | Acts as an antioxidant in the tissues; acts as a coenzyme; neuromuscular function |
| **Vitamin K** | Soyabeans, cabbage, green leafy vegetables, spinach and cereals, cauliflower | Prothrombin production is catalyzed by this enzyme; it is also essential for the synthesis of other blood-clotting components |
| | **Water-soluble vitamins** | |
| **Vitamin C** | Citrus fruits, peppers, and tomatoes. | It is necessary for collagen production, iron absorption, and transport, and it is a water-soluble antioxidant |

**TABLE 4.3** *(Continued)*

| Micronutrient | Major food source | Function |
|---|---|---|
| | **Vitamin B complex** | |
| **VitaminB1 (Thiamine)** | Bread, nuts, cereals, and seeds, peas and beans | It combines with phosphorus to generate thiamin pyrophosphate (TPP), which is required for protein, carbohydrate, and fat metabolism; it is also vital for growth, appropriate appetite, digestion, and nerve function |
| **VitaminB2 (Riboflavin)** | Milk products, eggs, cereals, mushrooms, and almonds | Is essential for growth; has an enzymatic role in tissue respiration and operates as a hydrogen ion transporter; FMN and FAD production |
| **Vitamin B3 (niacin)** | Meat; fish; breast milk; poultry; whole-grain breads, cereals, and egg yolk | Aids in the release of energy from food and the maintenance of normal skin. It also aids in the correct functioning of the nervous system and the reduction of fatigue |
| **Vitamin B6 (Pyridoxine)** | Meat, fish, yeast extract, poultry, egg yolk, sesame seeds, soyabeans, some fruit, and vegetables | Helps to make red blood cells, which carry oxygen around the body. In the synthesis and break-down of amino acids and unsaturated fatty acids from essential fatty acids; essential for conversion of tryptophan to niacin; essential for normal growth |
| **VitaminB12 (Cobalamin, Cyanocobalamin)** | Breast milk, poultry, meat, fish, cheese, egg | Required for nucleic acid and nucleoprotein production, as well as RBC maturation and folate metabolism |
| **Folacin (Folate)** | Peas and beans, green leafy vegetables, oranges, berries | It is required for the appropriate maturation of RBCs and for the production of nucleic acids |
| **Pantothenic acid** | Meat; poultry; fish; egg yolk; legumes; vegetables | It is involved in the intermediate metabolism of glucose, fat, and protein |
| **Biotin** | Meat, yeast, egg yolk, bananas, vegetables, water melon, strawberries, grape fruit | Coenzyme carrier of carbon dioxide; plays a vital function in the metabolism of fatty acids and amino acids; essential component of enzymes; involved in reactions requiring the lengthening of carbon chains |

in the large intestine by gut bacteria, producing short chain fatty acids and gases like $CO_2$, methane, and hydrogen. Produced fatty acids are absorbed into the blood stream and provide a small amount of energy. The amount of gas produced depends on the type of fiber eaten and the gut bacteria present.

Dietary fibers are broadly categorized into the following 2 groups:

a. Water-insoluble/less fermented fibers
b. Water-soluble/well-fermented fibers

**a. Water-insoluble/less fermented fibers:** Water-insoluble fibers do not dissolve in water and are not digested by digestive enzymes. These mainly help in bulking of stool and quick easy passage of digestive tract. These are hemicellulose, cellulose, and lignins.

- **Cellulose:** Polysaccharides composed of up to 10,000 glucose units are organized linearly with a 1,4 glycosidic bond. Amylase is unable to break down cellulose. The fundamental structural component of the plant cell wall is cellulose. Concentrated alkali renders them insoluble, while concentrated acid renders them soluble. Grains, vegetables, fruit, nuts, and cereal bran are all good sources of cellulose in the diet.
- **Hemicellulose:** Hemicellulose is a type of polysaccharide found in cell walls that has a backbone of 1,4 glucosidic bonds. In dilute alkali, it dissolves. Cereal grains, vegetables, fruit, legumes (such as peas, beans, chickpeas, and lentils), and nuts are all good sources of iron.
- **Lignins:** Lignins are a non-carbohydrate component of the cell wall. Phenyl propane polymer with a complex cross-linking structure. These are resistant to bacterial degradation. Dietary source of lignins is foods with a woody component, for example, celery and the outer layers of cereal grains.

**b. Water-soluble/well-fermented fibers:** Soluble fibers dissolve in water and form a gel that binds the fecal matter and also prevent non-propulsive colon contraction. Gut bacteria digest soluble fibers successfully in the large intestine, creating short chain fatty acids and gases (methane, hydrogen, and CO2). Fatty acids enter the bloodstream and supply a tiny quantity of energy. The amount of gas produced is determined by the fiber type consumed as well as the presence of bacteria in the colon. Abdominal distension, pain, and wind are all symptoms of a highly

soluble fiber diet. Bacteria in the large intestine and intestine respond to increased intake with time, and symptoms normally subside (Bendale, 2022).

Examples of soluble fibers are pectin, gums, and mucilage.

- **Pectin:** D-galacturonic acid is one of the key ingredients and structural components of the walls of vegetable cells, and it also works as an intercellular cementing element in pectin. Pectin is a water-soluble, gel-forming substance. Fruits and vegetables, legumes, nuts, and potatoes are examples of dietary sources.
- **Gums and mucilage:** Nonstarch polysaccharides are thick gelling fibers that help maintain the walls of plant cells together. These are described to be very branched polysaccharides which form gels, bind water and other organic matters. Gums are sticky exudates formed in response to shock (i.e., gum arabic). They are mostly made from guar gum and gum Arabic. Guar gum is a galactomannan that is isolated from Cyamopsis tetragonolobus seed (guar). Partial enzymatic hydrolysis produces a product which can be used as a soluble dietary fiber. Mucilage is secreted in the endosperm of plant seeds and acts to prevent unnecessary dehydration. Leguminous seed plants (guar, locust bean), seaweed extracts (carrageenan, alginates), and microbial gums are all examples of gum (xanthan, gellaren). Examples of mucilages are gum acacia, gum tragacanth, gum karaya, gum tragacanth, and isapgul husk.

### *4.2.5 OTHER DIETARY FIBERS*

1. **Beta-glucans:** These are glucose polymers that have a branched structure obtained from cell wall of oats and barley.
2. **Resistant starch:** Starch and starch breakdown products that are not absorbed by the small intestine. Legumes, potatoes, and cereal grains are used to make this dish.
3. **Oligosaccharides:** 3-9 monomers make up a short chain carbohydrate. Onions, chicory, and Jerusalem artichokes contain fructo-oligosaccharides and galacto-oligosaccharides.

4. **Micro components** (waxes, cutin, and suberin): Dietary sources include cereal grain. The assessment of under nutrition requires various parameters that include nutritional intake, nutritional status, and functional indicators.

    - Nutritional intake: The adequacy of dietary calorie, protein, and micronutrient (vitamins and minerals) intake is determined by estimating the amount of food consumed. Individuals are classified as well-nourished or malnourished based on whether their food intake meets their macronutrient (energy, protein, and fat) and micronutrient requirements.
    - Nutritional status: To evaluate whether a person is well-nourished or undernourished, physiological, biochemical, or anthropometric variables are used. Growth in children and changes in body weight in adults are the most common and trustworthy assessments. Biochemical tests are also a viable option. Biochemical assessments alone, with the exception of particular cases such as iron deficiency anemia, are insufficient to determine deficient nutritional status; in general, they become aberrant only in advanced under nutrition.
    - Functional indicators: Most organ systems experience functional implications as a result of malnutrition, with detectable and occasionally quantitative impacts.

Research on food and nutrition is critical for their long-term security (Jorgensen, 2018). Global food security is achieved by the circular economy which is increasing effective exploitation of natural resources that have limiting food waste and loss and also, mitigating biodiversity loss, the circular economy, when included into the food chain, offers options to ensure universal food sustainability. In a repeated practice, the resources are consumed, lowering the requirement for fresh raw materials in food production. This effective usage of natural resources for food in a circular economy aids biodiversity recovery by limiting further conversion of natural habitats to agricultural land, which is a single leading cause of biodiversity loss. The problem of dropping food loss and waste needs a comprehensive understanding of what constitutes food loss and waste. Waste is theoretically nonexistent in a circular food system because it is employed as a feedstock for another cycle, resulting in a system that replicates natural regeneration (Merli, 2017).


**FIGURE 4.1** Approaches to decrease wastage of food in the food supply chain in a spherical food system (Valoppi, 2021).

*Source*: Adapted from Valoppi, 2021.

Better understanding of the specific nutritional science is still relatively new, despite the fact that food and nutrition have been studied for millennia. In 1926, less than 100 years ago, the first vitamin was extracted and chemically defined, kicking off a half-century of research into single-nutrient insufficiency disorders (Carpenter, 2003). Nutritional research on complex noncommunicable chronic diseases such as cardiovascular disease, diabetes, obesity, and cancer is even more recent, having surged in the previous two or three decades, notably around the year 2000. Many of the known important vitamins and minerals were identified and synthesized during the first two decades of the twentieth century, and they were used to prevent and cure nutritional deficiency-related disorders such as scurvy, beriberi, pellagra, rickets, xerophthalmia, and nutritional anemias (ACS, 2002). Casimir Funk proposed the concept of a "vital amine" in food in 1913, after noticing that the hull of raw rice protected birds against a beriberi-like disease. This "vital amine" or vitamin was initially identified in 1926 and given the name thiamine before being manufactured as vitamin B1 in 1936. Vitamin C was isolated and definitely shown to defend against scurvy for the first time in 1932 (Backstrand, 2002). Animal and human being studies established the nutritive origin of severe nutrient deficiencies, which led to the development

of dietary strategies to combat beriberi (Thiamin), pellagra (Niacin), scurvy (Ascorbic acid), pernicious anemia (Cobalamin), rickets (Cholecalciferol), and also additional deficit diseases. The chemical manufacture of vitamins, on the other hand, swiftly displaced food-based techniques in favor of treatment with specific nutritional supplements. This foreshadowed the contemporary use and promotion of individual and bundled multivitamins to prevent deficiency, beginning the vitamin supplement business as a whole (Bishai, 2002).

New research objectives in nutrition science are emerging, based on evidence for the diverse effects of various foods, processing methods, and eating patterns. These include the impact of certain fatty acids, flavonoids (Keservani and Sharma, 2014). To jointly address maternal fitness, child growth, infection hazard, and noncommunicable illnesses, comprehensive inquiry is essential for lower-income countries and populations (Mozaffarian, 2016; Mozaffarian, 2011).

## 4.3 METHODS

Various approaches can be used to check food supply and consumption. From national statistics to personal use, several strategies were used. Individual, home, and institution data can be integrated to create a regional or national level of consumption. Different nutritional assessment methods are used, such as domestic food production (level I), total food availability (level II), and household measurements (levels III and IV). Measurement of food consumption in individuals (level V) is used (Bingham 1987; Biró, 2002; Cameron, 1988; Bingham, 1991; Burke, 1947; Nelson, 1997).

**A. (Level I) Domestic food production**

Agriculturalists and food producers, such as farmers, are subject to the majority of government requirements under this strategy. They have to provide a report on how much food they produce. This is part of a longer-term food experiment that provides insight into food supply accessibility. It also includes information on food security in the countries as well as levels of agricultural self-sufficiency. It is useful for organizing food supplies, but not so much on its own. However, there is nothing like it as a completely self-sufficient country in practice. The quality of reporting varies depending on the country. Developed countries that have big farms and industrial development give extensive and accurate statistics data than developing countries.

**B. (Level II) Total food availability**

The UN's Food and Agriculture Organization (FAO) (FAOSTAT database 2013) is in charge of international hunger relief initiatives and provides data on food balance and consumption. The FAO's major mission is to encourage people to live active and healthy lives that ensure that everyone has access to food and security, as well as that people consume sufficient amounts of high-quality food on a regular basis. As shown in Figure 4.1 which shows balance sheet that is updated annually, it relates to any changes with respect to type of consumable food and the necessities of nutritional components in proper range. The first component of a food balance sheet, which is related to a country's food system, is production, imports, and stock movements in relation to food make up the domestic food supply. The second component is domestic food use, which includes feed, seed processing, waste, and food export. Per capita numbers, which include food commodity supply, are the third factor.

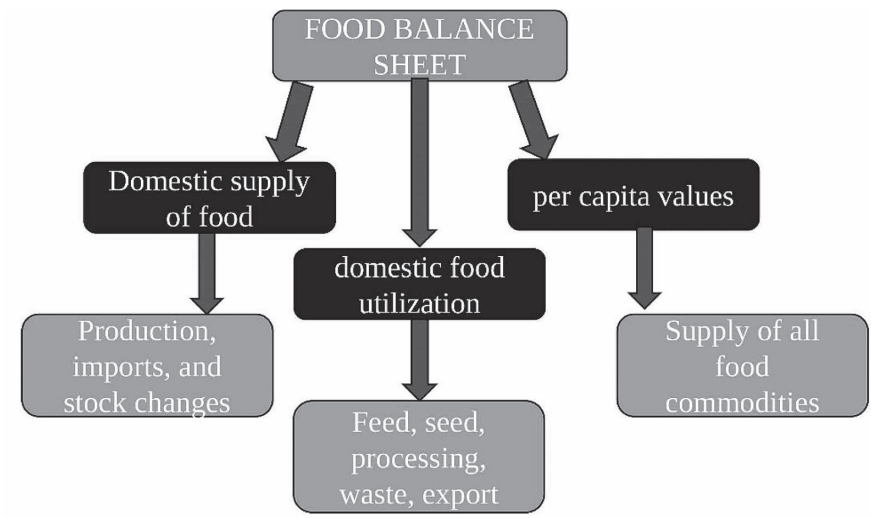



**FIGURE 4.2** Food balance sheet.

As per the data of balance sheet, it is helpful to monitor disease condition and healthy condition. In a recent study, the Global Dietary Database's nationally representative individual-based dietary surveys were compared to estimates published in FAO food balance sheets.

**C. Household measurements (Levels III and IV)**

At the domestic level to estimate food consumption four levels are used that are food accounting, inventories, household recall, and last one is the list recall are the basic methodologies.

- **Food Accounting Method**
  All household food purchases are properly recorded using this approach, either in terms of amount or cost, or both. Typically, no data on changes in storeroom stocks are obtained before or throughout the study period. Menu data can be used to assess the consumed diet percentage away from home. The proportion of consumed diet away from house can be estimated using menu records. Records of foods acquired and eaten away from home are also recorded. It is estimated that 5–10% of waste which is generated is fixed. Using appropriate consumption statistics such as food consumption data, the energy and nutritional composition of the household diet can also be assessed. Although variations in stocks are not occupied into consideration, it is thought that the average alteration across a large enough number of families is zero. The National Food Survey (NFS) (herc.ox.au, 2022) and the Family Expenditure Survey (FES) were combined in 2001 to establish the Expenditure and Food Survey (EFS). When the EFS became part of the Integrated Household Survey (HIS), which is maintained by the Office for National Statistics, it was renamed the Living Costs and Food Survey.

- **Inventory Method**
  The inventory strategy is like the food account method, in the same way that all food records that enter the house are generated by asking respondents. At the opening and the completion of the survey period inventories of stored food are collected. This technique was employed by the National Food Survey (NFS) previous to 1952, and it comprised the first survey of city working-class communities. The capacity of respondents to provide perfect inventory data is usually good. The method gives a precise estimate of how much food and nutrients are accessible for consumption in a given residence.

- **Household Records Method**
  The method is beneficial in countries where a substantial component of the food is prepared at home rather than bought or preprocessed**.** In this method record of household members food consumption is assessed. The total estimate is reduced by the amount of

food consumed by visitors. This method is a fusion of recall and recording methods. The interviewer usually by telephonic contacts in the morning, finds the household composition, and enquires the respondent to remember the amounts of diet used to make breakfast. At the time of launch the foods that will be used are measured in household procedures. An afternoon interview allows for the estimation of lunch waste in addition to the measurement and recording of ingredients for the evening meal. The method's shortcomings are comparable to those who belong to the food account method.

- **List recall Method**
  This method is based on a structured survey, in which particularly for a specific period generally for 1 week the respondent is asked to recollect the amount and charge of food purchased for household consumption. It considers not only food purchases and acquisitions, but also food consumption. Previously, the approach of this method was employed in the US Food Consumption Analysis. The technique is perfectly suitable to communities where the majority of food is bought rather than home-based. Food eaten away from home, food consumed by visitors, and food and nutrition distribution within households continue to be issues.

**D. Measurement of food consumption in individual Method (level V)**

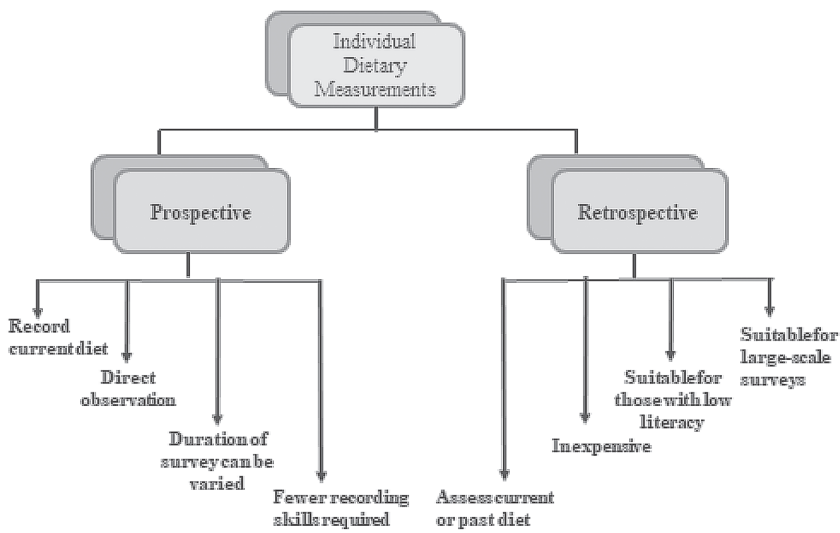



**FIGURE 4.3** Individual dietary measurements.

As shown in Figure 4.3, individual dietary assessment can be carried out by two methods like prospective and retrospective methods. Both are important as per the record of diet.

There are different techniques for prospective records that are used like: (1) weighed record, (2) unweighed record, (3) duplicate diet method, and (4) food checklist

## 4.4 TOOLS

According to the ASN (the American Society for Nutrition), there are several tools that are necessary for the improvement of nutrition research including (1) omics, (2) bioinformatics, (3) databases, (4) biomarkers, and (5) cost-effectiveness analysis.

- **Omics**—By using nutrigenetics and nutrigenomics research several nutrients interact by using genetic factor, proteins, and metabolites that will aid in defining an individual's health (Combs, 2013). Using genomics, individualized nutrient requirements, as well as how nutrients interact in the body are being studied. It will aid in the development of new nutritional and illness biomarkers, as well as determining and reflecting an individual's nutritional condition (Ohlhorst, 2013).
- **Bioinformatics**—It is a discipline of computer science that studies the information technology to create and improve tools for acquiring, storing, organizing, retrieving, and analyzing biological data. For managing and analyzing nutritional data nutrition researchers will use this. There is a correlation between nutrition and health with these techniques. Databases are necessary to gain the full benefits of bioinformatics since they make nutritional data readily accessible in a machine-readable way (Danielle, 2007).
- **Databases**—In this tool food and additional composition as well as ingestion data are linked. In this database, foods and their bioactive constituents, containing nonessential nutrients, are included. Improvement in data collection enhanced with accompaniments such as food intake photographic records, etc. (Praveen, 2019).
- **Biomarkers**—Individuals and subpopulations healthiness and dietary position determined and supervised via intake, outcome, also exposure biomarkers. For assessing development and management

of diseases these biomarkers used that response to diet and nutrition. Also, initial detection and prevention is possible (Dragsted, 2017). Development and validation to correctly track food and nutrient intake is possible if food supply is continually altered (Pico, 2019).

- **Cost-effectiveness analysis—**It is a method of computing and associating the relative costs plus profits of different nutrition research treatments. Cost-effectiveness analysis aids in determining the best cost-effective choice with the maximum public health advantage (Jaspreet, 2013).

## 4.5 CONCLUSION

Different nutritional assessment methods are used, such as domestic food production (Level I), total food availability (Level II), and household measurements (Levels III and IV). Measurement of food consumption in individuals (Level V) is used. Omics, bioinformatics, records, biomarkers, and cost-effectiveness analysis are also key instruments for the improvement of nutrition research, according to the American Society for Nutrition (ASN). Microarray and nanotechnology are two developing technologies that have the potential to promote nutrition research by supporting in the discovery, progress, and delivery of a variety of intervention techniques to improve health and minimize the risk and complications of a variety of diseases. The study's key finding is that human health requires enough nourishment daily. Previous studies and review papers have found that both forms of malnutrition such as under nutrition and over nutrition are harmful to one's health.

**KEYWORDS**

- **food**
- **nutrition**
- **noncommunicable disease**
- **health**
- **aging**
- **malnutrition**
- **assessment**

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